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March 16, 2018

British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC
V6Z 2N3

Attention: Mr. Patrick Wruck, Commission Secretary and Manager, Regulatory Support

Dear Mr. Wruck:

Re: British Columbia Utilities Commission (Commission) Inquiry into the Regulation of Electric Vehicle (EV) Charging Service (the Inquiry) ~ Project No. 1598941

FortisBC Inc. (FBC) Evidence

In accordance with Commission Order G-19-18 establishing the Regulatory Timetable for the above noted Inquiry, and amended by Commission letter dated March 1, 2018 (Exhibit A-6), FBC is pleased to file the attached Written Evidence in the above noted proceeding.

FBC welcomes the opportunity to review the potential regulatory issues with the Commission and interested stakeholders, and looks forward to participating in a constructive and forward-looking Inquiry process.

If further information is required, please contact the undersigned.

Sincerely,

FORTISBC INC.

Original signed:

Diane Roy

Attachments

cc (email only): Registered Parties

Before the British Columbia Utilities Commission

An Inquiry into the Regulation of Electric Vehicle Charging Service

Evidence of FortisBC Inc.

March 16, 2018

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1. INTRODUCTION

By Order G-19-18 the British Columbia Utilities Commission (BCUC or the Commission) established the preliminary scope and issues for an Inquiry into the Regulation of Electric Vehicle (EV) Charging Service (the Inquiry), and invited registered interveners to file evidence based on the preliminary scope of the Inquiry and on any other matters that may assist in the review of the Inquiry.

This FortisBC Inc. (FBC) submission is structured as follows:

Section 2: FBC Evidence

Section 3: FBC's Responses to Scope A Questions on the Basis for Regulation

Section 4: FBC's Responses to Scope B Questions on Rate Design and Rate Setting

Section 5: Other Matters

FBC believes that public utilities, non-utility participants and government have an important role to play in developing the market for public EV Charging Service and supporting the expansion of the use of EVs in BC. These entities are best positioned to support the growth in EV adoption, and in particular EV Charging infrastructure. In order to drive widespread EV adoption across all vehicle classes, easy access to charging infrastructure will be required.

2. FBC EVIDENCE

Before responding to the questions posed by the Commission in Exhibit A-1 of the Inquiry, FBC provides a summary of overarching considerations related to EVs and EV charging stations in BC as context to support topics raised in the scope of the Inquiry.

2.1 MARKET SHARE AND GROWTH

EV charging is a growing segment of energy use in BC and elsewhere in Canada, the United States and internationally. However, even with this growth and the currently existing subsidies provided by government, EVs are still projected to only comprise a small percentage of the total vehicles on the road even six years from now. For example, by 2024, BC is expected to have between 56,000 and 120,000 EVs on the road representing approximately 2.5 percent to 5.6 percent of vehicles on the road while Canada is estimated to have between 350,000 and 420,000 EVs representing approximately 1.8 percent to 2.1 percent of vehicles on the road. Based on annual EV Sales anticipated in 2024, this represents a 5.4 percent to 16 percent market share of new vehicle purchases in BC and a 3.7 percent to 4.6 percent market share of new vehicle purchases in Canada[1].

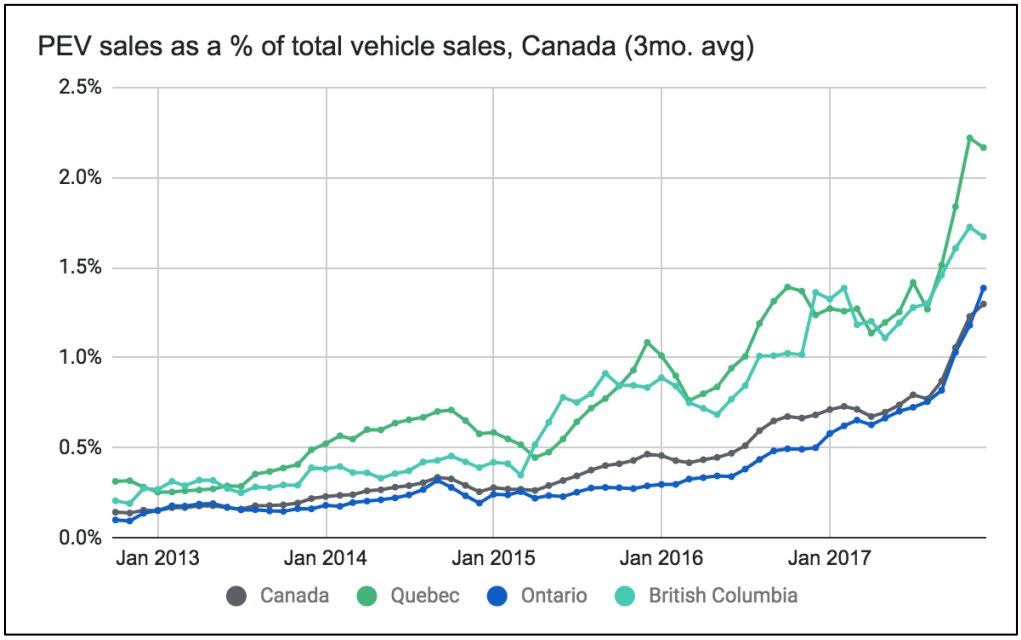
EV sales in 2017 were accelerated by an expanding lineup of fully electric vehicles.[2] A monthly breakdown of Canadian EV sales for the previous 5 years illustrates the growth of EV sales as a percentage of total vehicle sales. The figure below shows slower growth in 2013 and then an increasing total sales percentage each year.[3] While there has been an increase in the sale of EVs since 2013, at approximately 1.3 percent of total vehicle sales in 2017 for Canada and approximately 1.7 percent of total vehicle sales in 2017 for BC, EV sales still do not represent a significant portion of overall vehicle sales. Additional EV charging infrastructure is important in advancing the adoption of EVs in the province. Without adequate charging infrastructure deployed throughout the province, it is unlikely that the progression of EVs market share will progress quickly.

[1] Page 17-18, Table 1 and Table 2, EV Technology and Market Overview (Appendix 1). Powertech Labs Inc. were commissioned by the Township of Langley, Metro Vancouver and City of Abbotsford to develop this overview. Completed October 19, 2016.

[2] Page 13, 2017 Fleetcarma Summary of Electric Sales in Canada (Appendix 2)

[3] Page 17, 2017 Fleetcarma Summary of Electric Sales in Canada (Appendix 2)

Figure 2-1: PEV Sales as a Percentage of Total Vehicle Sales, Canada [4]



The EV market is growing in both absolute numbers of vehicles and the number of different models being offered by automakers[5]. The battery capacities of EVs and associated driving range on a full battery are also increasing with each year, in both previously available EV models and in new models coming to the market. However, Governments at both federal and provincial levels are involved in promoting EV adoption and public EV charging infrastructure through providing incentives and other support to EV purchasers and infrastructure developers. Based on the current and future projections of the market share and the number of EVs in BC, increased development of adequate charging infrastructure is essential to further develop the market for public EV Charging Service and support the expansion of the use of EVs in BC.

A summary of different types of EVs, levels of charging services currently available in BC, current rate and rate structures for EV charging service in BC, and the current regulatory framework of EV charging service in BC is provided below.

2.2 TYPES OF ELECTRIC VEHICLES [6]

EVs are a broad category of vehicle, which includes any vehicle charged by being plugged in (PEV) and includes plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles

[4] Appendix 3 (FBC's Application for Approval of Rate Design and Rates for EV Charging Service - the FBC EV Application) includes a 2016 EV Technology Report and Market Overview that provides an analysis of the growth in the number, type and technical specifications of EVs. The EV Technology Report and Market Overview is also included as Appendix 1 to this filing for ease of reference.

[5] Electric Vehicle Sales in Canada, 2017. Retrieved February 28, 2018 from https://www.fleetcarma.com/electric-vehicle-sales-canada-2017/

[6] Section 3.1, EV Technology and Market Overview (Appendix 1).

(BEVs). A BEV or fully electric car typically can travel up to 250 kilometres on a full charge, with some models capable of over 400 kilometres.[7] A PHEV will run on a battery for the extent of its electric range (typically under 100 kilometres[8]) until the battery is depleted, at which time the gasoline engine takes over for the remainder of the distance travelled until the battery is recharged.

2.3 TYPES OF EV CHARGING SERVICE

There are three levels of EV Charging Service that offer different amounts of power for charging EVs.[9]

Table 2-1: EV Charging Types

Type of Charging	Charging Level	Time to Charge	Vehicle Type	Typical Locations	Costs to Install
Level 1	AC (120 volt)	Four hours for 30 minutes of driving	PHEV or BEV	Residences, some public	$200-$2,000
Level 2	AC (240 volt)	Four hours for full charge	PHEV or BEV	Residences, Municipal locations, office towers, parks, recreational facilities, shopping malls	$1,000 - $2,500
Level 3	Direct Current Fast Charging (DCFC)	30 – 60 minutes for full charge	BEV only	Highway corridors	$50,000 - $100,000

FBC notes that there are still relatively few charging stations in BC, and particularly Level 3 stations. The Commission's Frequently Asked Questions document in the EV Charging Service Inquiry notes that there are about 1,000 public EV charging stations in BC. A report by Mogile Technologies Inc. (the Mogile Report) documenting the number and range of rates for Level 2 and DCFC stations across Canada is included as Appendix 4. It identifies a number of Level 2 and Level 3 DCFC charging locations in BC and across Canada. FBC has summarized the information in Table 2-2 below, noting that each EV charging location may have multiple stations and/or ports.

[7] PlugNdrive Electric Cars Available in Canada. Retrieved March 2, 2018 from https://www.plugndrive.ca/electric-cars-available-in-canada/

[8] PlugNdrive Electric Cars Available in Canada. Retrieved March 2, 2018 from https://plugndrive.ca/electric-cars-available-in-canada

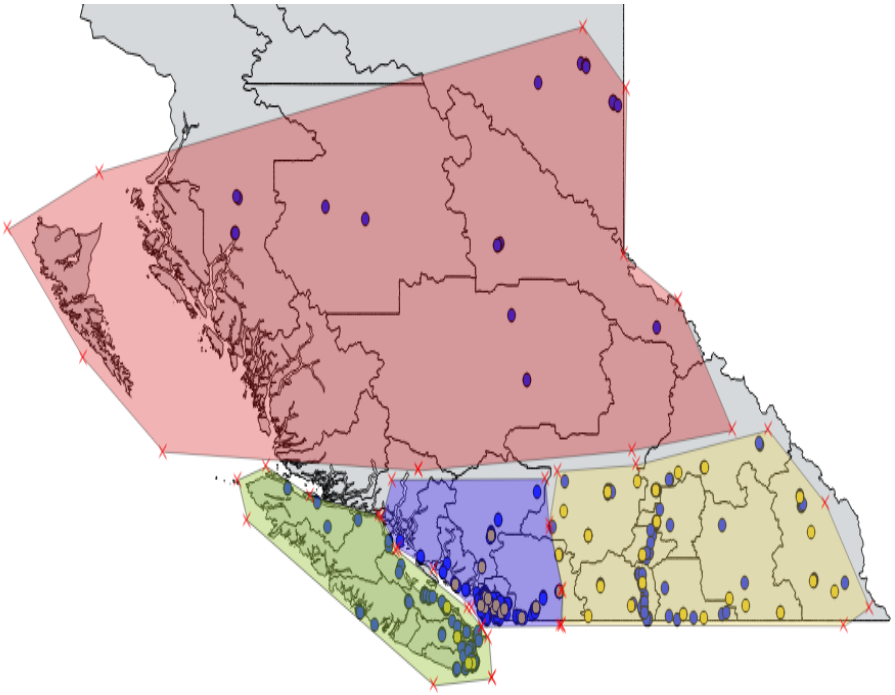
[9] Fleet Carma Electric Vehicle Charging Guide. Retrieved November 24, 2017 from https://www.fleetcarma.com/electric-vehicle-charging-guide/

Table 2-2: EV Charging Station Types in BC[10]

Type of Charging	# of Locations	# of Ports
Level 2	532	940
Level 3	42	43
Total	574	983

Further, there are some areas of the province where little or no EV Charging stations exist. Figure 2-2 below reflects the location, number and type of charging stations in BC. Blue dots represent Level 2 locations; yellow dots represent DCFC locations. As there are a limited number of Level 2 and Level 3 charging locations in the province and some areas with minimal or no charging stations, FBC sees a role for the utility, other entities and the various levels of government in developing the market.

Figure 2-2: Overview of Level 2 and DCFC Charging Locations in BC[11]



Most EV Charging today is free or near free, provided by governments, or one manufacturer (Tesla). Based on the current state of the EV market and projections for the near future, FBC believes that investment by both utilities and government is required to encourage growth.

[10] Excludes Tesla chargers
[11] A further breakout by region is provided in Figures 1 through 4 in the Mogile Report (Appendix 4).

2.4 VARIATION IN TECHNICAL SPECIFICATIONS

There were approximately 15 models of BEVs and 27 models of PHEVs available for purchase in Canada in 2017[12], each with different technical specifications for battery capacity, maximum AC charging rates and, if the EV model is capable of DCFC charging, models will have different maximum DC charging rates and be compatible with different DC Charging standards.

To demonstrate the range of driving distances per charge and charging specification of EVs, FBC has provided Table 2-3 below.

Table 2-3: 2016 Summary of Significant EV Models Currently Available in North America[13]

Model	Vehicle Type	Electric Range (EPA certified)	Battery Capacity	Max AC Charging Rate	DC Charging Standard Supported	Max DC Charging Rate
Nissan Leaf	BEV	135-172km	24-30kWh	6.6kW	CHAdeMO	50kW
Chevrolet Volt (2016)	EREV (PHEV)	85km	18.4kWh	3.6kW	-	-
Tesla Model S	BEV	351-507km	60-100kWh	19.2kW	Tesla SuperCharger, CHAdeMO (via adaptor)	135kW (Supercharger) 50kW (CHAdeMO)
Tesla Model X	BEV	381-465km	75-100kWh	19.2kW	Tesla Supercharger, CHAdeMO (w/ adaptor)	120kW, 50kW CHAdeMO
Toyota Prius Plug-in	PHEV	18km (blended – gas assist)	4.4kWh	3.3kW	-	-
BMW i3	BEV or EREV	130km	18.8kWh	7.4kW	CCS	50kW
Smart ED	BEV	109km	17kWh	3.3kW	-	-
Ford C-Max/Fusion Energi	PHEV	32km	7.6kWh	3.3kW	-	-
Chevrolet Spark EV	BEV	132km	21.3kWh	3.3kW	CCS	50kW
Kia Soul EV	BEV	150km	27kWh	6.6kW	CHAdeMO	100kW
Mitsubishi iMIEV	BEV	100km	16kWh	3.3kW	CHAdeMO	44kW
Ford Focus Electric	BEV	122km	23kWh	6.6kW	-	-
Volkswagen eGolf*	BEV	134km	26.5kWh	6.6kW	CCS	50kW

[12] Page 18, 2017 Fleetcarma EV Sales in Canada (Appendix 2).
[13] Table 6, EV Technology and Market Overview (Appendix 1).

The information provided above demonstrates that depending on what vehicle model is purchased, the charging rate, the distance travelled per charge, and options available to the EV owner for charging service will be different.

2.5 RATES FOR EV CHARGING SERVICE

Overall, the bulk of EV charging service is currently provided either free of charge or at a very low rate; most charging stations are providing a subsidy to the EV users that utilize them.

Table 2-4: EV Charging Rates in BC

Type of Charging	Number	Rate Description	Rate
Level 2 – Free of Charge/Unsure	1,105	No charge	N/A
Level 2 – Rate Charged	2	Session Based	$1.00 - $3.00 per session
Level 2 – Rate Charged	34	Time Based	$0.15 - $3.00 per hour (1 > $3.00)
Level 2 – Rate Charged	1	Usage Based	$0.15 - $0.35 per kWh
Level 3 – Free of charge/Unsure	13	No charge	N/A
Level 3 – Rate Charged	25	Usage Based	$0.18 - $0.35 per kWh (usually with a minimum charge)
Level 3 – Rate Charged	5	Time Based	$10 - $21 per hour[14]

With respect to free charging service, there is a misconception held by some that electric utility ratepayers are indirectly paying for the "free" EV charging service that is available to EV drivers at many locations in BC. Other than a few public utility-owned stations, the municipality, business or other organization providing "free" EV charging service pays for the grid electricity used at its EV charging facilities under an existing account with BC Hydro or FBC and absorbs these electricity costs, as well as the net capital[15] and operating costs of the EV charging facilities, as a cost of doing business, but does not attempt to recover these costs from EV charging station users (although parking rates may apply).

Currently in the province, there is a wide variation in rates for EV charging service and in many cases, the rate is free or subsidized.

[14] On an interim basis, the Commission approved a charge rate of $9.00/half hour for EV charging at five FBC DCFC stations in FBC's service territory on the Highway 3 corridor in southern BC. The City of Vancouver has received Council approval of a time-based charge of $16.00 per hour for DCFC charging plus the regular city parking rate at the location where the charger is situated, and $2.00 per hour for Level 2 charging plus the regular city parking rate at the location where the charger is situated. As FBC understands it, these time-based rates will be implemented in Vancouver in the coming months. A copy of the City of Vancouver report titled User Fees for City Owned and Operated Public Electric Vehicle Charging Stations (Vancouver Report) is included as Appendix 5.

[15] EV charging stations may have received grants or incentives that offset a portion of the full capital costs of the station.

2.6 CURRENT REGULATORY FRAMEWORK IN BC

The sale or resale of electricity for EV charging falls within the current definition of public utility activity in the Utilities Commission Act (the UCA).[16] The UCA definition of "public utility" is as follows:

> **"public utility"** means a person, or the person's lessee, trustee, receiver or liquidator, who owns or operates in British Columbia, equipment or facilities for
>
> (a) the production, generation, storage, transmission, sale, delivery or provision of electricity, natural gas, steam or any other agent for the production of light, heat, cold or power to or for the public or a corporation for compensation, or
>
> (b) the conveyance or transmission of information, messages or communications by guided or unguided electromagnetic waves, including systems of cable, microwave, optical fibre or radio communications if that service is offered to the public for compensation,
>
> but does not include
>
> (c) a municipality or regional district in respect of services provided by the municipality or regional district within its own boundaries,
>
> (d) a person not otherwise a public utility who provides the service or commodity only to the person or the person's employees or tenants, if the service or commodity is not resold to or used by others,
>
> (e) a person not otherwise a public utility who is engaged in the petroleum industry[17] or in the wellhead production of oil, natural gas or other natural petroleum substances,
>
> (f) a person not otherwise a public utility who is engaged in the production of a geothermal resource, as defined in the *Geothermal Resources Act*, or
>
> (g) a person, other than the authority, who enters into or is created by, under or in furtherance of an agreement designated under section 12 (9) of the *Hydro and Power Authority Act*, in respect of anything done, owned or operated under or in relation to that agreement;

As far as sale or resale of electricity for EV charging is concerned, the UCA definition, along with other sections of the UCA, means that:

[16] In the Bakerview Ecodairy Decisions G-71-16, the Commission determined that "With the $0.35 per kilowatt-hour fee for the provision of EV charging services to the public, EcoDairy's EV DCFC station will then be operating for resale of electricity to the public for compensation. It will therefore be a public utility as defined by the UCA"

[17] "petroleum industry" is a defined term in the UCA.

- A public utility may offer EV charging service for compensation (in other words, charge a rate), but the rate, including terms and conditions of service, would have to be allowed and approved by the BCUC.
- The exemption for municipalities and regional districts in item (c) above enables these entities to offer EV charging service at municipally-owned facilities, either free of charge or for compensation without Commission oversight of the rates or terms and conditions of service.
- The primary option for private parties, if they do not wish to fall under the UCA public utility definition, is to offer EV charging service to the public free of charge[18]. Private parties wishing to receive compensation for the resale of electricity for EV charging purposes must either obtain an exemption from portions of the UCA or obtain BCUC approval for the EV charging service[19].

The provincial government has enacted a number of pieces of legislation and policy that support the use of clean and renewable energy sources, including the Clean Energy Vehicle (CEV) Program as a component of BC's Climate Leadership Plan. The Climate Leadership Plan and the CEV Program are intended to encourage and accelerate the adoption of CEVs in BC for their environmental and economic benefits.

In March 2017, amendments to the Greenhouse Gas Reduction (Clean Energy) Regulation (GGRR) OIC 101-2017 established a number of prescribed undertakings pertaining to electrification in various sectors of the provincial economy, including the transportation sector.

Section 4 of the GGRR (the electrification section) establishes a number of measures to promote the use of electricity for the purposes of reducing greenhouse gas (GHG) emissions. Projects or programs respecting technology that may enable a utility's customers to use electricity instead of other sources of energy that produce more greenhouse gas emissions are considered to be a prescribed undertaking for the purposes of section 18 of the *Clean Energy Act*. Specifically, section 4(3) of the GGRR establishes several prescribed undertakings in subsections (a) through (e). Subsections (c) and (e) as follows, are those most pertinent to the EV Charging Service Inquiry:

> (c) a project, program, contract or expenditure for research and development of technology, or for conducting a pilot project respecting technology, that may enable the public utility's customers to use electricity instead of other sources of energy that produce more greenhouse gas emissions;

[18] There is some ambiguity about whether private parties selling EV charging service on a time basis, similar to an hourly parking rate, would be engaging in the resale of electricity according to the UCA public utility definition.

[19] Bakerview Ecodairy Ltd. applied for an exemption from Part 3 of the Utilities Commission Act for EV charging service at its place of business. The BCUC issued Order G-71-16 (and Reasons for Decision) on May 19, 2016 exempting the applicant from the requirements of Part 3 of the UCA except for sections 25, 38, 42, 43, 44, and 49.

> (e) a project for the construction, acquisition or extension of a plant or system, that the public utility reasonably expects is necessary to meet the public utility's incremental load-serving obligations arising as a result of an undertaking defined in paragraph (a), (b), (c) or (d), if the public utility reasonably expects any one such project to cost no more than $20 million.

The development of EV charging infrastructure contributes toward the achievement of the provincial energy and climate action objectives. Deployment of EV charging stations promotes the use of EVs in BC and supports the use of clean or renewable resources, reduces BC GHG emissions, encourages individuals to switch to lower GHG emission fuel sources, encourages communities to reduce GHG emissions and use energy efficiently, and encourages economic development and the creation and retention of jobs.

The development of EV charging infrastructure stations is consistent with the intent of these prescribed undertakings, particularly considering that these stations will enable customers to use electricity for transportation rather than more carbon-intensive fuel sources. These considerations with respect to Section 4 (3) of the GGRR and the strong alignment with government policy discussed above confirm the merits of utilities providing EV charging service and stimulate market demand in the province.

Section 1.2 of FBC's Application for Approval of Rate Design and Rates for EV DCFC Service – the FBC EV Application (Appendix 3) includes a summary of policies and legislation and how they support EV adoption and the establishment of enabling infrastructure such as charging stations in BC, giving due recognition to the resulting positive environmental and economic impacts.

3. SCOPE A: BASIS FOR REGULATION

In this section, FBC addresses Scope A items as identified by the Commission, which pertain to the following three topics:

1. Nature of market for EV Charging Stations;
2. Customer Choice in Charging Stations; and
3. Regulation of Charging Stations.

Question 1: Do EV charging stations operate in a competitive environment in BC or are they a natural monopoly service?

EV charging and the adoption of EVs can be characterized as being in an emerging market that is closely connected to public utility activity by virtue of using electricity from the grids of public utilities such as FBC and BC Hydro.

The market is emerging (and not competitive) because:

- There are financial barriers to entities entering the market due to demand being low and therefore infrastructure is not cost effective, even when considering subsidies and incentives from government and other agencies[20];
- There are few buyers and sellers; and
- The few customers have limited choice in who they buy from.

To promote the development and growth of the deployment of EVs and EV charging infrastructure in BC, electric utilities are playing an important role. This is evidenced by the current ownership of existing stations in the Province, and in particular the ownership of Level 3 charging stations[21]. Table 3-1 below shows that of the Level 3 or DCFC stations in the Province, 74.5 percent are owned by a Utility and 19.6 percent owned by Tesla. After removing Tesla's stations (which can only be utilized by Tesla vehicles), virtually all stations are owned by utilities.

[20] This is demonstrated by the analysis FBC completed of EV charging revenues compared to the charging station cost of service provided in Figure 3-1 of the FBC EV Application (Appendix 3), which shows that there is under-recovery of costs in the initial few years in each of the sensitivity scenarios.

[21] Table 5 and 6 of the Mogile Report (Appendix 4)

Table 3-1: Station Ownership in BC (Percentage of total charging locations)

Level 2				
Utility	**Municipality**	**Business**	**Tesla**	**Uncertain**
0.6%	23.7%	49.3%	19.6%	6.8%
Level 3 or DCFC				
Utility	**Municipality**	**Business**	**Tesla**	**Uncertain**
74.5%	0.0%	5.9%	19.6%	0.0%

Table 3-1 demonstrates that the ownership of Level 2 charging stations is more diverse than the ownership of Level 3 charging stations. For Level 2 charging service, business and municipalities own the bulk of these stations. FBC considers this diversity in ownership for Level 2 charging service to be reflective of drivers such as alignment with municipal bylaws[22], employee and customer attraction, and public image and tourism development. Much of the Level 2 charging service is provided for free in exchange for these benefits and not for economic reasons or to provide fuelling service specifically. There is still a relative lack of public charging infrastructure, particularly of the Level 3 DCFC variety, indicating that a competitive market does not exist.

FBC believes that the main barriers to the mass adoption of EVs for personal transportation are:

- concern by prospective EV buyers that they might not be able to make it to where they want to go or that they might not have charging infrastructure close by when needed[23]; and
- the current number of EV owners (buyers) and estimated demand for EV Level 3 charging service does not support recovery of the infrastructure and service costs, particularly in the earlier years.

Another important aspect in assessing the competitiveness and maturity of the markets for EV adoption and EV charging infrastructure is to consider the effects of government policy and programs in the overall EV marketplace. Governments at both federal and provincial levels are involved in promoting EV adoption and public EV charging infrastructure through providing incentives and other support to EV purchasers and infrastructure developers. These programs recognize that although EVs will deliver desirable environmental benefits in the transportation sector, they are currently more expensive than conventional gasoline or diesel-fuelled vehicles and that expanded charging infrastructure (that may not be fully economic on its own) is necessary to serve the unique needs of the EVs. The presence of such government involvement in this marketplace is evidence that the market is still emerging.

[22] The City of Coquitlam zoning bylaw requires newly built apartments, houses and townhouses to be equipped for at least one Level 2 charging station per dwelling unit. https://pluginbc.ca/port-coquitlam-passes-ev-charging-bylaw/

[23] There are currently only eight fast charging stations located in FBC's service territory (excluding Tesla supercharger stations) and as demonstrated in Figure 1 above, there are some areas of the province where very few or no EV charging stations exist.

Government, utilities, businesses, municipalities and other entities all have a role to play in the deployment and growth in the number of EV charging stations in the province in order to support provincial energy objectives. While there are still financial barriers to overcome, government incentives help reduce some of the financial barriers to the provision of public EV charging infrastructure. Cooperation between utilities and municipalities has undoubtedly been critical to the development of Level 3 EV infrastructure in BC to date. Achieving BC's energy objectives will require continued cooperation and collaboration between utilities and municipalities, but must also include businesses who so far have largely been limited to only supporting Level 2 charging infrastructure, primarily due to the significant costs involved in installing and operating Level 3 charging stations. Despite this, and as demonstrated by Tesla's supercharger siting model, businesses can play a critical role in facilitating cost-effective siting options for both Level 2 and Level 3 charging sites, the continued deployment of which are critical to accelerating EV adoption in support of BC's energy objectives.

In summary, a competitive environment for services provided by EV charging stations does not currently exist in BC. The emerging EV market requires involvement by government, utilities, businesses, municipalities and other entities to grow the number of EV charging stations in the province. Government incentives, and involvement by government, utilities, and other entities are important to further develop this emerging market.

Question 2: Are the customers of EV charging stations captive or do they have a choice?

Customers of EV charging stations have limited access to public charging service when compared to the availability of gasoline and diesel for internal combustion engine vehicles. In the vast majority of the province, and even significant parts of the Lower Mainland, there is not even one public charging station conveniently available to EV owners. Where private charging stations are available to the public they are generally Level 2, and therefore charging times are longer and EV owners may be subject to restrictions imposed by the owners. These limited choices mean that for many users, only home charging is a viable option.

Despite EV owners having some choices available to them, depending on their location in the province and the type of EV they operate, both the electricity customer (when charging at home) and the charging station operator, is captive for their supply of electricity from the utility, except where they elect to install some self generation capacity.

Question 3: Should the Commission regulate the services provided by EV charging stations? What are benefits and detriments to such regulation?

In this emerging EV market, both public utilities and other entities can co-exist. FBC believes that when a public utility provides EV charging service, it should be regulated and the related costs should be included in its utility rate base and cost of service. The level of regulation and involvement of the Commission can be less than under traditional utility monopoly regulation; different approaches to regulation can be used in the place of detailed regulatory applications from utilities to speed the implementation of EV charging infrastructure across the province.

The Commission has indicated in other decisions or reports such as the Alternative Energy Services Report (Order G-201-12) and the Proposed Regulatory Framework and Guide for Thermal Energy Service Utilities (Order G-231-13A) that it will be guided by key principles such as: "where regulation is required use the least amount of regulation needed to protect the ratepayer" and "the benefits of regulation should outweigh the costs". The Commission has discretion in how it chooses to regulate public utility activities, and in this case, as in others, the degree and nature of the regulation should be appropriate to the circumstances. FBC believes that, regardless of what level of regulation the Commission ultimately determines is appropriate for EV Charging Stations, utilities have an important role to play in the development of the EV market and should be encouraged to provide this service to facilitate the deployment of EV charging infrastructure in this province and support the BC climate action goal of reducing GHG emissions.

As an example, this Inquiry deals with similar issues and questions related to EV charging service regulation and rate design as already dealt with by California Public Utilities Commission (CPUC). FBC believes there is a lot to learn from the California experience, where the government of California has been taking an active role in developing the EV market for last 10 years but where only 4.5 percent[24] of the overall vehicles on the road are electric today. In that jurisdiction, previous attempts to allow the market to develop competitively have not succeeded.

Whether or not EV charging station services should be provided by utilities regulated was considered in California by the CPUC. Initially, the CPUC expressed strong concerns with regard to utility ownership of EV charging infrastructure and providing EV charging services, and imposed strict limits on such activities[25]. However, in a 2014 decision (D.14-12-079), the CPUC overturned its earlier prohibition against utility EV infrastructure ownership[26]. The CPUC cited the following as reasons for overturning the broad prohibition on utility ownership of EV infrastructure:

> …the utilities have a crucial role in the electrification of transportation as the infrastructure support and fuel supplier in their service territories.
>
> …certain market segments are harder for third parties to penetrate and the utilities may be better positioned to develop those market segments or support third party providers to do so.

[24] As of October 2017, the state has 337,482 zero-emission vehicles (ZEV). While that only makes up 4.5 percent of the state's total vehicle fleet, that number grew 53 percent between 2013 and 2017.

[25] CPUC Decision 11-07-029, p. 49-50 http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/139969.PDF

[26] CPUC Decision D.14-12-079, p.7 (http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M143/K682/143682372.PDF)

> …even limited utility involvement to accelerate the PEV infrastructure market can improve the business case for third parties.[27]

The CPUC in its recent decisions has directed California's electric utilities to include EV charging infrastructure in their rate base and has allowed rate recovery from all ratepayers of any revenue shortfalls from these activities (or the refunding of surpluses when revenues exceed costs).

Consistent with recent CPUC Decisions, FBC believes that there are a number of potential benefits resulting from utilities providing regulated EV charging services. Benefits of utility involvement in EV charging infrastructure include:

- the adoption of practices to support reliable EV charging service, particularly in those areas where there are very limited choices available to EV customers;
- planning for the adequacy of the local distribution system and upgrades to infrastructure in advance of deployment of the station(s)[28];
- Long-term pricing stability and reliability, as utilities will not be entering and exiting the market according to the current market opportunities; and
- Costs associated with various locations can be blended so that the higher cost to serve locations are mitigated by the lower cost to serve locations.

If future demand for EVs in BC grows significantly, electric utilities will be impacted regardless of who owns the EV charging infrastructure. Since EV charging will impact the utility's load, depending on the location and the timing of the load, utilities need to be involved in understanding what is happening in the EV marketplace. This includes being aware of developments with respect to EV charging in the service territory and assessment of the adequacy of the local distribution system in advance of an installation, and to upgrade any infrastructure if required.

Deployment of EV infrastructure should be considered as a whole in BC and not as individual locations. The BCUC can enable the mass deployment of public infrastructure in the public interest and which may balance the obligation to serve all customers in all locations (profitable and unprofitable) with the right to serve all locations; this is advantageous for network infrastructure that relies on having a large and diverse geography, irrespective of the costs of individual locations.

[27] CPUC Decision D.14-12-079, p.7 (http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M143/K682/143682372.PDF)

[28] As noted in FBCs 2016 Long Term Electric Resource Plan at pages 90-91, proactive utility involvement in the deployment of EV charging infrastructure is critical to ensuring that any resulting system impacts are mitigated through asset management and/or system design practices.

FBC believes that in an emerging EV market, there is room for both public utilities and non-regulated entities to participate and that any concerns can be mitigated through appropriate oversight by the Commission, such as through the establishment of guiding principles that would allow utilities to support the development of EV markets in BC.

Public utility participation in the provision of EV charging service, and the appropriate level of regulation by the Commission, is important in this emerging market. The primary focus of all participants at this time should be to facilitate the deployment of EVs and charging infrastructure in this province to reduce GHG emissions consistent with BC's climate action goals.

4. SCOPE B: RATE DESIGN AND RATE SETTING

In this section, FBC will address Scope B items as identified by the Commission, which pertain to the following four topics:

1. Rate design and customer pricing options;
2. Use of the existing wholesale, commercial, or some other rate;
3. Inclusion of EV charging station assets into regulated rate base; and
4. Risk of cross subsidization from EV charging service.

Question 4: Should the rate design of EV charging stations be established under a public utility's traditional cost of service model or some other model? And within that context, what are the customer pricing options (e.g. energy-based rate vs. time-based rate)?

Model to establish rate design of EV charging stations

In this section, FBC discusses the rate design for the recovery of the costs of the charging station itself. Further, FBC confines its comments here to the rate design for utilities that provide the charging station service, since there are many situations where another entity may provide the service for free due to other benefits that do not apply to the utility model[29]. The power supply rate is discussed separately in response to question 5 below.

For utility public charging service, the overall cost of providing the charging station service needs to be considered, in order to avoid significant cross subsidies to other utility ratepayers. The utility cost of service model is the starting point for setting the cost recovery requirements.

However, the rate itself needs to consider:

- a reasonable recovery of the cost of service itself;
- the willingness of customers to pay the rate; and
- an efficient use of the charging station.

In consideration of these factors, in the early years of implementation, it will be necessary for some recovery of costs to come from general ratepayers. Strict adherence to a cost-of-service model on a year-by-year basis may result in prohibitively high EV charging rates in the early years that would discourage EV customers from using the charging stations.

[29] As discussed above, these include alignment with municipal bylaws , employee and customer attraction, and public image and tourism development

To address the possible negative consequences of very high initial rates, the Commission has accepted approaches like adopting levelized rates in the context of new utilities or new services with growing load over a long term. FBC believes that rate-setting approaches such as these should be adopted in the context of EV charging service. A levelized approach was utilized by FBC in its FBC EV Application (Appendix 3) and resulted in a rate that falls reasonably in the range of other Level 3 charging stations in the marketplace, and also making it competitive with the cost of gasoline.

If EV charging service is provided by a utility, it is appropriate to continue to use the cost of service model as a starting point to establish rate design, and adapt it to the emerging market.

Customer Pricing Options

The possible rate structures for EV charging could include time-based, energy-based, demand-based or customer-based components.

However, the energy-based and demand-based options are limited at this time, particularly since FBC is not aware of any station vendors that have Measurement Canada accreditation for metering internal to EV charging stations. Once an accredited Measurement Canada meter becomes available, an energy-based or demand-based rate, possibly in combination with a time-based rate, would be a preferred solution. As described in an information bulletin issued by Measurement Canada (provided as Appendix 6), charging stations using an energy or demand-based rate must use a meter that is approved by Measurement Canada:

> Electricity sold on the basis of energy
>
> Charging stations that sell electricity on the basis of energy (kWh) or time-related demand (kW) are considered meters. This means that device owners must:
>
> - use defined units of measurement
> - make sure the meter type is approved by Measurement Canada
> - find an authorized service provider to inspect a new meter before using it and to re-inspect the meter periodically
> - make sure the meter is sealed properly
> - register as a contractor to sell electricity

With this background, FBC believes that the time-based rate structure is the most reasonable and practical option at this time. For time-based rates, the charging fee is based on the length of time a station is occupied (i.e. the time connected to the charger). Charging a rate for the amount of time the space is occupied generally encourages turnover and increases availability so that charging stations are used by those who need them for EV charging and not simply as parking spaces. Hourly fees are simple to understand by customers, and mirror existing rate

structures for parking meters. However, time-based rates may result in more costly charging on an energy consumed-basis for vehicles with a lower charging capacity.

Question 5: Should the EV charging station service rate be based on a public utility's existing wholesale or commercial retail rate or some other rate?

This section discusses only the power supply rate. The recovery of capital and operating costs is addressed in response to question 4 above.

FBC believes that the rate for public EV charging service should accommodate both third party or utility ownership and operation of the EV charging station. This suggests using the same utility rate for electricity supply to the EV charging station whether there is utility or third party ownership of the station. The common rate would be for the cost of electricity in the EV charging service (i.e. an input cost).

FBC recommends that a new rate should be developed for electricity supply to EV charging stations, since its existing retail and wholesale rate schedules contain components, such as demand charges or high customer charges that would make them inappropriate to support the development of EV charging infrastructure in the province. The rate should reflect the unique characteristics of the service being provided.

Question 6: Should public utilities include EV charging stations in their regulated rate base or through a separate non-regulated entity?

To support the development of EV charging infrastructure in the province, utilities should include EV charging stations in their regulated rate base. This is consistent with what has been approved by the CPUC in California.

This approach is also consistent with the treatment afforded to compressed natural gas (CNG) or liquefied natural gas (LNG) stations owned by FortisBC Energy Inc. Utility ownership of CNG and LNG fueling stations and inclusion in utility rate base was confirmed by the province's establishment in 2012 of the GGRR (discussed above in regard to electrification amendments to the regulation passed in 2017). Among other things, the GGRR sets out several types of projects, programs or expenditures (referred to as "prescribed undertakings") pertaining to promoting the use of CNG and LNG in the transportation sector, including spending allowances for utility ownership and operation of CNG and LNG fueling stations. The intent of the GGRR is to reduce greenhouse gas emissions in BC in the transportation and other sectors. The GGRR is a regulation under section 18 of the Clean Energy Act. The Commission must allow a utility carrying out a prescribed undertaking to recover the costs in rates. As discussed above in section 2.5, the 2017 "electrification" amendments to the GGRR provide a basis for EV charging infrastructure to be counted as prescribed undertakings and support utilities being able to include the costs in utility rate base and cost of service.

Question 7: If public utilities provide EV charging services within their regulated business, is there a risk of cross subsidization from other rate classes to support this new service and if so, is the proposed rate design potentially unduly discriminatory?

Utility investment in EV charging service is required to develop the market, and in consideration of the potential public benefits associated with EV DCFC stations, as well as the alignment with BC government policy objectives regarding the GHG reduction strategies and adoption of clean energy vehicles.

Depending on how demand materializes over the coming years, there is the potential for some cross-subsidization from other rate classes to support this new service.[30] This needs to be balanced against the need to develop the EV market, to support government policy, and the potential for net benefits to be provided to other rate classes.

As discussed above, FBC's proposed rate to recover the capital and operating costs of its EV charging station service is based on the cost of service of stations, net of contributions in aid of construction received from other parties. It is likely that in early years of operation, costs will exceed revenues and could result in small deficits based on the conventional components of cost of service analysis. However, as the demand grows over the coming years, the service may generate a net benefit to general ratepayers over time. And when considering the potential for low carbon fuel credits, this could occur even in the early years.

Because of this, FBC believes that the potential for significant cross-subsidization from other ratepayers is small. This situation with EV charging stations is analogous to other utility projects such as system extensions, or larger projects such as transmission lines or substations, where a project is constructed in advance of the load growth, and incremental revenues from sources such as new customer attachments do not fully recover the costs right away. Further, any such potential for cross-subsidization needs to be considered in light of the provincial government's policies that support the use of clean and renewable energy sources. As an example of where this concept has been implemented successfully, the GGRR established by the province allows utilities to own and operate CNG and LNG stations and include the costs in utility rate base and cost of service to promote these emerging markets and to reduce greenhouse gas emissions in BC in the transportation and other sectors.

Ownership of EV charging infrastructure by electric utilities as part of their regulated business is not uncommon in North America. California has already dealt with similar regulation and rate design issues related to EV charging services. FBC sees value in learning from their experience. As discussed in response to Question 3, the CPUC expressed concern with regulating the utility ownership of EV charging infrastructure and utilities providing EV charging

[30] Refer to Appendix 3 - FBC EV Application, Section 3.4.6 that assess the potential impact on FBC's other electric customers from FBC's proposed EV charging rate. Table 3-2 of Section 3.4.5 provides a comparison of the EV refuelling rate sensitivity using different demand scenarios.

services in 2010-2011. However, in its December 2014 decision (D.14-12-079)[31], the CPUC overturned the broad prohibition against utility EV infrastructure ownership.

In its recent February 2016 decision D.16-01-045[32], regarding San Diego Gas and Electric Company (SDG&E), the CPUC concluded that Electric Vehicles charging infrastructure ownership by SDG&E should be permitted under a pilot program and related costs corresponding to about 3,500 EV charging stations, during a sign-up period of approximately 3 years could be recovered from SDG&E's ratepayers, net of any revenues generated from the EV charging stations.

Similarly, in its December 2016 decision (D.16-12-065)[33], the CPUC approved Pacific Gas and Electric Company (PG&E) ownership of EV supply infrastructure to support up to 7,500 EV charging ports in multi-unit dwellings, disadvantaged communities and workplace and allowed capital expenditures in Phase 1 of PG&E's Electric Vehicle Program (Phase 1) to be recovered from utility ratepayers, net of any revenues from these activities.

Southern California Edison Company (SCE) is authorized[34] to include related costs in its revenue requirement to implement the Phase 1 pilot Charge Ready and complementary Market Education Programs.

On February 16, 2018, the Public Utility Commission of Oregon approved the Portland General Electric Company (PGE) application to undertake three pilot programs in support of accelerating transportation electrification. PGE's program will expand its electric avenue project by owning six EV charging stations with each containing up to four DCFCs. In addition, the program includes electric bus charging stations, education, and outreach.[35]

In alignment with the experience elsewhere, FBC believes that a public utility should provide EV charging Service within its regulated business to achieve the goal of reducing GHG emissions in accordance with the Government clean energy goals and initiatives. The primary focus at this time should be to facilitate the deployment of EV charging infrastructure.

[31] Page 7 of CPUC Decision D.14-12-079 issued on December 22, 2014. Follow the link: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M143/K682/143682372.PDF

[32] Page 3 of CPUC Decision D.16-01-045 issued on February 4, 2016. Follow the link: http://docs.cpuc.ca.gov/publisheddocs/published/g000/m158/k241/158241020.pdf

[33] Page 2 of CPUC Decision D.16-12-065 issued on December 21, 2016. Follow the link: http://docs.cpuc.ca.gov/publisheddocs/published/g000/m171/k539/171539218.pdf

[34] CPUC Decision D.16-01-23 issued on January 25, 2016 regarding Southern California Edison Company's application for its Charge Ready and Market Education Programs

[35] Public Utility Commission OF Oregon approval Decision 18-054 http://apps.puc.state.or.us/orders/2018ords/18-054.pdf

5. OTHER MATTERS

Question 8: Any other matters that may assist in the effective and efficient review of the Inquiry?

Another item that may assist in the effective and efficient review of the Inquiry is to consider amendments to the UCA or an exemption from parts of the UCA that would encourage non-utility companies to participate in and encourage the development of the EV market.

6. SUMMARY

FBC believes that a public utility has a critical role to play in supporting the growth of the EV market by facilitating the deployment of EV Charging Infrastructure to meet BC's climate action goals in reducing GHG emissions.

In this emerging EV market, public utilities and non-utility participants can co-exist where different levels of regulation may apply, and a public utility providing EV charging service may include costs and revenues in utility rate base and cost of service.

Any rate design for EV charging service should balance the cost recovery requirements with the need to develop and promote the expansion of the EV market.

FBC recommends that a new rate schedule should be developed for electricity supply to EV charging stations considering the unique characteristics of the service.

The primary focus at this time should be to help facilitate the expansion of this emerging market to support the use of clean and renewable energy sources as part of Climate action goals.

Appendix 1

2016 POWERTECH LABS
EV TECHNOLOGY AND MARKET OVERVIEW

Powertech Advanced Transportation	REPORT	RPT0001-01406
	EV Technology and Market Overview	

Background Report

EV Technology and Market Overview

October 19 2016

Status: Final
Revision: 01

Josh Power, Township of Langley
Greg Brooks, City of Abbotsford
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Ref# *Proposal 16-4652*	Date: 18-DEC-2015	

RPT0001-01406-D01	EV Technology and Market Overview

RPT0001-01406-D01	EV Technology and Market Overview

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DISCLAIMER

This report was commissioned by the Township of Langley, Metro Vancouver and City of Abbotsford. Interpretation of the results of this study, as expressed in the report, is entirely the responsibility of the consultant authors and does not imply endorsement of specific points of view by the Township of Langley, Metro Vancouver or City of Abbotsford. The findings and conclusions expressed in the report are the opinion of the authors of the study and may not necessarily be supported by the Township of Langley, Metro Vancouver or City of Abbotsford.

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EXECUTIVE SUMMARY

Electric Vehicles have become an increasingly important technology with excellent potential for reducing the cost and environmental impact of transportation. Municipalities in the lower mainland have significant influence over the growth of EV technology through implementing incentives, installing infrastructure and leading by example with their own vehicle fleets. With the potential for a large shift to electric vehicles over the coming years, municipalities must plan carefully to ensure that this new technology is supported in a way that maximizes benefits for citizens and the environment while accounting for future growth and fiscal responsibility.

This report is intended to provide context for broader EV charging infrastructure planning activities in BC. It provides an overview of the EV market, as well as technical information relating to EVs and the charging infrastructure required to support them.

Since late 2010, sales of EVs in North America have totaled over 500,000, with over 20,000 of those having been sold in Canada, and over 4000 in BC. Yearly sales rates have accelerated as a greater number of EV models have become available from various automakers. An analysis of two recent studies suggests that EVs will make up between 3-6% of the vehicle fleet in BC by 2024, and between 13-20% by 2030.

Section 3 provides definitions of various types of EVs, a summary of currently available electric vehicles including basic technical specifications, as well as a summary of EVs that will enter the market in the coming years. Three trends are observed among upcoming products: the advent of affordable Battery Electric Vehicles (BEVs) with significantly improved driving range of 300km or more; the arrival of electric SUVs in the North American market; and a surge of plug-in hybrid electric vehicle (PHEV) versions of a broad number of makes and models.

Section 4 introduces the various means of recharging EVs, including readily available and relatively inexpensive AC charging equipment, less common and more expensive DC fast charging equipment, as well as future technologies such as higher power DC fast chargers, wireless charging and battery swapping. Various technical details and standards pertaining to these charging methods are discussed.

Section 5 provides an overview of emerging “Smart Grid” technologies that have the potential to better integrate EVs into the grid and minimize their impact on electrical infrastructure. “Smart Charging” is a general concept that involves reducing charging rates at certain times to avoid peak loads, and is increasingly supported by a number of available technologies. Vehicle-to-Grid (V2G) is a concept that involves EVs acting as a source of energy, potentially to provide backup power or to support grid operations. V2G has been demonstrated in a number of pilot projects, but broader commercialization of this technology is still in question. Stationary Energy Storage systems can support grid operations by minimizing the impact of significant loads, while also providing the option of zero-emissions backup power for a limited time. Stationary Energy Storage systems are transitioning from a technology demonstration stage to broader commercialization.

Finally, Section 6 provides a brief summary of policies and programs supporting EV adoption in BC. These include purchase incentive, infrastructure deployment programs, and building codes.

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LIST OF ACRONYMS

AC	Alternating Current
BEV	Battery Electric Vehicle
CCS	Combined Charging System, the SAE standard for DC charging
DC	Direct Current
DCFC	Direct Current Fast Charge or Direct Current Fast Charger
DER	Distributed Energy Resource
DR	Demand Response
EREV	Extended Range Electric Vehicle
ESS	Energy Storage System
EV	Electric Vehicle (includes BEVs and PHEVs)
EVSE	Electric Vehicle Supply Equipment
FCEV	Fuel Cell Electric Vehicle
HEV	Hybrid Electric Vehicle
J1772	The SAE standard charging connector for AC charging
kW	Kilowatt
kWh	Kilowatt-hour
L1	Level 1 (AC charging)
L2	Level 2 (AC charging)
PEV	Plug-in Electric Vehicle (includes BEVs and PHEVs)
PHEV	Plug-in Hybrid Electric Vehicle
V2G	Vehicle-to-Grid

1 INTRODUCTION

Electric Vehicles (EVs) represent an excellent opportunity to reduce both the cost and the environmental impact of transportation. Using highly efficient electric motors and onboard batteries for electrical energy storage, EVs avoid the use of non-renewable fossil fuels and their associated air emissions. While it is important to take into account the environmental impact associated with electricity generation, studies have shown that EVs can make sense even in regions with largely coal-based electrical grids, and their "well-to-wheels" emissions are already improving considerably over time as grids around the world shift to cleaner forms of electricity generation[1].

While EVs were relatively common in the early 1900's, the advent of highways and intercity travel highlighted the driving range limitations of EVs, and the remainder of the 20th century was dominated by the internal combustion engine. Although the late 1990's did see a small surge of EV sales thanks to a government mandate in California, it wasn't until December of 2010 that the current generation of EVs began to take off, with the almost simultaneous launch of the Nissan Leaf and the Chevrolet Volt. Since then, over 1 million EVs have hit the road in the world, including over 500,000 in North America. While EVs still only represent about 1% of new vehicle sales in major markets, a diversifying array of EV models with increasing performance and decreasing price has led to steady sales growth across the globe, especially in the US, Europe and China. Some markets with particularly effective government policies have seen much higher penetration of EVs, such as Norway where EVs represent 20-30% of new vehicle sales throughout 2016.[2] Meanwhile, a number of European governments are considering banning the sale of gas-powered cars entirely within the next 10-15 years.[3]

In Canada, government support for EVs has so far come largely in the form of Provincial purchase incentives (in Quebec, Ontario and BC) and through charging infrastructure deployment. Municipal and Regional governments can play an important role in supporting EVs, especially by supporting the deployment of charging infrastructure in both public and private locations. Local governments can also help lead by example by adopting EVs into their own operations.

In order to help inform decision makers at local governments, this report is intended to provide a technical and market overview of electric vehicles and EV charging infrastructure, establishing context for future programs and policy development.

In many places, the reader may notice that information relating to pricing and sales may be discussed in terms of US numbers. While an effort will be made to present information in a Canadian context wherever possible, the automotive industry in Canada is largely influenced by what happens south of the border, and the level of detail of information pertaining to the US market is much greater.

[1] http://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions
[2] http://insideevs.com/norway-ev-sales-surge-in-september-with-volume-deliveries-of-tesla-model-x/
[3] https://electrek.co/2016/10/08/germany-push-europe-wide-ban-on-gas-powered-cars-by-2030-only-ev-sales-onward/

2 THE MARKET

2.1 North American EV Sales to Date

2.1.1 United States

Since the launch of the current generation of EVs in late 2010, the list of available models has increased steadily every year, and there are now almost 30 plug-in vehicles available for sale in North America across at least 15 makes. The US plug-in vehicle market is one of the largest in the world, with annual sales rate having surpassed 100,000 vehicles per year in 2014. The total number of EVs on the road in the US today is over 450,000, as of May 2016.[4]

Sales in the US were initially dominated by a few key models selling on the order of 1000-2000 vehicles per month, followed by a number of so-called "compliance cars" selling fewer than 200 vehicles per month, generally acknowledged to be sold by manufacturers seeking only to comply with California's zero-emissions vehicle regulations. This tendency has reduced in recent years, with a great number of automakers producing EVs in significant numbers:

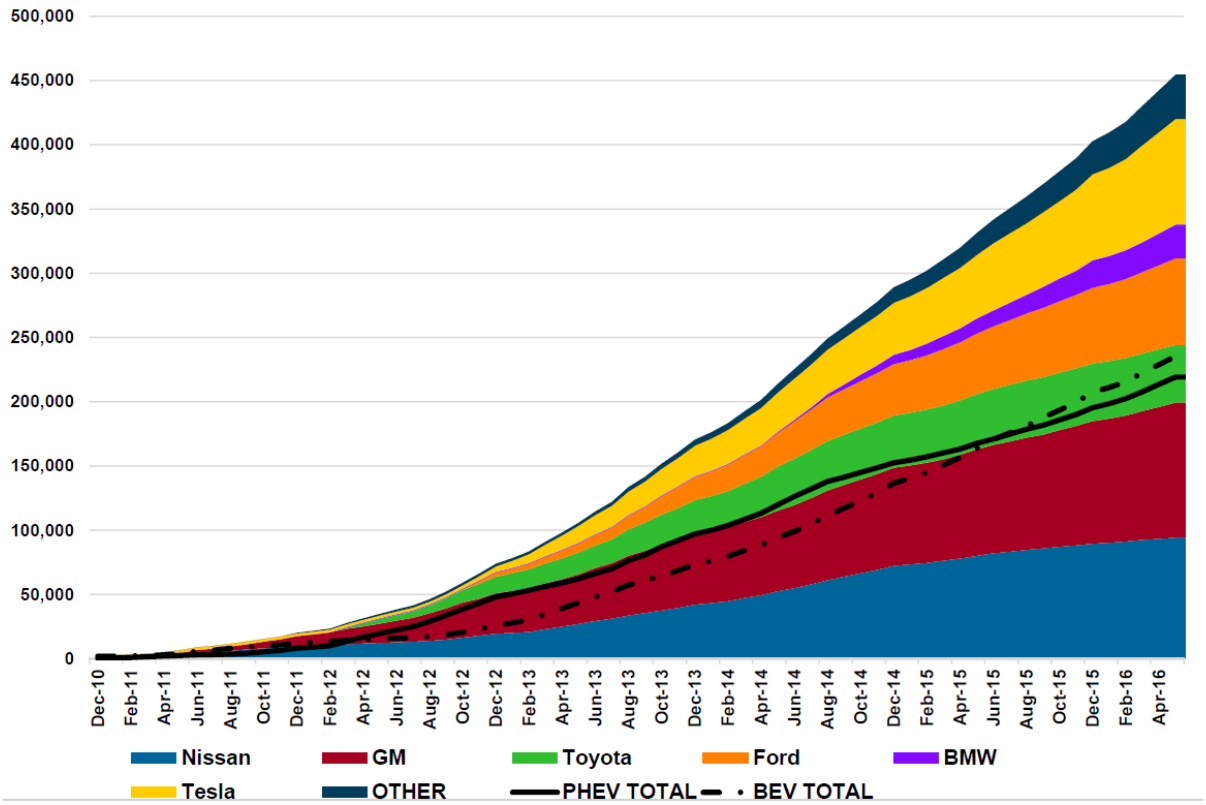


Figure 1 US Cumulative PEV Sales by make up to April 2016. Source: EPRI

[4] http://www.pluginamerica.org/

Cumulatively speaking, the overall number of EVs currently on the road in the US still shows signs of the strong lead in sales established by the Chevrolet Volt and Nissan Leaf (together representing about 40% of EVs currently on the road in North America), followed by the Tesla Model S, the Toyota Prius PHEV, and Ford's two Energi PHEV models (all 6 models collectively representing over 80% of the current EV fleet):

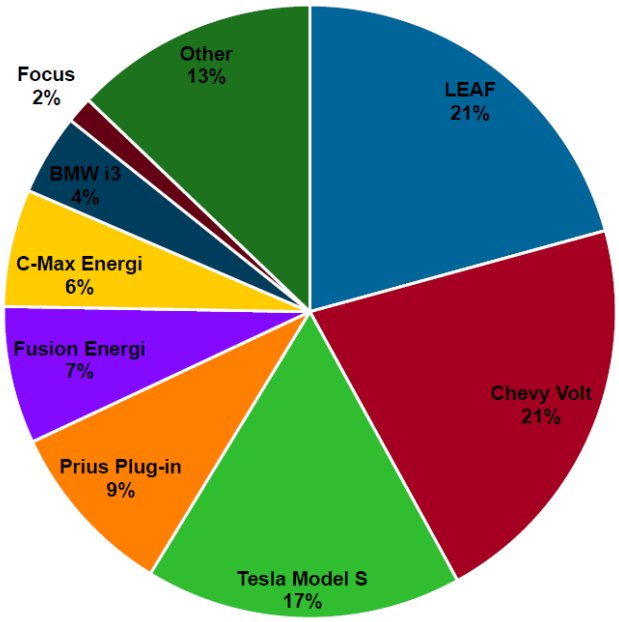


Figure 2: US Cumulative Sales as of May 2016. "Other" includes vehicles such as the Smart ED and the Toyota RAV4-EV. Source: EPRI

Looking specifically at recent sales shows a trend towards greater diversification and a greater number of models taking a significant share of the market, although the overall ranking of models is still fairly similar:

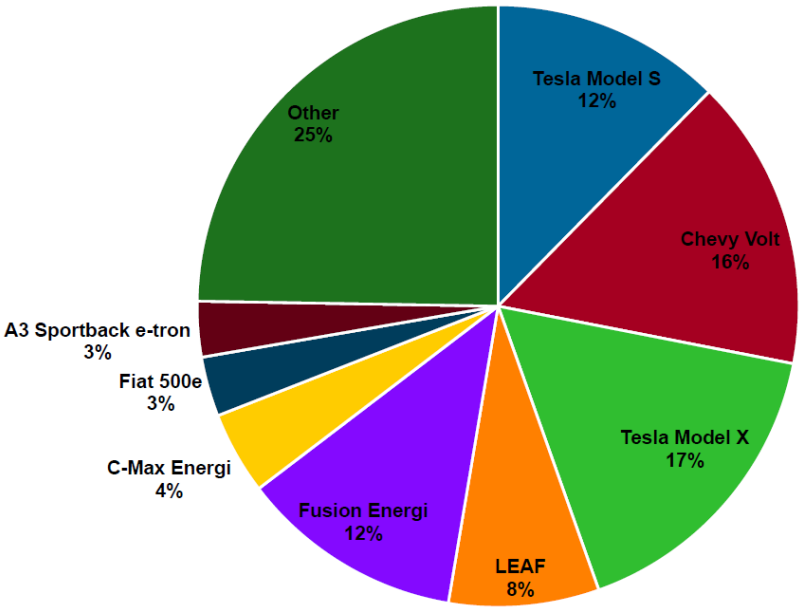


Figure 3: US EV Sales - May 2016. "Other" includes vehicles such as the Fiat 500e, the VW e-Golf, etc. Source: EPRI

2.1.2 Canada and BC

The Canadian EV market is behind the US market in terms of overall sales and diversity of models, although recent trends suggest that it is starting to catch up. With just over 20,000 EVs on Canadian roads today and around 500,000 in the US, cumulative Canadian EV adoption is about 30 % that of the US on a per capita basis. Canadian EV purchases accounted for 0.27% of all new vehicle purchases in 2014, which put Canada in 17th place for EV adoption in 2014 in terms of new vehicle market share, after such countries as the UK (0.58%), France (0.91%), Japan (0.98%), the Netherlands (3.94%) and Norway (13.93%), where very favourable tax incentives for EV purchases have propelled certain EV models into the top selling spots overall for all vehicles in Norway.[5] That said, recent sales data from 2016 shows a significant increase in Canadian EV sales, with sales in the first half of 2016 showing a 77% increase compared to 2014[6] and hitting a market share of 0.61% in July of 2016[7], not far off from the US EV market share of 0.88% for the same month[8]:

[5] Axsen, J., S. Goldberg, J. Bailey, G. Kamiya, B. Langman, J. Cairns, M. Wolinetz, and A. Miele (2015). Electrifying Vehicles: Insights from the Canadian Plug-in Electric Vehicle Study [Early Release]. Simon Fraser University, Vancouver, Canada.
[6] http://www.fleetcarma.com/ev-sales-canada-2016-half-year/
[7] http://www.greencarreports.com/news/1105955_plug-in-electric-car-sales-in-canada-august-2016-volt-laurels
[8] http://insideevs.com/july-was-3rd-best-ev-sales-month-in-u-s-2nd-highest-market-share/

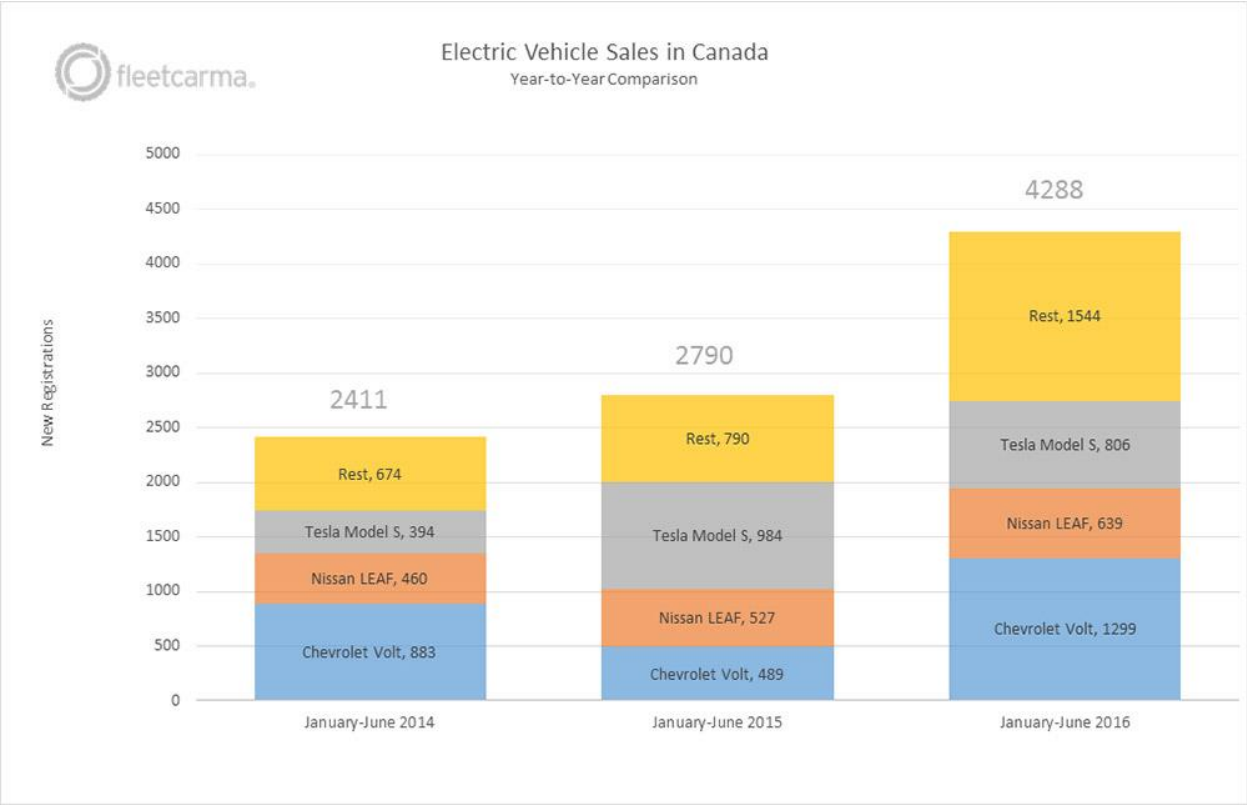


Figure 4: Growth in EV sales in Canada, comparing H1 sales from 2014 to 2016. Source: FleetCarma

One reason cited for this relatively slower adoption in Canada as compared to the US is a lack of federal support programs for EVs in Canada. While BC, Ontario and Quebec have all offered provincial rebate programs (up to $5000, $14000 and $8000, respectively), there is no federal incentive program in Canada that would reinforce the provincial program and support sales in provinces that do not have their own programs. Another potential reason for reduced market share in Canada is a lack of availability of EVs, both in terms of number of distinct models available for sale, as well as a lack of inventory of established models at dealerships.[9] A number of US states try to avoid this type of constrained supply by requiring automakers to sell a minimum number of EVs through a "Zero Emissions Vehicle Mandate". No similar regulations are currently in place in Canada, although it is being considered in Quebec.[10]

[9] Axsen, 2015.
[10] http://ici.radio-canada.ca/nouvelles/Politique/2016/06/02/001-voitures-electrique-cibles-vente-constructeur-projet-loi-quebec.shtml

Compared to the US, Canadian sales numbers show a slightly less diversified market with fewer available EV models, although there are still at least 20 EV models available in Canada. Generally speaking, Canadians show a strong preference for the Chevrolet Volt above all other plug-in vehicles, possibly reflecting benefits of a plug-in hybrid powertrain for colder climates (cold temperatures can exacerbate the range limitations of a pure battery-electric vehicle):

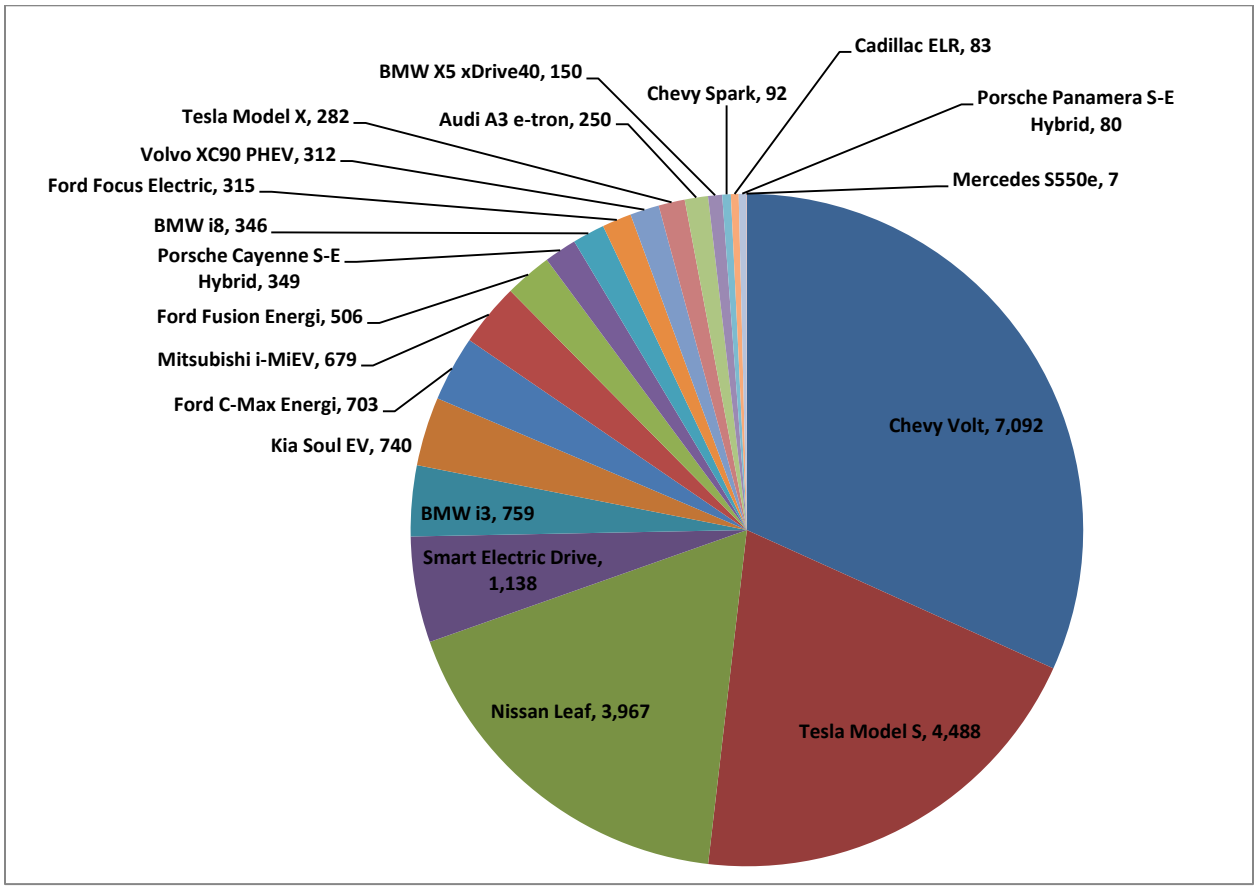


Figure 5: Cumulative Canadian EV sales by model as of July 2016. Source: Matthew Klippenstein, GreenCarReports.

The BC market reverses this tendency somewhat, with a slight preference for pure electric vehicles such as the Nissan Leaf and Tesla Model S as compared to the Chevrolet Volt. These two models represented about 50% of the total EV fleet in BC, which was just over 4000 vehicles as of July 2016:

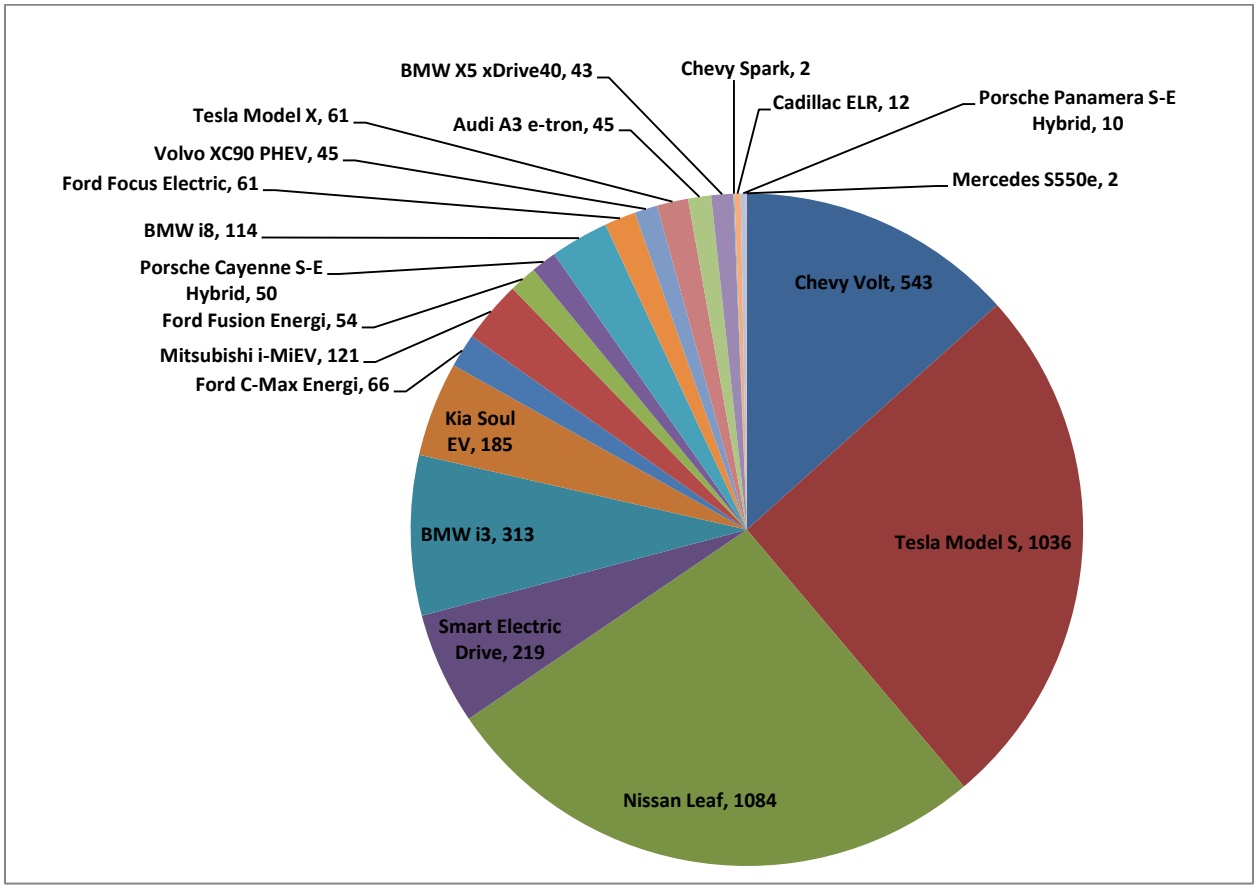


Figure 6: Cumulative BC EV sales by model as of June 2016. Source: FleetCarma.

Looking at a more recent monthly snapshot of EV sales in Canada shows that some of the more recently introduced models are selling in significant numbers. While these models haven't yet made a significant impact to the cumulative sales shown in the figures above, sales for the month of July 2016 show that models such as the all-electric Tesla Model X SUV, and the Audi A3, Volvo XC90 and BMW X5 plug-in hybrids are outpacing some of their predecessors, and contributing to a greater diversity in the Canadian EV market:

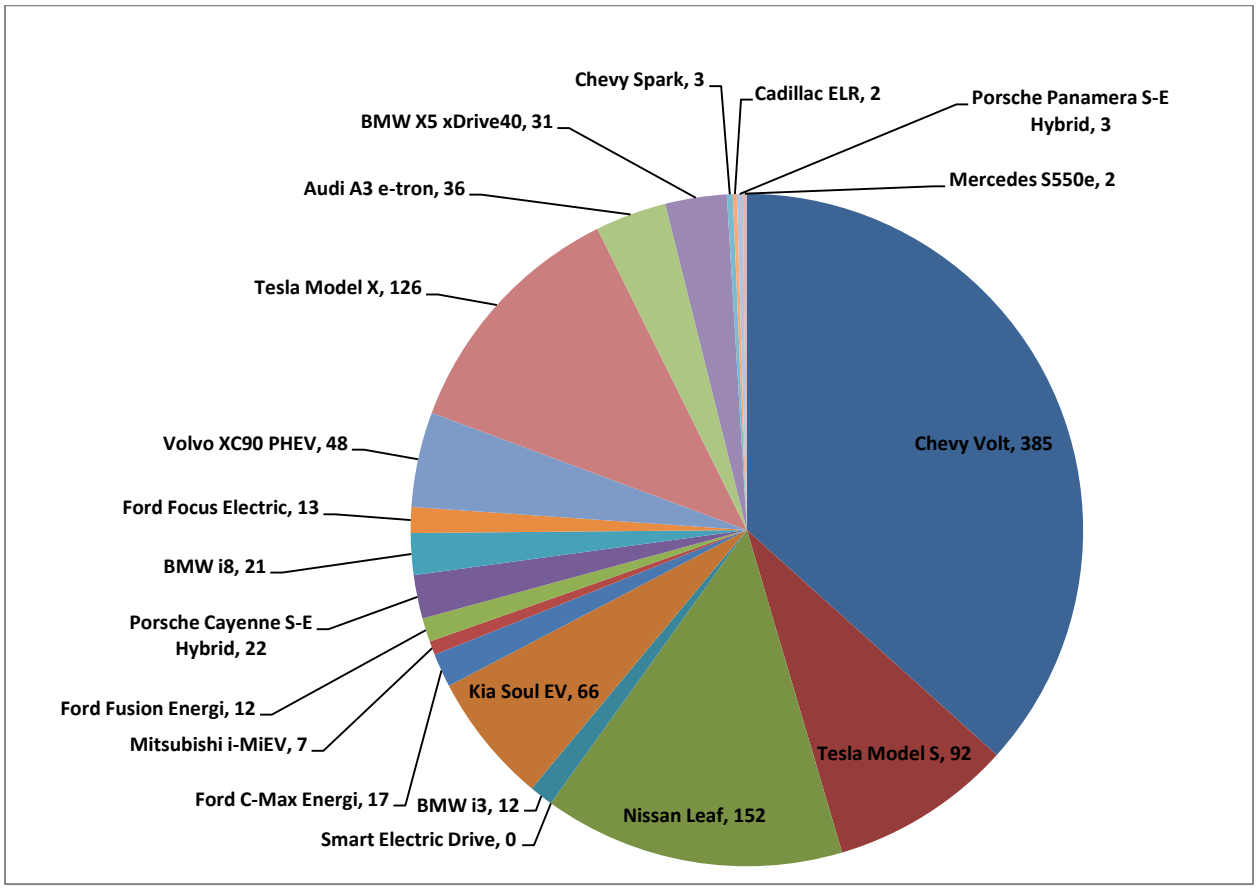


Figure 7: Monthly Canadian EV sales for July 2016. Source: Matthew Klippenstein, GreenCarReports

In 2014, ICBC reported a total of 1700 EVs in BC as of 2014, with 1200 of those being registered in the Lower Mainland.[11] The Lower Mainland has about 70% of BC's registered EVs, while only representing about 60% of BC's population, showing a slightly higher proportion of EV sales per capita, likely thanks to the suitability of EVs for urban and suburban lifestyles.

[11] http://www.icbc.com/about-icbc/newsroom/Documents/population.pdf

2.2 Projected Future Uptake of EVs in BC

Predicting the future growth of EV market share is difficult and a large number of important factors must be taken into account. Factors that may affect sales of EVs include:

1. EV model availability
2. Dealership inventory availability
3. Cost of vehicles, which in turn is largely affected by battery costs
4. Fuel and electricity prices
5. Government rebates and non-financial incentives
6. Availability of charging infrastructure
7. Consumer awareness

Two organizations have recently attempted to take these factors into account in order to assess future market share of EVs, specifically in the Canadian and BC contexts: Navigant Research and Simon Fraser University.

Navigant Research

Navigant Research regularly publishes reports establishing long-term forecasts for EV adoption in various regions, and in Q2 2015 published forecasts specifically for the Canadian market[12]. Navigant expects Canada to begin to catch up with the US EV market, with a compound annual growth rate of between 22.8% in the conservative scenario and 25.7% in the aggressive scenario over the next ten years, leading to annual EV sales of between 74,000 and 91,000 vehicles by 2024, or between 3.7% and 4.6% market share of new vehicle purchases. Cumulatively speaking, this would put the overall EV fleet in Canada somewhere between 350,000 and 420,000 EVs total. Assuming BC and the Lower Mainland still account for similar proportions of the Canadian EV market, this would translate to between 39,000 and 47,000 EVs in the Lower Mainland, about a 35-fold increase over today's numbers, although still only representing less than 4% of passenger vehicles in the region. The following table extrapolates the conservative and aggressive scenarios presented by Navigant to understand how these projections would impact the fleet composition in the Lower Mainland in 2024:

Table 1: BC and Lower Mainland EV sales estimates based on Navigant Research forecast for Canadian EV sales through to 2024.

Year 2024	Canada		BC		Lower Mainland	
	Low	High	Low	High	Low	High
Annual EV sales	**74,000**	**91,000**	12,000	14,500	8,300	10,000
Market Share	3.7%	4.6%	5.4%	6.6%	6.3%	7.8%
Cumulative EV sales	350,000	420,000	56,000	67,000	39,000	47,000
Percent of Fleet	1.8%	2.1%	2.5%	3.1%	3.0%	3.6%

Numbers in bold are directly pulled from Navigant Research's forecast, all other values are derived.

Simon Fraser University

Researchers at SFU's Energy and Materials Research Group (EMRG) have performed a detailed analysis of factors affecting EV sales in BC, including a survey of over 1700 new vehicle owners from BC and elsewhere in Canada, and have incorporated this analysis into an EV sales forecast tool that predicts EV adoption in BC through to 2030[13]. In particular, the researchers found that availability of a diverse range of EV models is crucial in order to ensure significant growth in EV adoption. Fortunately, as will be detailed later in this report, a variety of new EV products are already coming to market in the next few years, and EMRG's more optimistic projection would likely apply. This projection suggests that EV market share of new vehicle purchases will be between 6% and 16% in 2024, and between 20% and 23% by the year 2030:

[12] https://www.navigantresearch.com/wp-assets/brochures/MD-EVGEO-15-Executive-Summary.pdf
[13] Axsen, 2015.

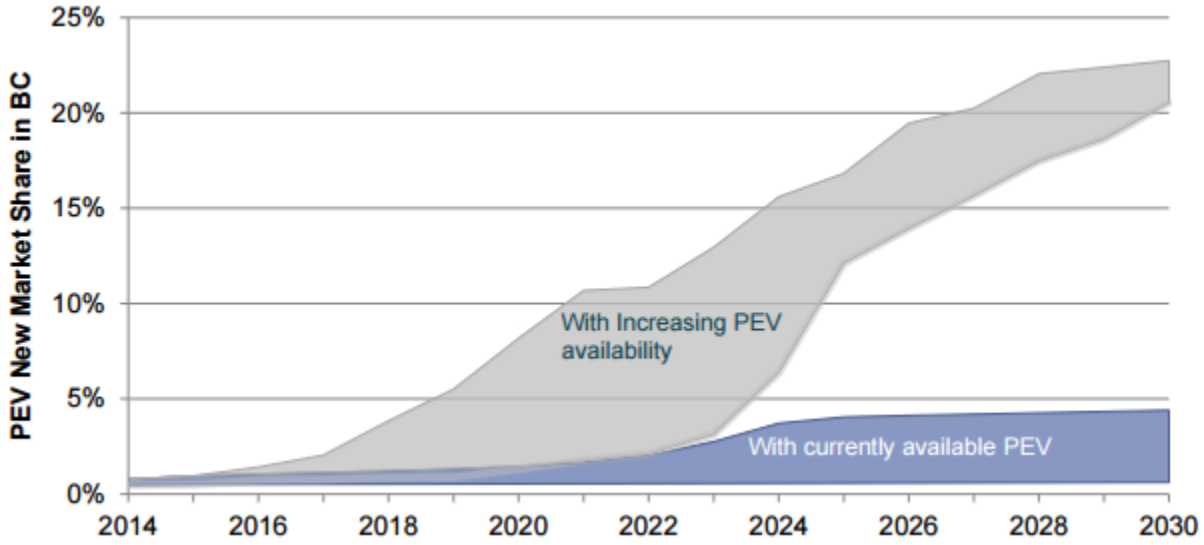


Figure 8: SFU Energy and Materials Research Group's projection for EV adoption in BC[14]

For the purpose of comparison with Navigant's forecasts, values can be taken for the year 2024 and assuming that current market trends continue to increase the availability of new PEV models. In order to map these market share values to an overall fleet size in BC and the Lower Mainland, certain assumptions need to be made regarding year-to-year growth rates and regarding the relative portion of EV sales in the Lower Mainland with respect to the rest of BC. These values are presented in the following table:

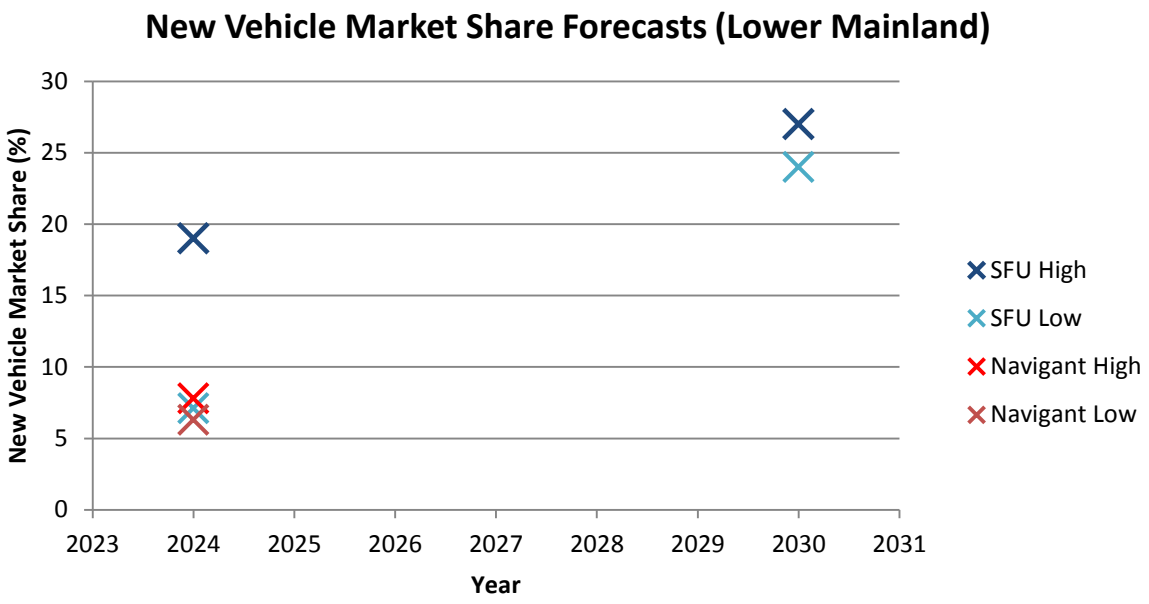
Table 2: BC and Lower Mainland EV sales estimates based on SFU forecast for EV market share in BC.

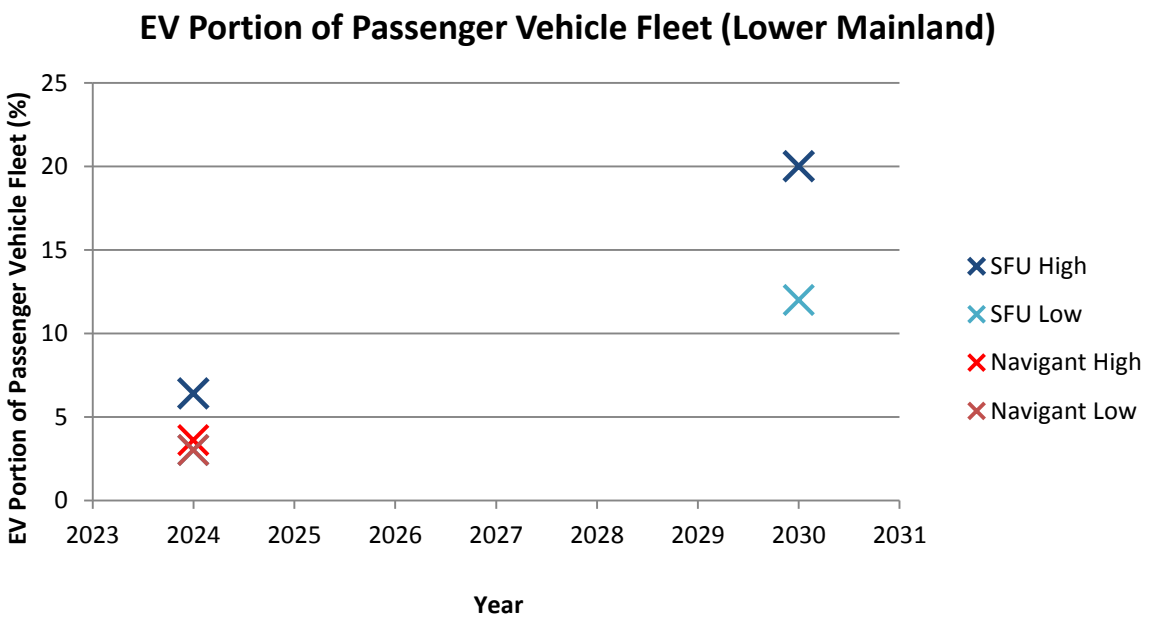
Year		BC		Lower Mainland	
		Low	High	Low	High
2024	Annual EV sales	13,000	35,000	9,300	25,000
	Market Share	**6%**	**16%**	7.1%	19%
	Cumulative EV sales	56,000	120,000	40,000	85,000
	Percent of Fleet	2.6%	5.5%	3.0%	6.4%
2030	Annual EV sales	44,000	50,000	30,000	35,000
	Market Share	**20%**	**23%**	24%	27%
	Cumulative EV sales	224,000	380,000	160,000	270,000
	Percent of Fleet	10%	17%	12%	20%

Numbers in bold are directly pulled from SFU's forecast, all other values are derived.

[14] Axsen, 2015.

The following two figures compare the forecasts of both studies, showing that there is relative agreement between Navigant Research's predictions and the low end of SFU's prediction for 2024. Only SFU's research provided a forecast for the 2030 timeframe.





2.3 Current usage of public EV infrastructure in BC

Beginning in 2013, a large number of public Level 2 and DC Fast Charge stations were installed across BC as part of a number of related initiatives, funded in part by the provincial and federal governments. Under a related initiative, Powertech Labs and FleetCarma developed the evCloud, a web-based platform for collection of usage data from the 4 most popular types of public charging stations in BC. The evCloud has a public facing website intended to support public awareness of EV charging infrastructure (www.fleetcarma.com/evCloud), while also supporting in-depth research into infrastructure usage data by utility, government and academic researchers. This research will help to inform future deployments of EV infrastructure, both at a broad public policy level, and at the level of individual station owners, helping to build an understanding around what kind of business models might exist for private investment in EV infrastructure. Some usage data is available to the public directly from the evCloud website, while summary reports are available to the public through BC Hydro and Natural Resources Canada. This section contains some highlights from this data set.

The evCloud is connected to over 460 charging stations across over 200 locations in BC. Of those stations, at least 250 are installed across 195 locations in the Metro Vancouver region:

Table 3: Usage statistics for charging stations in Metro Vancouver[15]

Metro Vancouver Level 2 Stations	
Number of stations monitored	250
Number of locations monitored	195
Average number of charge events per week:	969 (9.5 per location)
Busiest week:	2073
Average charge connect time:	4h36m
Average charge energy	7.4kWh

The following list shows the top ten busiest Level 2 charging locations in BC with publicly available data, ranked according to most number of charge events per week:

Table 4: Top-ten busiest Level 2 charging stations in BC (with publicly available data), data from Dec. 2015 to May 2016

Location	Venue Type	Overall ranking*	Number of Ports	Charge Events	Energy Dispensed (kWh)	Average Charge†	Charges /Week
Total for All locations			428	51,080	373,181	7.3 kWh, 3hr29min	1,986
Average L2 Location			2	278	2,028	7.3 kWh, 3hr29min	11
Richmond City Hall	Gov't	5	2	1,149	7,981	7.0 kWh, 1hr36min	47
Saanich Commonwealth Place	Leisure	9	2	1,003	6,324	6.3 kWh, 1hr48min	39
Edible Canada	Retail	10	2	994	6,114	6.2 kWh, 1hr39min	39
Lougheed Town Centre	Retail	11	2	974	4,988	5.1 kWh, 1hr14min	38
North Vancouver	Gov't	14	2	888	5,565	6.3 kWh,	35

[15] The region "Metro Vancouver" includes Burnaby, Langley, Maple Ridge, North Vancouver, Pitt Meadows, Tri-Cities, Richmond, Surrey, Delta, Vancouver, West Vancouver, and White Rock

Location	Venue Type	Overall ranking*	Number of Ports	Charge Events	Energy Dispensed (kWh)	Average Charge†	Charges /Week
City Hall						1hr50min	
Pearkes Recreation Centre	Leisure	16	2	857	4,925	5.8 kWh, 1hr34min	33
Metropolis at Metrotown	Retail	18	6	797	5,155	6.5 kWh, 1hr43min	31
Maple Ridge Business Centre**	Business	19	3	734	6,341	8.6 kWh, 9hr20min	29
ArtSpring Parking Lot (Salt Spring)	Leisure	20	2	711	4,380	6.2 kWh, 1hr35min	28
Guildford Towncentre	Retail	21	2	705	3,305	4.7 kWh, 1hr08min	27

* Overall ranking shows how these stations with publicly available data rank against all evCloud stations
** Being a Business Centre, employees may use EV spots for daily parking/charging.
† *Average Charge* refers to the average energy dispensed and the amount of time the vehicle is plugged in

Usage data from DC fast charge stations is of particular importance, as this is often considered "critical" EV infrastructure for enabling longer driving distances, and higher cost of installation and operation place a higher importance on establishing business models to support deployment. The following table provides a summary of the use of DCFC stations that were operational from June 1 to November 30, 2014:

Table 5: Usage of DCFC stations in BC – December 2015 to May 2016 (lifetime stats in parentheses)

Station	Online Since*	Charge Events	Energy Dispensed (kWh)	Fuel Displaced (L)*	Average Charge†	Charges/ Week
Total	n/a	4987 (11,158)	52,046 (109,318)	20,818 (43,727)	10.4 kWh, 26 min	194 (108)
Duncan	*6-Jun-14*	822 (1829)	9721 (19,451)	3889 (7780)	11.8 kWh, 32 min	31 (18)
North Vancouver	*19-Nov-14*	371 (1882)	3387 (16,536)	1355 (6615)	9.1 kWh, 25 min	28 (25)
Surrey	*2-Jun-14*	714 (1642)	9704 (18,992)	3882 (7597)	13.6 kWh, 27 min	27 (16)
Colwood**	*6-Jan-16*	618	4459	1784	7.2 kWh, 22 min	26
Saanich	*22-April-15*	619 (1315)	5356 (11,400)	2142 (4560)	8.7 kWh, 27 min	24 (20)
Abbotsford	*12-May-15*	422 (756)	4966 (8172)	1986 (3269)	11.8 kWh, 27 min	23 (14)
Squamish	*31-Aug-14*	470 (993)	5279 (10,845)	2112 (4338)	11.2 kWh, 31 min	18 (11)
Nanaimo	*4-Jun-14*	257 (655)	2838 (6645)	1135 (2658)	11.0 kWh, 28 min	10 (6)
Sechelt	*12-Feb-15*	240 (619)	1981 (4751)	793 (1900)	8.3 kWh, 22 min	9 (8)
Langley	*21-Jul-15*	175 (245)	1545 (2130)	618 (852)	8.8 kWh, 25 min	7 (5)

Station	Online Since*	Charge Events	Energy Dispensed (kWh)	Fuel Displaced (L)*	Average Charge†	Charges/ Week
Salmon Arm**	*8-Jan-16*	80	710	284	8.9 kWh, 37 min	4
Kamloops	*20-Jun-14*	81 (376)	718 (3431)	287 (1372)	8.9 kWh, 34 min	3 (4)
Hope	*18-Dec-15*	44	563	225	12.8 kWh, 37 min	2
Penticton**	*20-Feb-16*	24	205	82	8.5 kWh, 29 min	2
Merritt	*19-Aug-15*	16 (44)	256 (650)	103 (260)	16.0 kWh, 33 min	1 (1)
Keremeos**	*11-Dec-15*	24	292	117	12.2 kWh, 24 min	1
Whistler**	*25-Feb-16*	6	48	19	8.0 kWh, 26 min	n/a
Boston Bar**	*21-Jan-16*	1	8	3	n/a	n/a
West Kelowna**	*27-May-16*	3	8.8	4	n/a	n/a
Revelstoke	*24-Aug-15*	8	88	35	11.0 kWh, 30 min	n/a

*Fuel equivalency assumes 1kWh provides similar driving range as 0.4L of gasoline. "Online Since" date based on first communications with evCloud; some DCFC stations were operational before they came "online".
**Stations shown in grey were not in operation for the full duration of the reporting period.
† *Average Charge* refers to the average energy dispensed and the amount of time the vehicle is plugged in

The following figure is a snapshot of usage during the month of May 2015, showing how utilization varies considerably from one location to the next. One conclusion that can be drawn from this map is that DCFC stations located close to urban areas have so far been used much more regularly than stations along corridors that may facilitate longer trips. Utilization of stations may be impacted by the fact that the majority of stations are free-of-charge, although the station in Victoria is still the 3rd most heavily used station, despite requiring a usage fee to access the station.

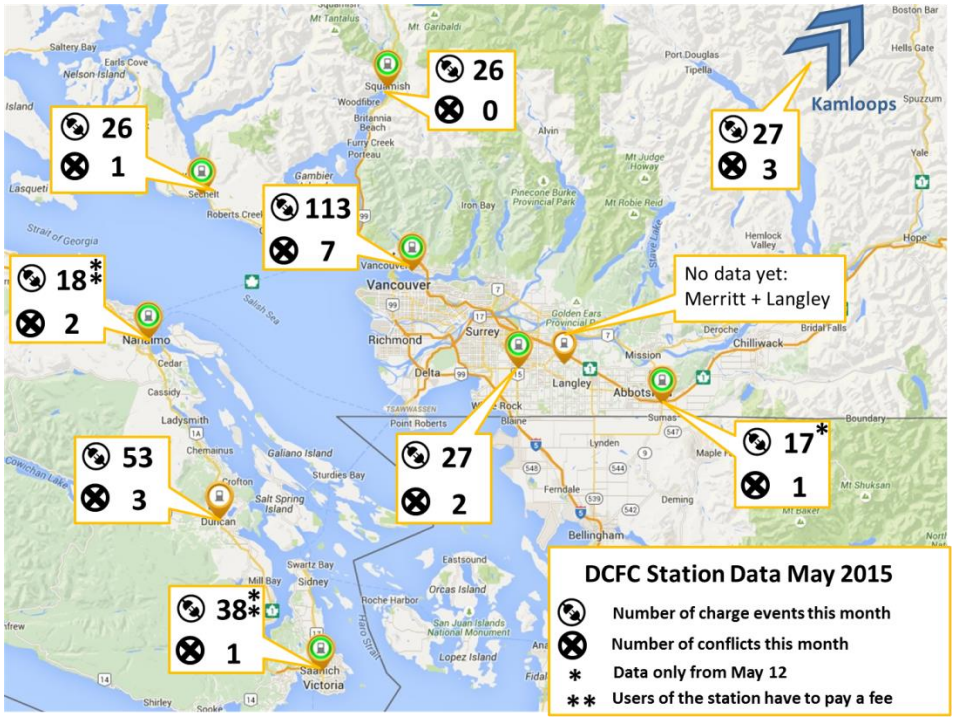


Figure 9: Usage of DCFC stations during May 2015, "conflicts" representing signs of queuing

In the previous figure, a "conflict" is defined as any two charge events at a given DCFC station that are separated by less than 5 minutes, indicating that an EV driver may have had to wait in line before accessing the station. This metric provides an additional means of identifying congestion at stations, beyond simply the overall number of usage sessions. This distinction is important for stations that may see concentrated usage on particular days, but lower utilization over all. Congestion at stations will be an important consideration for future expansions of the DCFC network, and will likely drive a requirement for DCFC stations to support multiple vehicles charging at once. The following graph highlights that the number of conflicts is accelerating considerably as overall utilization of the DCFC stations increases:

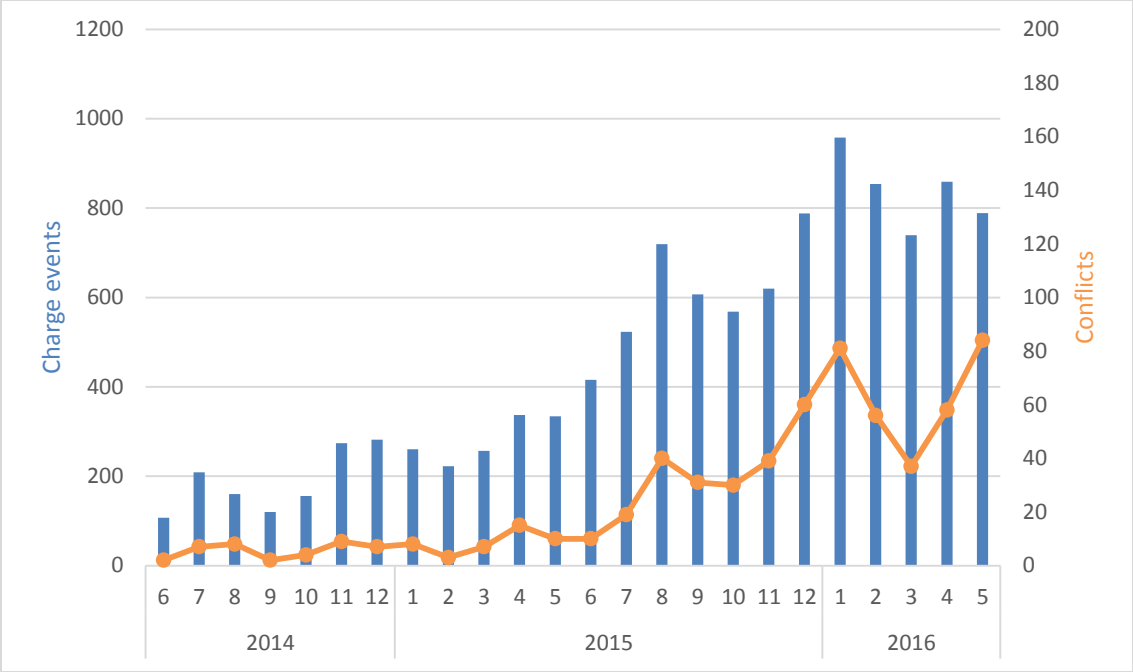


Figure 10: Usage data for DCFC sites in BC - congestion is increasing rapidly

Figure 11: Visual evidence of congestion at the Bakerview Ecodairy DCFC in Abbotsford

3 THE VEHICLES

3.1 Types of Vehicles

Since the late 1990's, a number of different types of "electrified" vehicles have come to market with varying levels of ability to move using electric power. The following are a few definitions to help clarify the distinction between these types of vehicles:

- **Hybrid Electric Vehicle (HEV):** A vehicle with both internal combustion and electric powertrains, but that cannot be charged from the grid and requires refueling using gasoline or other fuel.
    - **Examples:** Toyota Prius, Toyota Camry Hybrid, Ford C-Max

- **Battery Electric Vehicle (BEV):** A vehicle that is solely powered by an electric powertrain recharged from the electric grid. Also sometimes called "Pure EV" or "100% Electric".
    - **Examples:** Nissan Leaf, Tesla Model S, BMW i3

- **Plug-in Hybrid Electric Vehicle (PHEV):** A Hybrid Electric Vehicle that can be recharged from the electric grid, typically with the ability to travel significant distances without burning fuel, but with a combustion powertrain that can enable longer distances and faster acceleration.
    - **Examples**: Toyota Prius PHV, Ford C-Max Energi

- **Extended-Range Electric Vehicle (E-REV):** A type of PHEV that functions as a fully-performing BEV until the battery is depleted, at which point an internal combustion "range extender" (REx) or other auxiliary power unit (APU) is used to power the vehicle to enable longer distances. E-REVs typically have larger battery packs than PHEVs.
    - **Examples:** Chevrolet Volt, BMW i3 REx

- **Fuel Cell Electric Vehicle (FCEV):** A vehicle with an electric powertrain which may include a battery but primarily relies on a hydrogen fuel cell for power, and which can only be refueled with hydrogen[16].
    - **Examples:** Toyota Mirai, Hyundai Tucson FCEV

[16] The concept of a plug-in hybrid fuel cell electric vehicle, fueled by both hydrogen and electricity, has been shown by a number of automakers, and Mercedes is expected to launch such a vehicle with the GLC F-Cell in 2017: http://www.greencarreports.com/news/1104440_mercedes-benz-glc-to-offer-worlds-first-plug-in-fuel-cell-powertrain

This report will use the general term Electric Vehicle (EV) to include any vehicle that can be plugged in: Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Extended-Range EVs. In some technical contexts, the term Plug-in Electric Vehicle (PEV) is used instead, leaving "EV" to refer specifically to a BEV, but a more conversational language will use EV in the broader sense to denote any vehicle that can be charged up from the grid. The following diagram depicts the categorization of the above electrified vehicle types, with electric vehicles highlighted in red:

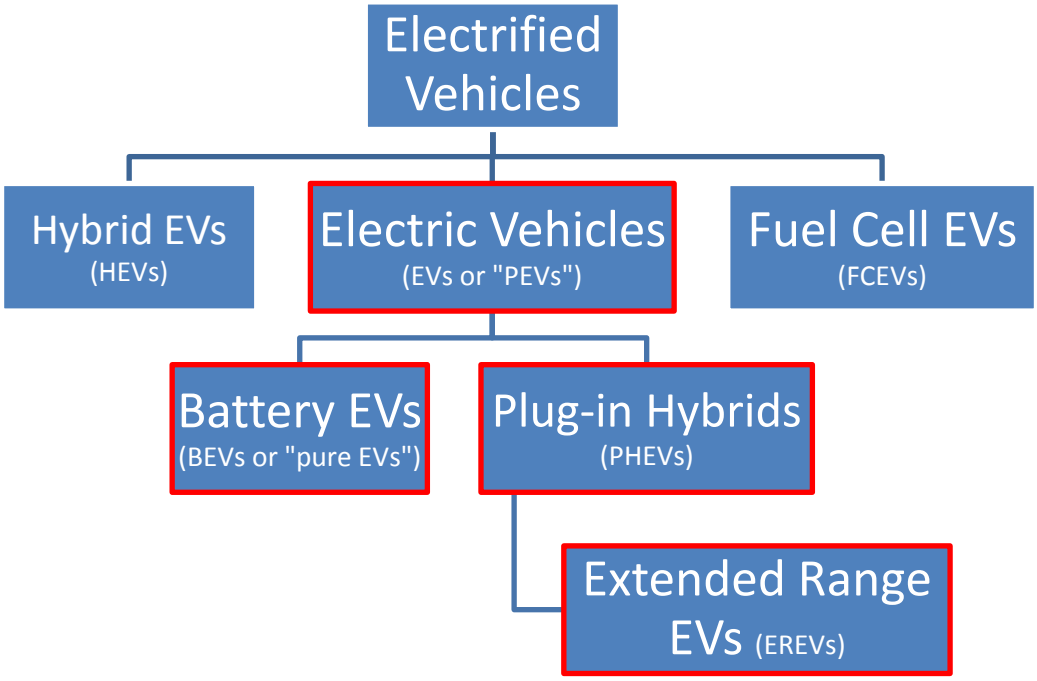


Figure 12 - Categorization of electrified vehicles; "plug-in" electric vehicles are highlighted in red.

While charging infrastructure may be less crucial to the operation of a PHEV (which has the ability to run on fuel once the battery is depleted), studies have shown that PHEV drivers may recharge more frequently, thereby achieving a comparable overall amount of electric driving as some BEV models.[17] In fact, public charging may have a greater impact on overall PHEV energy use, in that charging at a destination can often extend EV-mode range to cover an entire return trip, whereas BEVs can sometimes make a return trip without an actual need for charging at a destination. For this reason, it is recommended that charging infrastructure planning take into account all types of EVs in order to support greater overall EV adoption and maximize environmental benefits.

[17] http://avt.inel.gov/pdf/EVProj/eVMTMay2014.pdf

3.2 Currently Available EVs in North America

The following is a table of some of the most significant EV models available today, based on overall sales and availability. (See section 2.1 for overall sales numbers of these models in North America).

Table 6: Summary of significant EV models currently available in North America

Model	Vehicle Type	Electric Range (EPA certified)	Battery Capacity	Max AC Charging Rate	DC Charging Standard Supported	Max DC Charging Rate
Nissan Leaf	BEV	135-172km	24-30kWh	6.6kW	CHAdeMO	50kW
Chevrolet Volt (2016)	EREV (PHEV)	85km	18.4kWh	3.6kW	-	-
Tesla Model S	BEV	351-507km	60-100kWh	19.2kW	Tesla SuperCharger, CHAdeMO (via adaptor)	135kW (Supercharger) 50kW (CHAdeMO)
Tesla Model X	BEV	381-465km	75-100kWh	19.2kW	Tesla Supercharger, CHAdeMO (w/ adaptor)	120kW, 50kW CHAdeMO
Toyota Prius Plug-in	PHEV	18km (blended – gas assist)	4.4kWh	3.3kW	-	-
BMW i3	BEV or EREV	130km	18.8kWh	7.4kW	CCS	50kW
Smart ED	BEV	109km	17kWh	3.3kW	-	-
Ford C-Max/Fusion Energi	PHEV	32km	7.6kWh	3.3kW	-	-
Chevrolet Spark EV	BEV	132km	21.3kWh	3.3kW	CCS	50kW
Kia Soul EV	BEV	150km	27kWh	6.6kW	CHAdeMO	100kW
Mitsubishi iMIEV	BEV	100km	16kWh	3.3kW	CHAdeMO	44kW
Ford Focus Electric	BEV	122km	23kWh	6.6kW	-	-
Volkswagen eGolf*	BEV	134km	26.5kWh	6.6kW	CCS	50kW

*Products not currently available in Canada

3.3 Upcoming Products

Looking at upcoming models that have been announced by a number of automakers, four important trends stand out:

1. **Affordable long range BEVs**: While Tesla's Model S has shown that pure electric vehicles can be made with a driving range that is comparable to a conventionally fueled vehicle, its purchase price puts it out of reach of the majority of buyers. A number of automakers, however, are confirmed to be developing relatively affordable BEVs with a range of between 240km and 320km. The following are a few models with expected specifications, pricing and availability:

   a. **Chevrolet Bolt**
      - Compact hatchback
      - 383km Range
      - US$ 37,500
      - Available in late 2016

   b. **Tesla Model 3**
      - Midsize sedan
      - 345km range
      - US$35,000
      - Available in 2018

   c. **Nissan Leaf** (2nd generation)
      - Midsize hatchback
      - 240km range
      - US$30,000
      - Available in 2017

Figure 13: 2017 Chevrolet Bolt

   Increased range will make pure EVs more appealing for long trips, while also putting greater burden on charging infrastructure due to larger batteries. The "30 minutes to 80%" fast charge times often quoted for current products using typical 50kW DC Fast Charge stations will increase, unless charging stations increase in power to match these new products. Likewise, Level 2 AC charging will likely increase in power level, up to a possible maximum of 19.2kW, with 10kW being a more achievable target within reach of typical household electrical panels. Existing Level 2 infrastructure cannot typically deliver these higher power levels and would need to be replaced if higher power charging is desired.

2. **Even *more* affordable medium range BEVs:** While the above-mentioned "200-mile" EVs have attracted considerable media attention, 2016 saw the launch and/or announcement of a number of BEVs that serve to fill the gap between these "200-milers" and the first generation affordable BEVs that offered approximately 120-140km of range. In a number of cases, these are revised versions of existing BEVs that have been updated with a higher capacity battery, including the 2016 Nissan Leaf, the 2017 BMW i3, the 2017 Ford Focus Electric, and the 2017 or 2018 VW eGolf, all having batteries of between 30-36kWh and ranges of between 172-200km. If priced competitively relative to the longer range options, these models may find a market with two-car households, where the BEV is only required for daily commuting and not normally used for longer distance trips.

3. **Plug-in SUVs, Crossovers and Minivans:** While the Mitsubishi Outlander PHEV SUV has recently been one of the best-selling plug-in vehicles in Europe, the SUV-friendly North American market has been oddly starved of plug-in SUVs, crossovers and minivans so far. This began to change in late 2015, with the arrival of a number of PHEV models, largely at the more luxurious end of the market. The following are all plug-in hybrid mid-size SUVs, the majority of them with around 20-30km of EV range, although the Mitsubishi Outlander currently available in Europe offers an EV range of over 40km:

Figure 14: BMW X5 xDrive40e

   a. **Porsche Cayenne S E-Hydrid** (available now)
   b. **BMW X5 xDrive40e** (available now)
   c. **Mercedes GLE 550 e** (available now)
   d. **Audi Q7 e-Tron** (available late 2016)
   e. **Volvo XC90 T8** (available now)
   f. **Mitsubishi Outlander** (available early 2017)

   Pure electric SUVs are also starting to hit the road, with the **Tesla Model X** having launched in late 2015. The Model X has specifications similar to the Model S but with seating for 7, higher ground clearance, and standard all-wheel-drive. Audi and most recently BMW have since both announced tentative plans to develop similar all-electric SUVs or crossover vehicles in the 2018 to 2020 timeframe. Finally, the Chrysler Pacifica Hybrid will launch in late 2016 with 48km of electric range, becoming the first plug-in minivan, the first plug-in model from Chrysler, and also the first potentially large-volume plug-in vehicle assembled in Canada.

Figure 15: Chrysler Pacifica Hybrid

4. **Multiplication of PHEVs:** A number of automakers, particularly high-end German makes such as Mercedes, BMW and Audi, have announced that they will produce PHEV versions of the majority of their vehicle lineup. Most of these PHEVs have a modestly-sized battery, providing an electric range of around 20-30km, most will support Level 2 charging at 3.3kW, and most are not expected to support DC fast charging. Toyota will also be launching its next generation plug-in Prius in late 2016, the Prius Prime, now with a more competitive electric range of 40km, although seating has been reduced to four.

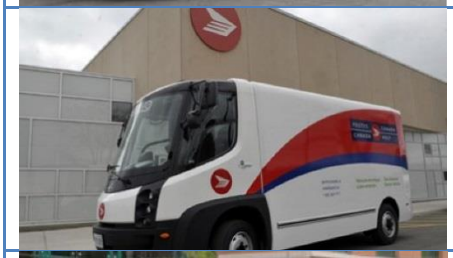
   a. **Hyundai Sonata PHEV**
   b. **Toyota Prius Prime**
   c. **Various BMW sedans (eg 3-series, 7-series, 5-series)**
   d. **Various Mercedes sedans (S-Class, C-Class)**
   e. **Various Audi hatchbacks and sedans (A3 e-Tron, A6 e-Tron)**

Table 7: Summary of upcoming EV models with expected specifications

Model (availability)	Vehicle Type	Electric Range	Battery Capacity	Max AC Charging Rate	DC Charging Standard Supported	Max DC Charging Rate
Chevrolet Bolt (2016)	BEV	383km	60kWh	10kW	CCS	75kW+
Tesla Model 3 (2018)	BEV	320km	60kWh	20kW	Tesla Supercharger, CHAdeMO w/ adaptor (expected)	120kW, 50kW CHAdeMO
Nissan Leaf (2017/2018)	BEV	240km	48kWh	10kW	CHAdeMO	75kW+
Ford Focus Electric (2016)	BEV	160km	30kWh (estimated)	6.6kW	CCS	50kW
BMW i3 (2016)	BEV,EREV optional	183km	33kWh	7.2kW	CCS	50kW
VW eGolf (2017)	BEV	200km	36kWh	7.2kW	CCS	50kW
Hyundai IONIQ (2016)	BEV	180km	28kWh	7.2kW	CCS	100kW
Mitsubishi Outlander (2017)	PHEV	40km	12kWh	3.3kW	CHAdeMO	50kW
Chrysler Pacifica Hybrid	PHEV	48km	16kWh	6.6kW	-	-
Hyundai Sonata (2016)	PHEV	30-40km	10kWh	3.3kW	-	-
Toyota Prius Prime (2016)	PHEV	40km	8.8kWh	3.3kW	-	-
Porsche Cayenne BMW X5 Mercedes GLE Audi Q7 Volvo XC90 (all 2016)	PHEV	20-30km	8-10kWh	3.3kW	-	-
Various Luxury sedans (2016-2017)	PHEV	20-30km	6-10kWh	3.3kW	-	-

3.4 Commercial Vehicles

While the vehicles discussed in the previous sections are primarily passenger vehicles, a large number and variety of commercial plug-in vehicles have entered the market in recent years, including delivery vans, utility trucks, and transit buses. The following table provides a quick summary of some of the commercial EVs that are currently available in North America (some with only limited availability of pre-production vehicles as of this writing):

Commercial EVs		Vehicle Type
	Smith Electric Delivery Truck (Previously in use by Novex) Range: [65 – 160 km] Payload Capacity: [725 – 7,400 kg]	BEV
	Nissan e-NV200 Van (available in Europe, limited availability in North America) Range: 170 km Payload Capacity: 703 kg	BEV
	Navistar eStar (in use by Canada Post) Range: 160 km Price: US$150,000 Battery swap available	BEV
	EVI Step-Van (in use by UPS in California) Range: 145 km Capacity: [662 – 970ft^3]	BEV
	VIA Motors V-Trux (in limited use by select utility fleets) Range: 64 km (electric) Payload Capacity: 1,000 lb	PHEV
	VIA Motors Shuttle Van (limited availability) Range: 55 km (electric) Payload Capacity: 2,000 lb	PHEV

Commercial EVs		Vehicle Type
	Odyne Bucket Truck (in use by City of Vancouver) Engine-off bucket operation Battery: [14 – 28 kWh]	PHEV
	Proterra Catalyst (In use by several US transit agencies) Battery: [79 – 660 kWh] Range: [79 – 563 km] Fast overhead charging	BEV
	NovaBus (limited trial by the Société de transport de Montréal) Fast overhead charging	BEV
	New Flyer (under test by Winnipeg Transit) Battery: [100 – 300 kWh] Fast overhead charging	BEV
	BYD K9 (In use by several US transit agencies) Range: [250 - 299 km] Price: [S$395,000 – S$592,600]	BEV
	BYD T7 (Class-6 Truck) Range: 200 km Battery: 175 kWh	BEV

Commercial EVs		Vehicle Type
	BYD Q1M (Class-8 Terminal Tractor) Range: 15 hours Battery: 209 kWh Max Torque: 1106 lbs-ft	BEV

3.5 Other Vehicles

3.5.1 E-bikes and Scooters

E-Bikes and E-scooters are road-legal, two-wheeled vehicles. To be classified as an E-Bike, a vehicle must have pedals for human propulsion, have a less-than 500W motor and be speed-limited to 32km/h; they do not require a licence or registration. The battery is usually small (less than 1 kWh), so it can often be removed and hand-carried to be charged on any outlet. Electric scooters are limited to 1.5kW and are subject to the same restrictions as scooters with a less-than 50cc gasoline motor. Their battery packs are between 1 and 2 kWh.

Typically, both E-bikes and scooters charge from a standard 120V/15A outlet, located in almost every building in the country. Charging using a standard J1772 EV charging station is typically not supported, unless the charging station is also equipped with a 120V/15A outlet, as in some earlier models from ChargePoint.

3.5.2 Motorcycles

The two major manufacturers of electric motorcycles are Lightning and Zero. Battery packs range from 5 kWh to 20 kWh providing range from 70 km to 300 km depending on driving style and conditions.

Figure 16: Lightning LS-218 electric motorcycle

Electric motorcycles typically charge using a J1772 connector, allowing them to use a standard Level 1 or Level 2 EV charging station. The onboard charger delivers around 1.3 kW which equates to 20 km of range per hour. Some models may not have a J1772 connector, requiring a 120V/15A outlet, as with most E-bikes and E-scooters.

Fast charging options are available on the Lightning motorcycle, and it is expected that future motorcycles will come standard with DC Fast charging technology,(CCS or CHAdeMO) reducing the charging time to 15 minutes.

3.5.3 Small Utility Vehicles

Small Utility Vehicles are available from companies such as Polaris and John Deere. They are classed as Low-Speed Vehicles and are limited to 40 km/h, but are allowed to drive on most roads posted at 60 km/h or less. Low-Speed Vehicles must have an electric drivetrain under Transport Canada regulations. Most of these vehicles use lead-acid batteries for their low cost and ease of replacement; however, as lithium-ion technology becomes cheaper and more commonplace, lead-acid will be phased out.

The Polaris GEM comes with a standard lead-acid battery or an optional lithium-ion battery to reduce weight and increase range. Chargers can be level 1 or level 2 and can deliver up to 6 kW of power using the J1772 standard. The GEM is available in a variety of configurations for passengers (from two to six seats) and cargo (eg covered boxes or open pickup bed) with pricing ranging between approximately $10,000 and $20,000 USD. Polaris also offers an all-terrain vehicle with the lead-acid batteries.

Figure 17: Polaris GEM eL XD

Figure 18: John Deere Gator TE

The John Deere Gator TE is powered by lead-acid batteries and does not offer a lithium-ion option yet. Charging is carried out at around 1.5kW and uses a standard outlet. Top speed is 25 km/h. The Gator TE currently retails for $15,703 CAD, representing about a $6000 premium over a comparable gas-powered model.

The Might-E Truck is made by Canadian Electric Vehicles Ltd (CanEV), located on Vancouver Island. It has a top speed of 40 km/hour and it is powered by a 16 kWh lead-acid battery. The load capacity is between 300 and 500 lbs on road with a 1000 lb configuration off road. It is charged by a 72V/12A charger, delivering 864 W. CanEV also has experience converting over 60 aircraft refueling trucks from fossil-fuel to electric power. Pricing for the Might-E Truck was not immediately available.

Figure 19: CanEV Might-E Truck

3.6 Battery degradation

One concern that is often raised about electrified powertrains is the durability of batteries. Based on experience with consumer electronics and possibly older technologies such as lead-acid batteries, one might expect that an electric vehicle would need frequent and expensive battery replacements. Older battery chemistries also required users to follow certain usage practices, such as avoiding partial charge and discharge cycles due to the so-called “memory effect”. Modern EVs, however, all use lithium-ion batteries that are relatively robust and flexible. Most EVs come with an eight- to ten-year battery warranty, and automakers do not impose any strict requirements on charging patterns. That said, some battery degradation over time is expected, and some automakers only guarantee that the battery will retain 75% to 80% of its original capacity by the end of the coverage period.

Factors affecting battery degradation include calendar age, number of charge/discharge cycle, state-of-charge during storage (degradation is worst when the battery is full), and temperature (high temperatures degrade batteries faster). Regular usage of fast charging stations is generally discouraged by automakers, although a study

conducted by Idaho National Laboratory found that fast charging had less of an impact on battery life than expected, and that high temperatures and overall distance travelled (and hence battery usage cycles) were stronger factors[18].

While the oldest samples of the current generation of EVs have only been on the road for about six years, early reports suggest that battery degradation varies from one automaker to the next, likely due to differences in battery and vehicle design. The Nissan Leaf does not employ an active cooling system for its battery. Some reports suggested that this left the Leaf vulnerable to excessive battery degradation in extreme climates, and Nissan has since responded by introducing a modified battery chemistry that is more resilient to hot temperatures.[19] The Chevrolet Volt, meanwhile, does include an active cooling system for its battery, and GM has suggested this has allowed them to avoid any warranty battery replacements due to capacity loss[20].

A survey conducted by Plug-in America collected the odometer and battery capacity of over 500 Tesla Model S vehicles to estimate battery degradation[21]. Generally, the battery packs were found to lose about 5% of their capacity in the first 80,000 km after which the degradation slows; owners of vehicles with over 160,000 km have reported less than 8% degradation.

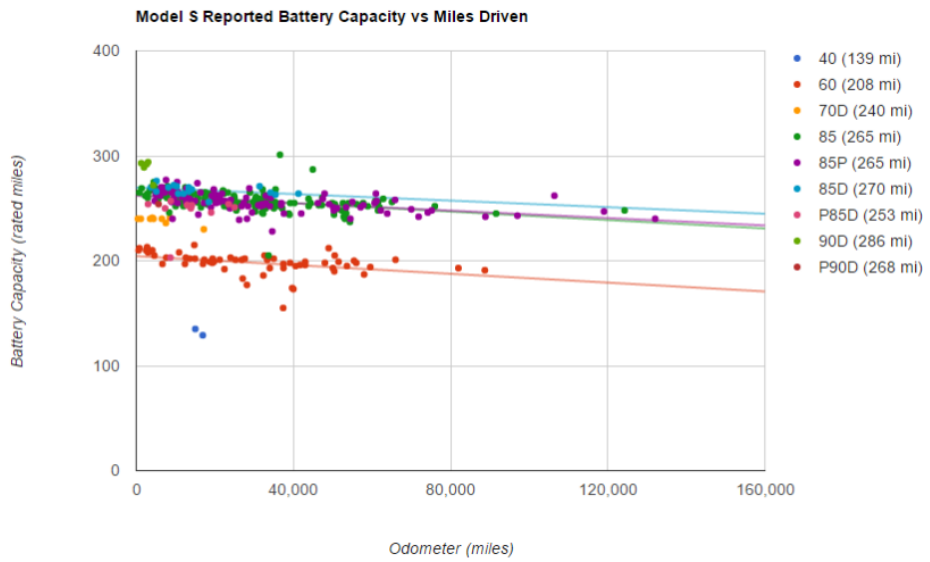


Figure 20: Model S battery capacity vs odometer readings – pluginamerica.org

[18] https://avt.inl.gov/sites/default/files/pdf/vehiclebatteries/FastChargeEffects.pdf

[19] http://www.greencarreports.com/news/1092983_nissan-leaf-battery-cost-5500-for-replacement-with-heat-resistant-chemistry

[20] http://insideevs.com/zero-first-generation-chevrolet-volt-battery-packs-replaced-due-general-capacity-degradation/

[21] http://survey.pluginamerica.org/model-s/charts.php

4 CHARGING INFRASTRUCTURE

An electric battery is a direct current (DC) device – there is a positive and a negative terminal, and they do not alternate! Charging an electric vehicle's battery therefore requires DC electrical power, whereas electricity is typically distributed in alternating current (eg 120V AC or 240V AC). This means that at some point, electricity must be converted from AC to DC. Whether this conversion happens onboard the vehicle or within a charging station is an important distinction for charging infrastructure.

The most common way to charge an EV is through AC charging. In this configuration, AC power from the grid is provided to the vehicle through the charge port, and an onboard component (the charger) converts this AC power to DC in order to charge the battery. This configuration allows the vehicle to charge in a broader range of places, as most of the specialized equipment is carried onboard the vehicle, and the stationary charging station can be quite simple. That said, the power of an onboard charger is more limited in order to avoid adding excessive cost and weight to the vehicle.

In the case of DC charging, the charging station itself performs the AC-to-DC conversion, and DC power is provided to the vehicle's charge port, bypassing the onboard charger and going directly into the vehicle's battery. With the DC charger off-board of the vehicle, it can be significantly larger and more powerful, and the higher cost of this equipment can effectively be shared across many users. On the other hand, this charging station is significantly more complicated and expensive than an AC charging station, adding to the cost of infrastructure deployment.

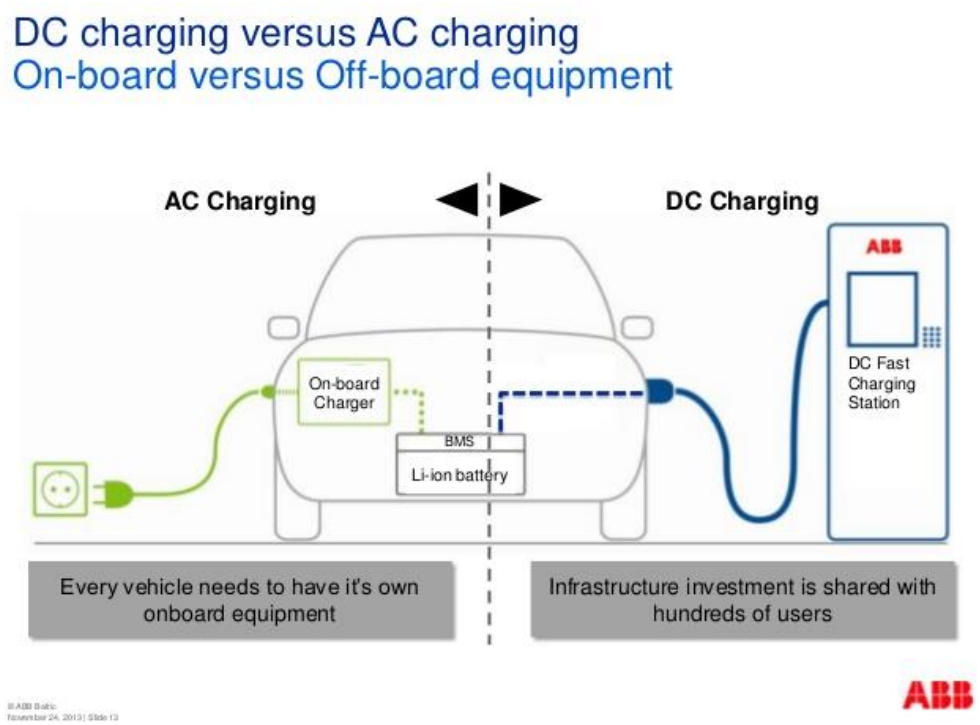


Figure 21: Diagram showing the difference between AC and DC charging - Source: www.abb.com

The following sections provide details on AC and DC charging, as well as two potential alternative means of replenishing an electric vehicle: wireless charging and battery swapping.

4.1 AC Charging

Since AC charging involves providing AC power to a vehicle's charge port, one might assume that all that is required is a simple extension cord plugged into a household outlet. This is close to true, but not quite. All passenger EVs sold in North America comply with the SAE J1772 standard which defines a standard connector and communications protocol for AC charging of electric vehicles. The J1772 standard ensures that a vehicle is aware of the limitations of the circuit it is connected to, ensures that power is only applied when the vehicle is actively requesting power (preventing bad connections, arcing and potential fire risks), and prevents the vehicle from being driven while a charging cable is still attached.

A J1772-compliant charging station or EV Supply Equipment (EVSE) essentially acts as an extension cord with these safety features built-in. An EVSE may either be a fixed piece of equipment, or a portable cordset that is kept with the vehicle in order to plug into existing outlets.

Charging Level	Specification	Charging Time	Application
AC Level 1	120V, 8-16A, 12A typical	PHEV: 8-12 hours BEV: 16+ hours	Suitable for PHEVs with smaller batteries. May be suitable for BEVs for overnight, workplace or long term parking.
AC Level 2	240V, 6-80A, 30A typical	PHEV: 2-4 hours BEV: 4-8 hours	Most common type of public charging.
AC Level 3 (in development)	3-phase AC	Large BEV: 2-8 hours	Standard in progress (SAE J3068) – intended to support large commercial vehicles.

4.1.1 AC Level 1

AC Level 1 charging is the slowest form of charging, although it is quite versatile due to the ubiquity of 120V outlets. Many PHEV owners and some BEV owners get by with only Level 1 charging at home. Four hours of charging at Level 1 can provide approximately 30km worth of range, depending on the vehicle and driving conditions. This may be sufficient to support daily driving with overnight charging or while charging at work. Supporting long distance travel on Level 1 becomes more problematic: at approximately 1.5kW, a full charge for a Nissan Leaf (24kWh battery) would take approximately 16 hours. A full charge for a Tesla Model S85 (85kWh battery) would take approximately 56 hours.

Charging Level	Panel Requirements	Charging time required to replenish 30km of range (~6kWh)	Charging time required to replenish 120km of range (~24kWh)
AC Level 1 (1.4kW)	120V, 15A	4h	16h

When discussing Level 1 charging infrastructure, it is important to consider the distinction between a simple 120V outlet, and a fixed Level 1 EVSE. While a 120V outlet is sufficient to provide power to an EV, the driver will be required to supply their own portable EVSE and leave this connected to the outlet. This can be less convenient to an EV driver – it can take a minute or two to unpack and connect a portable EVSE, and packing it up afterwards also takes time and can get messy depending on weather. This arrangement can also be less secure in that the EVSE may be easily stolen. This concern can be addressed either with a locking mechanism on the outlet, or by a charge port on the vehicle that may come equipped with a locking mechanism.

A level 1 EVSE addresses these concerns by fixing the equipment to the facility and allowing EV drivers to leave their portable EVSE in the trunk. This convenience may be appreciated in regular parking scenarios such as

workplace charging facilities where an EV driver might charge every day. EV drivers using long term parking facilities may be more willing to deal with these inconveniences as it is not likely to be as frequent a scenario.

AC Level 1: 120V outlet + driver-supplied EVSE

Advantage:

- Lowest cost

Disadvantages:

- Time it takes to unpack and pack up EVSE
- Mess of EVSE left on ground in bad weather
- Security – portable EVSE may be easily stolen if not otherwise locked

Applications:

- Long term parking facilities
- Locations where other infrastructure is unavailable

Figure 22: 120V Outlet + user supplied EVSE

AC Level 1: Fixed Level 1 EVSE

Advantages:

- Convenient for EV driver
- Security – EVSE is fixed in place
- Ability to implement access control and data collection

Disadvantage:

- Additional cost: $400-$1500 per port

Applications:

- Vehicles with light duty-cycle
- Long term parking facilities

Figure 23: Telefonix L1 PowerPost ($1500) and ClipperCreek ACS-20 ($400)

4.1.2 AC Level 2

Level 2 charging stations are the most common type of public charging infrastructure in North America, with over 35,000 Level 2 charging ports active as of August 2016[22]. The charging rate is typically more than doubled as compared to Level 1 charging, thanks to a higher voltage (240V vs 120V) as well as typically higher amperage circuits (40A being the most common, vs 15A circuits for Level 1). The J1772 standard supports Level 2 charging at rates between 1.4kW and 19.2kW. The actual charging rate will depend on the minimum of either the EVs maximum charging rate or the EVSE's available power. Most PHEVs and some BEVs are only capable of charging at 3.3-3.6kW due to the limitation of the onboard charger. Many BEVs now support Level 2 charging at 6.6-7.2kW (eg Nissan Leaf, Ford Focus EV, Volkswagen e-Golf). The Tesla Model S can draw up to the maximum 19.2kW allowed by the J1772 standard, provided the EVSE and electrical panel have sufficient capacity.

Charging Level	Panel Requirements	Vehicles Supported	Charging time required to replenish 30km of range (~6kWh)	Charging time required to replenish 120km of range (~24kWh)
AC Level 2 (3.3-3.6kW)	240V, 16A	All EVs	2h	8h
AC Level 2 (6.6-7.2kW)	240V, 40A	Most new BEVs	1h	4h
AC Level 2 (19.2kW)	240V, 100A	Tesla Model S	<0.5h	<1.5h

Figure 24: Some common Level 2 charging stations

4.1.3 AC Level 3 (in development)

AC Level 3 is a new category of charging that is in development as part of the SAE J3068 standard. It is intended to support larger plug-in vehicles such as electric buses and trucks; vehicles which would likely charge in commercial/industrial settings with access to high amperage 3-phase AC power. The standard is still under development but expected output power is 66 kW (480V/80A) with a connector similar to the Mennekes Type 2 plug, which is common in Europe instead of SAE J1772.

Figure 25: European "Mennekes" Type 2 connector

An advantage of this charging configuration is a symmetric three phase load, which helps preserve grid stability. Higher power levels could be possible as it uses a similar connector to the European Tesla Superchargers which deliver up to 140 kW DC.

[22] http://www.afdc.energy.gov/fuels/electricity_locations.html

4.2 DC Fast Charging

DC Fast Charging enables EVs to charge much more quickly, opening the door to longer distance trips and higher overall utilization of EVs. DC Fast Charging connects the charging station directly to the vehicle's battery terminals, therefore requiring a separate connection to the vehicle than that used for AC charging (unless wiring on the vehicle is automatically reconfigurable, such as with the Tesla Model S).

DC fast charging used to be referred to as "Level 3" charging, but this nomenclature was revised in 2011 in order to distinguish between the different charging configurations, and to leave the door open for definition of 3 charging levels for both AC and DC charging.

DCFC capabilities are most commonly available with BEVs, with the BMW i3 REx (equipped with range extending engine) standing out as the only PHEV currently available in North America with a DCFC port. Generally speaking, PHEVs have sufficient power from the gasoline portion of the powertrain to support long distance travel without the need for recharging. Studies have shown though that PHEV owners charge their vehicles more frequently than BEV owners[23], leading some to speculate that PHEV drivers may go out of their way to use a fast charge station in order to avoid burning gasoline on longer trips. While not yet available in North America, the Mitsubishi Outlander PHEV includes a CHAdeMO DCFC port in European and Japanese markets, and other automakers have suggested future PHEVs are likely to offer DCFC as an option.

4.2.1 DC Charging Rates

The most common DCFC stations in North America as of 2015 support charging at up to 50kW, and this aligns well with the maximum charging rate supported by the most common BEVs (eg those with ~24kWh of battery capacity, ~120km of range). These vehicles can actually only support this maximum charging rate during the earlier part of a charge event, and the charging rate must be tapered down as the battery approaches a full charge. The following graph shows a charge event that started at approximately 50% state-of-charge (SOC), with the charging rate beginning to reduce after only 5 minutes of charging:

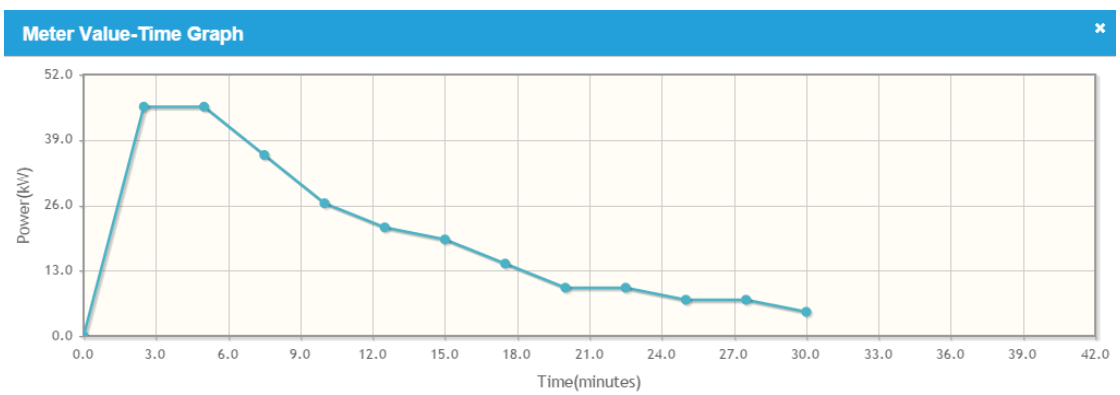


Figure 26: A charge event from a 50kW DCFC station

For this reason, some manufacturers (such as Bosch and Fuji) have launched DCFC products that are limited to 25kW, arguing that overall charging times for the current generation of EVs are not increased significantly, especially when vehicles are plugged in at 30% SOC or higher. Fuji claims that a typical EV charging from 30% SOC to 77% SOC would only require 7 additional minutes to charge using a 25kW station as compared to a 50kW station[24]:

[23] http://avt.inel.gov/pdf/EVProj/eVMTMay2014.pdf
[24] http://www.americas.fujielectric.com/systems/ev-charger/dc-quick-chargers-electric-vehicles-ev

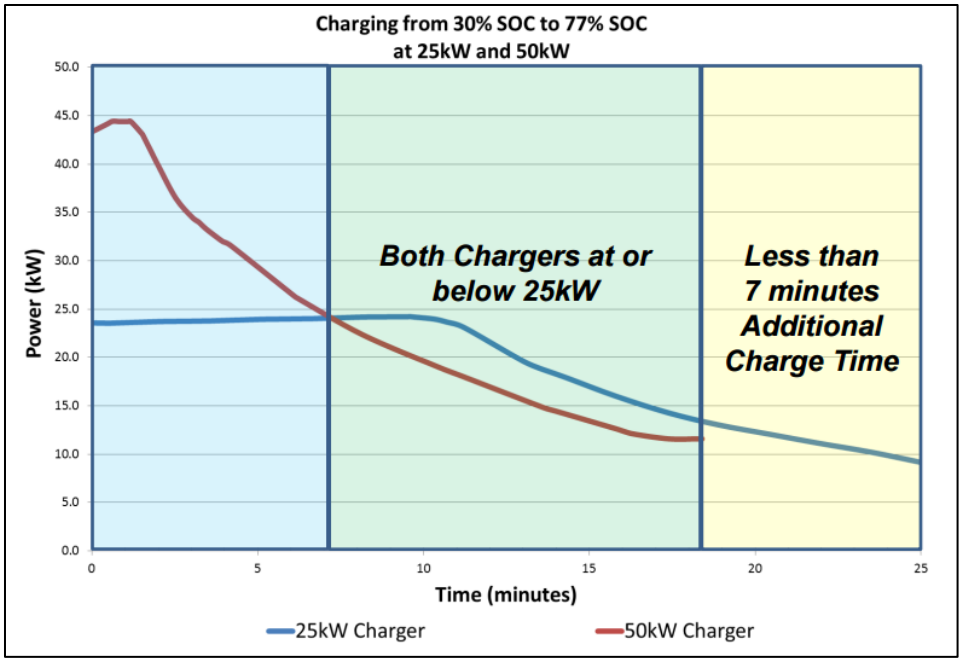


Figure 27: Comparison of 25kW and 50kW DCFC charge curves - www.americas.fujielectric.com

Fuji is also correct to highlight the reduced installation and operation costs of lower power DCFC stations. It is important to consider, however, that future BEV models with significantly longer range will require longer charge times, and will likely support a higher charging rate than the products currently on the market (much like the Tesla Model S can currently support charging at up to 135kW). A BEV with 320km of range would likely take over 2 hours to charge to 80% on a 25kW station, vs about 1 hour on a 50kW station. This next generation of longer-range BEVs has many considering the need to increase DCFC charging rates to 100kW and even higher. The following table shows various power levels considered for DCFC charging:

Table 8: DCFC charging rates

Charging Rate	Charging Time	Notes
25kW	40 mins to 80% (120km range EV)	Lower cost installations, slightly slower overall charge time for current generation of EV (~120km range)
50kW	30 mins to 80% (120km range EV)	Most common DCFC, maximizes charging rate on current generation of EV
100-150kW	30 mins to 80% (200km range EV)	Not yet common, will support future EVs with larger batteries, broader support expected by 2018
135kW (Tesla Supercharger)	40 mins to 80% (Model S)	Proprietary solution
300kW	15 mins to 80% (400km range EV)	In development, expected by 2020

4.2.2 DCFC Standards

While all EVs sold in North America support the J1772 standard for AC charging, there are currently two competing standards for DC charging, as well as a proprietary solution used only by Tesla.

Tokyo Electric Power Company (TEPCO): CHAdeMO

CHAdeMO was the first DC fast charging protocol to be deployed, debuting with the Nissan Leaf and Mitsubishi iMIEV in 2010. It supports charging at up to 60kW, while most EVs currently max-out at 50kW. As of September 2016, there were over 1900 CHAdeMO charging stations in North America and 3500 in Europe.[25]

Figure 28: Nissan Leaf charging ports, left to right: CHAdeMO DCFC, J1772 AC

Society of Automotive Engineers (SAE): Combined Charging System (CCS)

SAE's CCS charging protocol was adopted by all North American and European automakers in 2012. The vehicle charge port has a smaller footprint than the CHAdeMO protocol by reusing the same communications wires as those used by the J1772 AC charging port, thus the name "Combined Charging System". The first CCS DCFC stations appeared in 2013, and as of September 2016, there are now over 600 available in North America[26] and over 2400 in Europe.[27] Note that the European version of CCS is based on the European "Type 2" connector, as opposed to the J1772 connector used in North America. This is in order to support 3-phase AC charging which is more common in Europe, although the communications protocol is shared in either case.

Figure 29: SAE CCS charge couplers, European version on left, North American version (J1772) on right. The associated AC-only charge couplers are shown above each CCS variant for reference.

[25] http://www.chademo.com/
[26] www.plugshare.com
[27] http://insideevs.com/number-of-ccs-combo-chargers-in-europe-exceed-2400/

Tesla Supercharger
Tesla began deploying its own DCFC infrastructure in 2013. Using the same port as for AC charging, the vehicle is required to reroute electricity past the on-board charger in order to charge the battery directly with DC power. Since 2013, Tesla has installed over 400 Supercharger stations worldwide, including 15 in Canada, with an average of about 6 charging stalls per station. These stations support charging rates of up to 135kW.

The Tesla Model S is also able to use CHAdeMO DCFC stations through the use of a Tesla-designed adaptor.

Table 9: Summary of DCFC standards

Standard	Supported Vehicles	Supporting Automakers
CHAdeMO	Nissan Leaf Mitsubishi iMIEV Kia Soul EV Tesla Model S (via adaptor)	Mitsubishi Nissan Kia
CCS	BMW i3 Volkswagen eGolf Chevrolet Spark Hyundai Ioniq Ford Focus Chevrolet Bolt	BMW Volkswagen Audi Mercedes GM Ford Fiat-Chrysler Hyundai
Tesla Supercharger	Tesla Model S	Tesla

Major Japanese automakers Honda and Toyota have not announced details for any upcoming BEV products, and their support for either DCFC standard is unclear. Meanwhile, some automakers have shown signs of adopting standards based on sales region, with BMW offering a CHAdeMO-equipped i3 for the Japanese market, and Tesla adopting the standard “Type 2” connector for European sales of the Model S and European Supercharge stations.

Multi-Standard DCFC Stations

The complications introduced by the existence of multiple standards for DC charging have largely been eliminated by the introduction of multi-standard DCFC stations. Much like a gas-station pump with multiple nozzles for different types of fuel, a multi-standard DCFC station allows an EV driver to simply plug the appropriate connector into their vehicle and commence charging. The additional connector does add some cost to the equipment, although this is small relative to the overall cost of the charging station and installation.

North American multi-standard stations typically have two connectors: CHAdeMO and CCS. European multi-standard stations also include a high power AC charge port, which is more commonly supported on European vehicles. Some manufacturers of North American dual-standard DCFC stations include:

- Efacec
- Signet
- AddÉnergie
- ChargePoint
- ABB
- BTC Power
- Schneider

Figure 30: Multi-standard DCFC stations: AddÉnergie, ChargePoint, and ABB (European version shown)

4.3 Wireless Charging

Both the AC and DC charging approaches discussed above are considered "conductive" charging, in that metal conductors are used to supply electricity to a vehicle. There are, however, a number of ways of delivering power without wires. One such method is through induction, or "inductive" charging, where a receiver coil mounted on the vehicle may receive power wirelessly from a sender coil which composes part of a wireless EVSE, or WEVSE. Alternating current in the sender coil creates an alternating electromagnetic field which in turn induces alternating current in the receiver coil. Such systems have been designed to transfer power between a sender coil mounted flat on the ground to a receiver coil mounted on the underside of a vehicle. This can be used to recharge an electric vehicle while stationary, or even potentially while a vehicle is travelling.

At least one after-market wireless charging retrofit package is available for installation on select EVs. PluglessPower (www.pluglesspower.com) offers a 3.3kW charging system compatible with the Nissan Leaf and Chevrolet Volt for under US$ 2000, with some Nissan and Chevrolet dealers able to assist with installation of the Vehicle Adaptor that's required on the vehicle. Telecommunications giant Qualcomm is also actively developing wireless charging technology for EVs, and has demonstrated wireless charging BMW vehicles as part of the FIA Formula E racing series.

Automakers are working together to establish automotive standards for wireless charging, and it is generally expected that the functionality will be incorporated into future models. In early 2016, SAE published the J2954 "Technical Information Report", a specification guideline that will evolve into a formal standard once field data can be collected from early deployments[28]. A large number of automakers and component developers (including PluglessPower and Qualcomm) have contributed to the development of J2954.

The advantage of wireless charging is largely convenience – an EV driver would no longer be required to manually plug their vehicle in, but would rather be required to park in a precise location within range of a WEVSE. The driver may be provided with driver aids that help guide the vehicle to this precise location such that the vehicle is within the required range to establish a wireless connection with the WEVSE. This added convenience may become critically important for scenarios that involve frequent stop-start cycles and many opportunities for

[28] http://standards.sae.org/wip/j2954/

charging, where manually connecting a traditional charging station may be impractical. This could include taxis operating in a queue or buses that recharge while picking up passengers at a stop.[29]

The disadvantages of wireless charging are increase in cost and decrease in efficiency. The US Department of Energy's Idaho National Laboratory found the above-mentioned PluglessPower system to have an overall efficiency of between 86% and 90%, depending on alignment and the vertical gap between the coils.[30] This would cause an increase in the overall energy consumption of an EV for a given distance by about 10-15%.

The combination of increased vehicle cost, increased charge station cost, and decreased efficiency means that wireless charging is likely to remain an optional convenience feature, and it is not expected to replace conventional conductive charging as the standard means of charging EVs for the foreseeable future. While the technology may establish a foothold in luxury vehicle segments where cost and efficiency are often traded off for convenience features, or for specific applications with frequent opportunities for charging (such as with taxis or fleet vehicles), these vehicles are still likely to be equipped with a standard charge port as well, to ensure compatibility with existing charging infrastructure.

Wireless Charging	
Opportunity:	Convenience and ease of recharging, especially for frequent stop/start cycles.
Challenges:	Added cost and reduced energy efficiency.
Status	After-market retrofit packages readily available for existing EVs. Some future vehicle models likely to support wireless charging as early as 2017.
Ideal application:	Buses charging at passenger pick-up/drop-off areas, taxis charging while in queue.

[29] "London Buses to be Recharged Wirelessly During Stops" http://evworld.com/news.cfm?newsid=34021
[30] http://avt.inel.gov/pdf/evse/EvatranWirelessChargingFactsheetAug2013.pdf

4.4 Battery Swapping

Battery swapping has often been discussed as a potential means of speeding up the process of replenishing an electric vehicle's state of charge. By physically replacing a depleted battery with a fully charged one, an EV driver would potentially be able to carry on with their drive within minutes while their original battery is recharged at the battery swapping/charging facility. This was the vision of the now-defunct Project Better Place, an Israel-based company that operated between 2007 and 2013. Better Place envisioned an EV industry with standardized battery designs and subscription-based ownership models that mimicked the cellphone industry. The challenges of battery swapping for passenger vehicles are largely due to physical design:

1. Given that an EV battery can be a very large component, it can be difficult to design it in such a way to be easily swappable without overly compromising the mechanical and electrical design of the vehicle.
2. Given challenge #1, standardizing the battery design such that batteries can be shared across a broad range of vehicle makes and models with a variety of designs is an even greater challenge.

More recently, Tesla Motors has demonstrated battery swapping with the Tesla Model S, and has even established a single battery swapping facility in California. The Model S's design lends itself well to battery swapping, with the battery slung underneath the vehicle making it relatively easy to remove. Yet even with this swapping-friendly design, and with an automaker that's entirely focused on a single vehicle model, Tesla has found that battery swapping may not be worth the effort, given the advances in fast charging capabilities. Tesla's free network of 135kW "Supercharge" stations can provide a 300km charge in less than 30 minutes, whereas a battery swap requires a fee of approximately $50 (mimicking the cost of a full tank of gasoline). With a battery swapping facility located approximately midway between San Francisco and Los Angeles, Tesla has found that this service is not very popular, with most of their customers opting for the free but slower supercharging service.

Battery swapping is, however, widely practiced with commercial vehicles, especially material handling equipment such as forklifts. The high duty cycle of some commercial vehicles can benefit greatly from the quick turnaround of a battery swapping approach, and the dedicated design of the vehicles operating in a large fleet out of a single facility can simplify the logistics.

Battery Swapping	
Opportunity:	Very fast turnaround for a full charge.
Challenges:	Complicates vehicle design, difficult to standardize across vehicles
Status	Basic demonstrations, limited operation at one Tesla facility. No foreseen broad availability for passenger vehicles.
Ideal application:	Material handling equipment and other dedicated commercial fleets.

4.5 Costs, Usage Fees, and Best Practices

4.5.1 Typical Costs

The following cost estimates are based on actual project experience, with Powertech having installed numerous Level 1, Level 2 and DCFC stations, and played a supporting role in many more projects.

The costs of EV charging equipment vary greatly depending on charging level. The following table provides approximate ranges for the three most common currently available types of charging equipment:

Table 10: Approximate charge station equipment costs

	Equipment Cost (per port)	Factors affecting cost
AC Level 1	$50-1500	Outlet vs EVSE
AC Level 2	$1500-5000	Output power, power management and networking capabilities, station manufacturer
DC Fast Charge	$15,000-50,000	Output power (25kW vs 50kW), station manufacturer, support for multiple standards

The cost of installation of charging equipment can also vary greatly. The following installation costs are based on Powertech's experience across multiple projects, and include all aspects of a complete EV charging installation, including signage and associate hardware:

Table 11: Approximate charge station installation costs

	Installation Cost (per port)	Factors affecting cost
AC Level 1	$500-10000	Various site-specific considerations: distance from power source, ground surface type, future-proofing, available electrical supply.
AC Level 2	$3000-15000	
DC Fast Charge	$20,000-80,000	

The cost of operating an EV charging installation depends heavily on the utilization of the station. According to information available through Powertech's evCloud website (www.fleetcarma.com/evCloud), the average charge station in Metro Vancouver is used about 6 times per week, dispensing an average of 6kWh of electricity each time, adding up to about $150 of electricity per year. Some of the busier Level 2 stations in the region can see more than twice this amount utilization, while the busiest DCFC stations are used greater than 20 times per week. Depending on the peak power demand of a utility account, charging stations can incur additional fees due to demand charges[31], adding up to $6000 per year for a single DCFC station. Finally, many charging stations require payment of a yearly service fee in order to support network transactions for usage fee collection, data collection and power management. Here are the yearly fees for some of the most common EVSE network operators in BC:

Table 12: Charge station network service fees (as of 2015)

Network	Yearly service fee per port
Highest	$300
Lowest	$125
Typical	$260

[31] A demand charge is a fee based not on the total energy consumed (in kWh) over a billing period, but rather on the peak power level (in kW) delivered at any point during that period. See https://www.bchydro.com/news/conservation/2013/demand-charge.html for more information.

The following table summarizes typical charge station operational costs:

Table 13: Charge station operating costs (per port)

	Yearly Energy Cost	Yearly Demand Charges	Yearly Network Fee	Total Yearly Cost
AC Level 1	<$100	0	0	<$100
AC Level 2	$250-500	$0 - 400	$125-300	$375-1200
DC Fast Charge	$300-1000	$1800 - 6000	$260	$2100-7000

4.5.2 Usage Fees

Many charging stations support the collection of usage fees through the use of network member cards and smart phone applications. These networks typically require a user to sign up for an account with each individual network, although there have been some efforts to establish roaming systems that allow networks to share members and allow universal access to equipment across multiple networks.[32]

Usage fees for charging stations can be based on:

- Per usage session
- Energy (kWh)
- Time (minute or hour)

The most common type of fee structure is based on time. A time-based fee can be effective in incentivizing users to move their vehicle once charging is complete, and can help ensure the most effective utilization of charging equipment.

Usage fees based on a per-kWh energy value can be preferable in terms of ensuring all users pay the same amount for the same service. The speed of charging may depend on a number of variables (vehicle type, state-of-charge of battery, battery temperature, power reduction due to load management) and so a usage fee based on the actual energy delivered may be the most fair.

In selecting a usage fee, it may be desirable to select a fee that recovers the operating costs of the station, while still keeping the cost of charging an EV comfortably below that of fueling a conventional vehicle on a per-km basis. In BC, at $1.40/litre of gasoline, this equivalency works out to about $0.50 per kWh, or about $1.65 per hour if charging at a rate of 3.3kW. A rate of $1 per hour is common at many stations in the province of Quebec.

In BC, almost all Level 2 charging stations are free to use, although many are located in paid parking lots where EV drivers pay the same rate as other drivers. DCFC stations in BC are gradually adopting a price of $0.35/kWh, placing the price comfortably below parity with gasoline, while still applying a premium fee for the fast charging service.[33]

Resale of electricity in BC is regulated by the BC Utility Commission, and so the application of usage fees for EV charging is being carefully considered by the BCUC. While in other areas, time-based usage fees have avoided the scrutiny of regulatory bodies, it is not clear whether this would still be considered resale by the BCUC.

[32] http://news.hydroquebec.com/en/press-releases/750/electric-circuit-and-vernetwork-combine-forces/
[33] http://pluginbc.ca/wp/wp-content/uploads/2014/08/FAQ-EV-DCFC-pilot_August1_2014.pdf

Currently, only registered utilities are allowed to sell electricity in BC, with a few exceptions:

- Any municipality may resell
    - Currently reselling through DCFCs: Saanich, Nanaimo, Langley, Princeton, Keremeos, Merritt
- Landlords providing electricity to tenants may resell at cost (no profit)
- Employers providing electricity to employees may resell at cost (no profit)

In 2016, the BCUC approved a one-time exemption that allows the Bakerview Ecodairy, a private business located in Abbotsford, to apply a usage fee of $0.35 per kWh for usage of the DCFC station that it hosts and operates[34]. The Ecodairy is required to submit annual reports to the BCUC that will hopefully help to inform any future decisions by the BCUC regarding broader application of usage fees for EV charging.

BCIT applies a fee to use its DCFC stations by charging for the parking spot on a time basis.

4.5.3 Public vs residential charging

Data collected for the EV Project led by Idaho National Lab shows that 80% of EV charge events take place in the home (almost always at level 1 or level 2), while 20% take place in public locations. Of that 20%, 83% occurs at a level 2 charging stations where the car may require a few hours to fully recharge. The average charging time at public level 2 stations in BC is around 90 minutes.[35]

Some charge events occur on level 1 stations but they are often unmonitored and impractical due to their low power, delivering less than 10 km of range per hour. Campgrounds, hotels and businesses allowing overnight parking could have some interest in allowing EVs to charge using level 1. Data collected estimates their use at 6% of the total of public charging.

DC fast chargers provide a high-power option, as the vehicle gets hundreds of kilometers of range per hour: drivers stay on average for 25 minutes. Despite this advantage only 11% of public charging events per car use DCFCs. One explanation is the convenience of level 2: they are often close to venues and more common than expensive DCFC units.

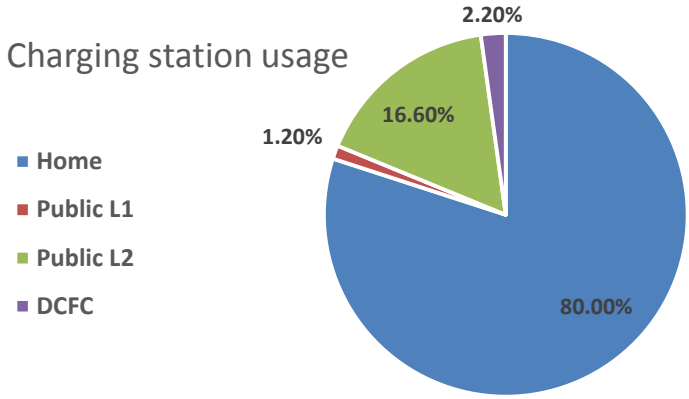


Figure 31: Charging at home represents 80% of all charging [The EV Project (Idaho National Laboratory, 2015)]

[34] http://www.ordersdecisions.bcuc.com/bcuc/orders/en/item/144369/index.do
[35] Powertech; evCloud report number four: BC Public EV Charging Station Usage

4.5.4 Other Considerations and Deployment Guidelines

For any parking lot that provides EV charging services, the number of parking stalls with access to charging equipment is an important consideration. Ideally, there should be adequate availability of charging stations to support the expected number of EVs visiting the parking lot at any given time. Section 0 recommended a guideline of 15-20% of parking stalls with access to charging infrastructure by the year 2030 based on expected uptake of EVs in the BC Lower Mainland. In order to manage growth of infrastructure leading up to that timeframe, and to prepare for increased adoption beyond 2030, it is recommended to deploy infrastructure in a way that enables scalability and easy expansion based on actual needs. While a deployment of charging infrastructure in 2016 may not be required to support 20% of parking stalls in a given lot, the long term costs of supporting that many stalls in the future can be reduced if the base infrastructure (such as transformers, electrical panels, conduit and wiring) are designed with future expansion in mind. With this base infrastructure in place, additional charging stations can be added at minimal cost as the need arises, based on analysis of utilization of existing stations.

In 2014, BC Hydro sponsored the development of the "Canadian Electric Vehicle Infrastructure Deployment Guidelines". These guidelines cover a broad range of topics that should be considered for any EV charging installation, including:

- Signage
- Accessibility requirements
- Lighting and shelter
- Vandalism
- Station layout design

These guidelines are publicly available as a PDF from the BC Hydro website – www.bchydro.com/ev.[36]

[36] https://www.bchydro.com/about/sustainability/climate_action/plugin_vehicles/charging___infrastructure.html

5 SMART GRID TECHNOLOGIES FOR EV CHARGING

"Smart Grid" is a term used to describe a number of technologies and concepts that can optimize the way we generate, deliver and consume electricity. There are a number of emerging Smart Grid technologies and concepts that have the potential to reduce the impact of EV charging on electrical infrastructure, and potentially even turn EVs into valuable assets that provide a net-positive benefit to the grid. The following sections provide a brief overview of some of the most relevant EV applications for smart grid technologies.

5.1 Smart Charging

"Smart Charging" is a term used to describe the optimization of EV charging according to electrical infrastructure conditions. One example of smart charging would be controlling EV charging loads according to the availability of renewable energy, such as wind or solar – flexible loads can be extremely beneficial for accommodating these typically variable sources of energy. In regions like BC that are rich in "firm" hydroelectric resources, smart charging may be most beneficial for addressing capacity constraints by deferring or reducing charging power at certain times. These constraints could be anywhere on the grid, from the generating stations all the way down to local distribution transformers, or even constraints within a site or building.

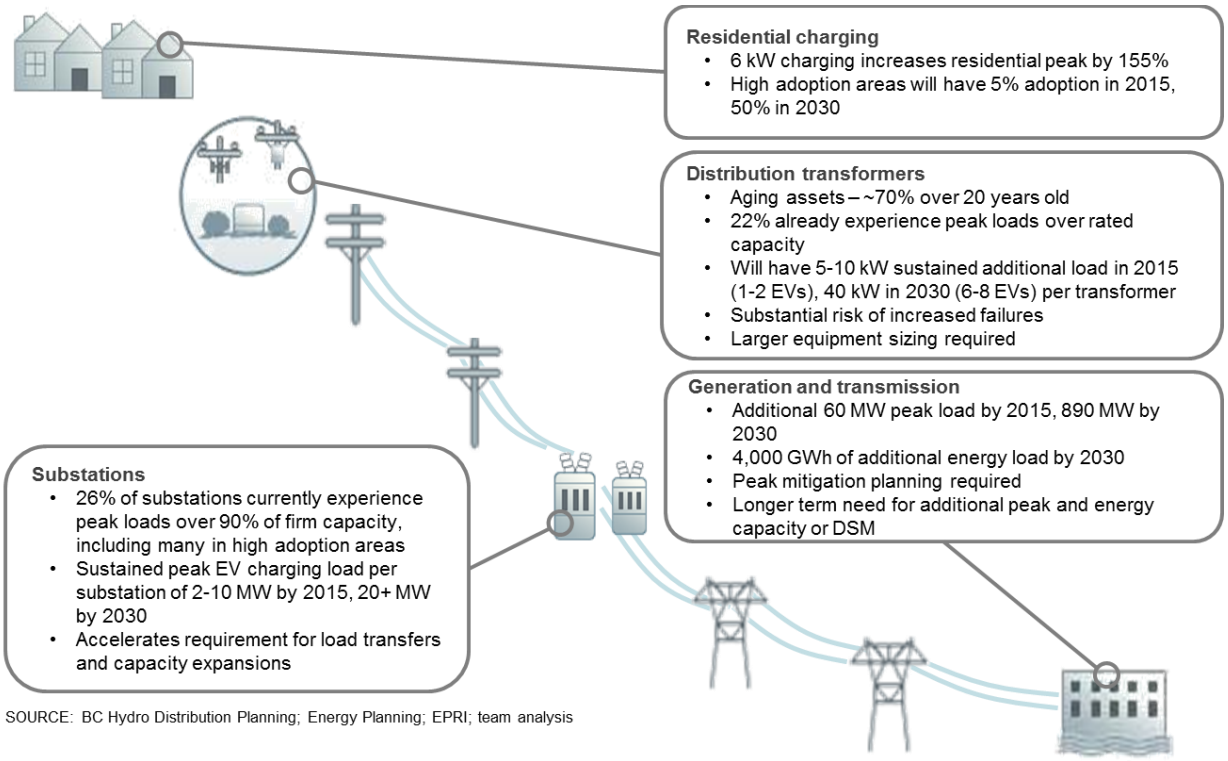


Figure 32: Diagram highlighting potential impact of EVs on various parts of the grid.

Depending on whether constraints exist on customer-owned assets (such as wiring within a building) or on utility-owned assets, there may be different types of systems and mechanisms to manage charging.

5.1.1 Utility-Interactive Smart Charging

For situations where smart charging is motivated by constraints on the utility's operations, a utility needs to establish a mechanism that incentivizes their customers to manage their charging loads accordingly.

Perhaps the simplest such mechanism that's already in practice today is variable electricity pricing. Either by employing a fixed Time-of-Use (TOU) pricing schedule (common practice), or through Real-Time-Pricing (RTP) that varies on a continual basis (less common), EV drivers can be incentivized to charge their vehicles at times of lowest demand. TOU pricing schedules are communicated to utility customers, and an EV driver can either:

a) Plug their EV in only during off-peak hours;
b) Use charge scheduling features built into their EV or EVSE to program charging accordingly;
c) Rely on an automated connection between their EV or EVSE and a utility pricing database to optimize charging schedule automatically.

BC Hydro does not employ Time-of-Use pricing, although this is now common practice in a number of other jurisdictions in North America. BC Hydro has announced that an EV-specific tariff is in development, with details expected in late 2016 or early 2017.

Some utilities are also exploring "Demand Response" (DR) systems where an EV can respond to signals from the utility and vary charging accordingly. These types of systems may rely on two-way communications between the utility and either the EVSE, the EV or both. The majority of these EV Demand Response programs are at the pilot stage, such as Pacific Gas and Electric and BMW's "i ChargeForward Program"[37] and FleetCarma and Toronto Hydro's "ChargeTO" program[38].

Smart Charging – Utility Interactive	
Opportunity:	Reduces impact of EV charging on utility assets
Challenges:	Need to establish value proposition for EV drivers
Status:	Large pilots in progress, broader roll-out dependent on standardized EV-utility interfaces
Ideal application:	Residential charging

5.1.2 Local Load Management Smart Charging

For scenarios where a customer may have local load constraints on their own electrical infrastructure, they may be motivated to implement Smart Charging using a local load management system, without the need for advanced, utility-interactive communications. These types of local load constraints become particularly relevant any time a large number of electric vehicles might be charging in the same location, such as in a workplace or fleet vehicle charging scenario. The 2015 Canadian Electrical Code added an allowance for sizing of circuits according to the maximum power allowed by a load management system, and this was adopted in BC in early 2016.

[37] http://www.bmwichargeforward.com/
[38] http://www.crosschasm.com/chargeto/

AddÉnergie Technologies - PowerSharing Systems

AddÉnergie Technologies, a Canadian manufacturer of EV charging equipment, has developed a charging solution specifically designed to address local load constraints. This solution consists of two main components:

1. **CoRe+ Level 2 charging stations** ($3250 each)
   - Mounted in pairs, up to 24 stations per installation
   - Up to 7.2kW each
2. **Site Controller** (one per installation, provided by AddÉnergie)
   - Communicates wirelessly with charging stations
   - Controls maximum power output of each charging station
   - Minimizes charging impact according to building demand schedule or through integration with building energy management system (eg BACnet)
   - Provides internet communications for EV driver user management and usage fee options

Figure 33: AddÉnergie CoRe+ Level 2 EVSE

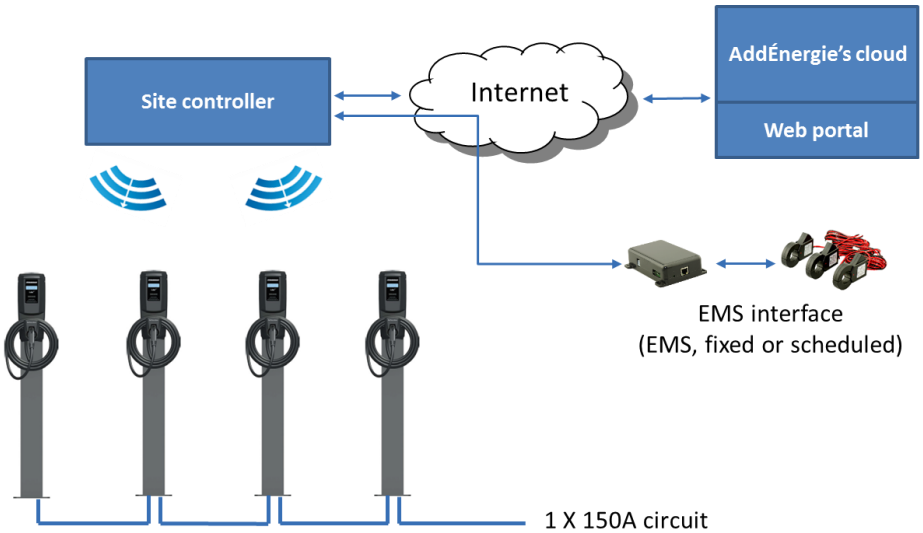


Figure 34: AddÉnergie's PowerSharing system with building EMS integration

While a single vehicle may charge at up to 7.2kW, the site controller may restrict charging to as low as 1.5kW if many vehicles are charging at the same time, or if it determines that the building is experiencing high overall demand. The approximate impact on charging time for a typical EV would be as follows:

Table 14: Impact on charging time for power sharing scenarios

Charging rate	Charging time required to replenish 30km of range (~6kWh)	Charging time required to replenish 120km of range (~24kWh)
1.5kW	4h	16h
7.2kW	1h	4h

Given typical commuting distances, most drivers would likely be able to receive a full charge by the end of a work day even with significant load management, although higher charging rates can be prioritized for certain drivers based on their specific driving needs.

Scalability

Another advantage of this solution is that it allows a charging installation to be expanded in the future as needed to support increasing EV adoption. By installing stations in a "daisy-chain" configuration along a single high-amperage circuit, additional charging stations can be added down the road without the need to add additional circuits, greatly simplifying and reducing the cost of future expansions.

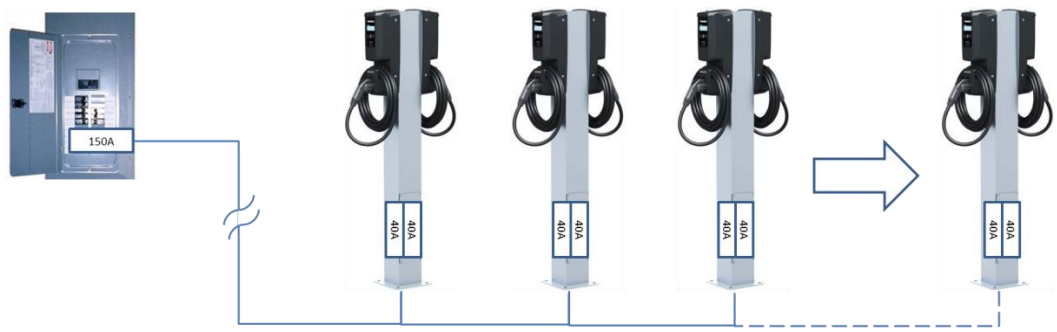


Figure 35: AddÉnergie's PowerSharing system enables expansion of EVSE installations using a daisy chain configuration

In the example above, a 150A circuit is shown expanding from six to eight 40A branch circuits through a daisy-chain configuration (each 40A branch circuit supporting one 7.2kW charging station). This 150A circuit could potentially support up to 24 charging stations, although in practice, AddÉnergie recommends reserving 10A per station (15 stations total in this case) in order to provide a minimum level of charging power for each station. This approach of sharing circuits across multiple charging stations is supported by the 2015 edition of the Canadian Electrical Code, and has been approved for multiple installations in Quebec.

ChargePoint – CT4000 Power Sharing

ChargePoint's CT4000 Level 2 charging station[39] also offers the ability to increase the total number of charging ports supported by a given size of electrical service by sharing a single 40A circuit across two charging ports. The charging station allows each port to charge at full power (7.2kW) if only one vehicle is connected, automatically reducing power by 50% (to 3.6kW) if both ports are in use. This allows a station host to effectively double the number of EVs that can be supported for a given size of electrical capacity, although it would not be as flexible in terms of optimizing a larger group of stations collectively and taking into account overall building demand. More recently, ChargePoint has announced availability of a panel-level load management solution similar to AddÉnergie's, relying on cloud-based control to manage groups of charging stations on shared infrastructure.

This Power Sharing capability is a standard feature of all dual-port CT4000 charging stations (CT402X), with pricing starting at approximately $6000 for a dual port station.

Figure 36: ChargePoint's CT4000 Level 2 EVSE with circuit-sharing capability

Smart Charging – Local Load Management	
Opportunity:	Reduces impact of EV charging on local electrical infrastructure
Challenges:	Need to establish value proposition for EV drivers
Status:	Availability from a limited number of charge station suppliers
Ideal application:	Workplace, fleet or public charging facilities supporting multiple EVs in a single location.

[39] http://www.chargepoint.com/files/73-001061-01-3_BR-CT4000-02.pdf

5.2 Vehicle-to-Grid

Vehicle-to-Grid (or "V2G") is the most common term used to describe the concept of an electric vehicle providing electric power back to the grid. Other terms include "bi-directional charging", "reverse power flow" and "EV as a distributed energy resource (DER)". EVs could effectively act as additional sources of generation on the grid, providing valuable services by alleviating peak demands on the grid, or by providing generation that is quicker to respond to changing grid conditions than some less agile types of power plants, thereby improving grid stability. V2G capable vehicles could also provide power during blackout scenarios, an application sometimes referred to as vehicle-to-home (V2H) or vehicle-to-building (V2B) – both typically considered special cases of V2G. Even in non-blackout scenarios, a V2G-capable vehicle could provide power back to a building in a way that offsets the rest of that building's energy consumption and minimizes its operating costs. Finally, the simplest form of V2G-like capability is for the vehicle to provide power to a stand-alone load, much like a generator that might be used to support power tools out in the field. This might be referred to as vehicle-to-load (V2L).

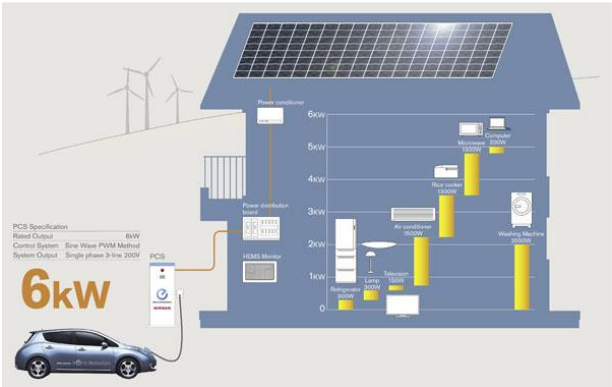


Figure 37: Nissan's Leaf-to-home system

While the above described services are all likely valuable to either the vehicle owner, building owner or electric utility, it becomes important to consider this value against the cost of providing such services. Unlike Smart Charging, V2G capabilities require significant additional equipment in the form of a DC-to-AC inverter, which may be either built into the vehicle or into a charging station (specifically one that connects to the vehicle through a DC charging port). This equipment is likely on the order of at least $1000-2000. Additionally, while Smart Charging should have little to no impact on battery life, V2G capabilities all involve adding additional usage cycles to the vehicle's battery. While these additional usage cycles may be small compared to normal use of the vehicle in driving mode depending on the specific V2G application, the impact on battery life must still be considered against the value of V2G services, and automakers must determine how to account for V2G in defining battery warranty parameters, which are currently based solely on calendar life and vehicle odometer readings.

For these reasons, V2G has thus far largely remained the subject of small trials and pilot demonstrations. These demonstrations generally require the support of the automaker, as accessing the battery onboard a vehicle for V2G purposes either requires an inverter that is built into the vehicle, or at least vehicle software that permits reverse power flow while connected to a DC station. The only products that have an apparent path to market availability are those that either support backup power functionality (such as Nissan's "Leaf to Home" system currently being tested in Japan, using a stationary inverter connected to the Leaf's DC charge port[40]) or systems that can be used to power equipment in remote locations (such as Via Motors' export power system[41]). Both of these applications treat the vehicle as a replacement for a gas-powered generator, and as such may find broader market appeal.

[40] http://www.nissan-global.com/EN/TECHNOLOGY/OVERVIEW/leaf_to_home.html
[41] http://www.viamotors.com/vehicles/electric-truck/

Figure 38: Export power panel on a VIA Motors V-Trux with 2x120V and 1x240V outlets

Vehicle to Grid	
Opportunity:	EVs can support electrical infrastructure and provide backup power for power outages
Challenges:	Significant additional cost, requires a clear value proposition for EV drivers
Status:	Largely limited to research projects and small scale pilot demonstrations.
Ideal application:	Fleet vehicles with low utilization, zero-emissions backup power.

5.3 Stationary Energy Storage

While not specifically an Electric Vehicle-specific smart grid technology, stationary energy storage can be particularly useful in accommodating the high electrical loads associated with charging of electric vehicles. Stationary Energy Storage Systems (ESS) often use lithium-ion batteries similar to those that are used to power electric vehicles, although potentially in much larger quantities. The size of an ESS depends entirely on its intended application, and can range anywhere from household units that are the size of a small refrigerator, intended to support rooftop solar power and provide occasional backup power, to utility-scale systems of multiple megawatt-hours that are intended to support grid operations, often built using one or several full-size shipping containers. A few of the most common applications for ESS include:

1. Supporting intermittent renewable energy sources;
2. Providing temporary backup power (duration depends on specifications and use, but durations of 2 to 20 hours are common);
3. Buffering out intermittent peak loads.

Figure 39: Tesla Powerwall Residential Battery

Any of these applications can be accommodated at a wide range of scales simply by scaling the design of the ESS accordingly. For example, peak loads can be accommodated at a grid-scale, with a large, multi-megawatt ESS fulfilling the role of traditional “peaker” power plants that only operate during periods of peak demand. At a much smaller scale, a single DC fast charge station can be supported by a relatively small ESS, minimizing the brief peak load typically seen during the first few minutes of a fast charge session.

Similarly, the recently announced Tesla Powerwall 10kWh residential lithium-ion battery can provide a typical home with 6 hours or more of backup power during an outage, while BC Hydro’s 1MW battery system in the Canadian Rockies can power the entire town of Field, BC for 6 hours or more during outages.

Energy storage systems of a wide range of sizes are now being deployed in large numbers in certain parts of the world. California in particular has recently seen a considerable surge in energy storage projects, thanks to a state

law which requires Californian utilities to procure 1.3 Gigawatts of energy storage capacity (equivalent to about 750,000 Tesla Powerwalls) by 2024, ranging from residential scale home-based batteries up to multi-megawatt transmission-interconnected systems.[42] This law puts an emphasis on cost-effective solutions, and the first rounds of procurement have already shown signs of an emerging competitive field of technology providers.[43]

Figure 40: A 500kWh lithium-ion battery system designed and built by Powertech Labs for BCIT's Energy OASIS Project, supporting a 250kW solar canopy over the parking lot, and supplying 2 DCFC and 2 Level 2 EV charging stations.

Stationary Energy Storage	
Opportunity:	Can reduce impact of EV charging on local electrical infrastructure, support renewable generation, and provide zero-emission backup power.
Challenges:	Cost – while volumes are driving costs down, systems typically have an installed cost of around $500-1000 per kWh.
Status:	Transitioning from largely research and pilot demonstrations to a more mature commercial market with quickly decreasing costs. Tesla's recently announced products have a cost as low as $250/kWh, although this does not include installation and supporting infrastructure.
Ideal application:	Facilities with constrained electrical infrastructure, high demand from EV charging, large amounts of variable renewable energy, and/or a desire for zero-emissions backup power

[42] http://www.greentechmedia.com/articles/read/sce-pge-issue-first-energy-storage-requests-to-meet-ab-2514
[43] http://www.greentechmedia.com/articles/read/california-dreaming-5000mw-of-applications-for-74mw-of-energy-storage-at-pg

6 EV PROGRAMS AND POLICIES IN BC

British Columbians can benefit from a number of programs and policies that aim to make EVs more affordable, increase access to charging infrastructure, and increase awareness of EVs. These programs are supported by a variety of organizations collaborating under the Plug in BC initiative, including the BC Ministry of Energy and Mines and BC Hydro. The PlugInBC.ca website acts as a hub of information for these programs, as well as a source for anyone looking to learn about EVs in general.

This final section of the report provides a brief overview of these programs, as well as a few potential future programs and priorities.

6.1 Vehicle Incentives

The Clean Energy Vehicle for BC Point of Sale Incentive Program provides up to $5000 off the purchase price of qualifying plug-in vehicles for B.C. residents, businesses, non-profit organizations, and local government organizations. The program is managed by the BC Ministry of Energy and Mines, with support from the New Car Dealers Association of BC. The stated goal of the program is to "stimulate the market such that by 2020, 5% of new light duty vehicle purchases in British Columbia are clean energy vehicles". More information is available here: https://www.cevforbc.ca/

As of March 2016, vehicles with an MSRP of over $77,000 are no longer eligible for the incentive. The actual incentive amounts depend on the vehicle's battery capacity:

- Between 4kWh and 15kWh: $2,500
- Above 15kWh: $5,000

This is actually the second phase of the CEVforBC purchase incentive, with the first phase having ended in March 2014, and the second phase not launching until a year later. The current phase is slated to run until March 31, 2018 or until funds run out, whichever comes first.

The CEVforBC purchase incentive can be combined with the BC SCRAP-IT program, under which an additional $3,250 can be put towards the purchase of a new EV in return for retiring an older vehicle. More information on the BC SCRAP-IT program can be found here: https://scrapit.ca/evprogram/

6.2 Charging infrastructure

6.2.1 Previous Level 2 Infrastructure Programs

Phase 1 of the BC Clean Energy Vehicle Program supported the deployment of a large number of Level 2 charging stations. In particular, 550 public Level 2 charging stations were installed across BC, primarily under the Community Charging Infrastructure fund. These public Level 2 charging stations represent the bulk of usage data monitored by the evCloud and presented in Section 2.3 of this report. A further 142 Level 2 stations were installed in multi-unit residential and commercial buildings, and incentives were provided for 306 Level 2 stations in single family homes.

6.2.2 Multi-Unit Residential Building Charging Program

In 2016, the BC government and Fraser Basin Council launched the MURB Charging Program, offering support for installation of Level 2 charging infrastructure in existing buildings. Retrofits were specifically targeted, as these can be particularly challenging from both a technical perspective, and in terms of meeting the expectations of a large number of stakeholders in any given building. The program provided 75% of cost up to $4,500 per charge port, and applicants were required to install additional conduit to allow for future expansions. The program was very popular and quickly filled up. More information is available here: http://pluginbc.ca/charging-program/murb/

6.2.3 Fleet Infrastructure Incentive

Also in 2016, the BC government and Fraser Basin Council launched the Fleet Infrastructure Incentive, in conjunction with the Fleet Champion Program, providing support for the installation of charging infrastructure for fleet vehicles. The program provides 33% of costs up to $2000 for the purchase and installation of a Level 2 charging station. More information is available here: http://pluginbc.ca/charging-program/incentives-for-fleets/

6.2.4 DCFC Phase 1

As part of the federally and provincially funded BC EV Smart Infrastructure Project, 30 50kW DC Fast Charge stations were installed across BC between 2013 and 2016 by BC Hydro with support from Powertech Labs. These DCFC stations are monitored by the evCloud data collection platform, and a summary of usage data was provided in Section 2.3 of this report. With the exception of the Bakerview Ecodairy in Abbotsford and the station installed at Powertech Labs, all stations were hosted by municipal or regional governments.

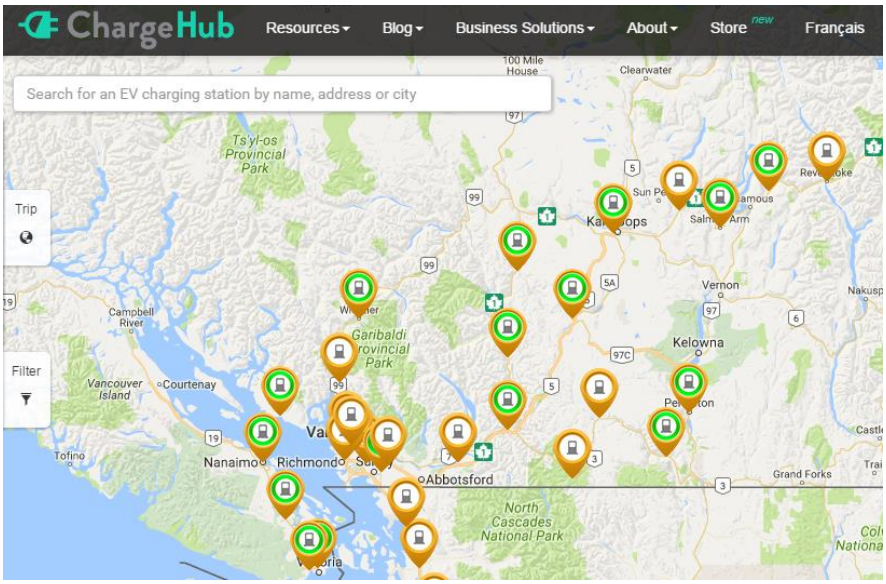


Figure 41: BC DCFC Phase 1 stations - www.chargehub.com

While the earliest DCFC stations installed under this program supported only the Chademo connector, additional funding provided by the BC government and BMW allowed BC Hydro and Powertech Labs to retrofit most of these early sites with dual-standard DCFC stations. See Section 4.2.2 of this report for a discussion of the DCFC standards landscape.

6.2.5 DCFC Phase 2

During the spring of 2015, the BC government announced funding to support up to 20 additional DCFC stations. Shortly afterwards, Fraser Basin Council conducted a gap analysis to help prioritize locations for future DCFC stations in BC, recommending an EV tourism approach, focusing on heavily populated urban areas with high EV adoption rates while connecting them to neighbouring destinations. In 2016, the federal government, through Natural Resources Canada, provided a funding opportunity to support up to 70 DCFC stations across Canada. In parallel, the BC government conducted a Request for Expressions of Interest from potential Phase 2 DCFC station hosts. Details and timing of the DCFC Phase 2 expansion are expected in late 2016.

6.3 Building Codes

Building codes can be an extremely effective tool for ensuring access to charging where it's most valuable and convenient, especially at home. EV infrastructure is much more costly to install as a retrofit as compared to during initial construction, so ensuring that new buildings are built with EVs in mind is an excellent way for governments to reduce barriers for EV adoption.

6.3.1 Vancouver Building Bylaw

Vancouver is the only municipal government in Canada to enforce its own building codes. Vancouver leveraged this mechanism back in 2008 to require that 20% of parking stalls in multi-unit residential buildings and all stalls in houses be "EV ready", requiring electrical infrastructure necessary to support the future installation of a charging station. This was expanded with a 10% requirement for commercial buildings in 2013. Vancouver is currently developing an electric vehicle infrastructure strategy that will aim to ensure that access to charging is available throughout the city, and this may include further revisions to the Building Bylaw. More information is available here: http://vancouver.ca/streets-transportation/electric-vehicles.aspx

6.3.2 Update to the BC Building Act

While the City of Vancouver is in a special position thanks to its Building Bylaw, the BC government sought to enable other municipalities to enact similar support for EV infrastructure in new buildings with an update to the BC Building Act in 2016[44]. Under this update, requirements for EV charging infrastructure in buildings are now considered "out-of-scope" of the BC Building Act, and this should provide local governments with greater flexibility to enact their own requirements related to EV charging infrastructure.

[44] http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/baguide_sectionb1appendix-june2016.pdf

REVISION HISTORY

Rev	Description	Revised by	Date
D01	Initial draft	JT	Sept 9 2016
D04	Revisions according to feedback and questions	ML,LW	October 7 2016
R01	Final revision	JT	October 19 2016

Appendix 2

2017 FLEETCARMA ELECTRIC VEHICLE SALES IN CANADA

Appendix 2

Electric Vehicle Sales In Canada, 2017

By Eric Schmidt Posted February 8, 2018 In Electric Vehicle News

The final numbers for 2017 are in. First, we cover the Fast Five, then dive into the detail.

Fast Five for 2017 EV Sales

+68%

Electric vehicle sales in Canada increased 68% year-over-year.

+120%

Ontario EV sales more than doubled in 2017, with year-over-year growth hitting 120%. Also noteworthy, New Brunswick had the highest year-over-year growth at 124%.

47,800

The total number of plug-in vehicles on the road in Canada is up to 47,800. Based on the sales trajectory, this number will cross 50,000 before the end of February 2018.

>2%

In Quebec, EV sales exceeded 2% of all passenger vehicle sales for last four months of the year.

2X

The all-electric (BEV) category outpaced the plug-in hybrid (PHEV) category, with year/year growth of +92% compared to +48%. While Canada used to be the land of the plug-in hybrids, there is now a notable shift towards BEVs.

2016 was a benchmark year, until this year

2016 was a strong year for EV sales in Canada. Electric Vehicle sales had increased the most in that year than in any previous year. And the total number of PEVs on the road was at an all-time high of nearly 50,000 vehicles. Battery electric and plug-in hybrid vehicles were selling equal numbers of models. 2017 has continued that strength and set new records across the board.

Appendix 2

Canadian EV sales figures, 2017

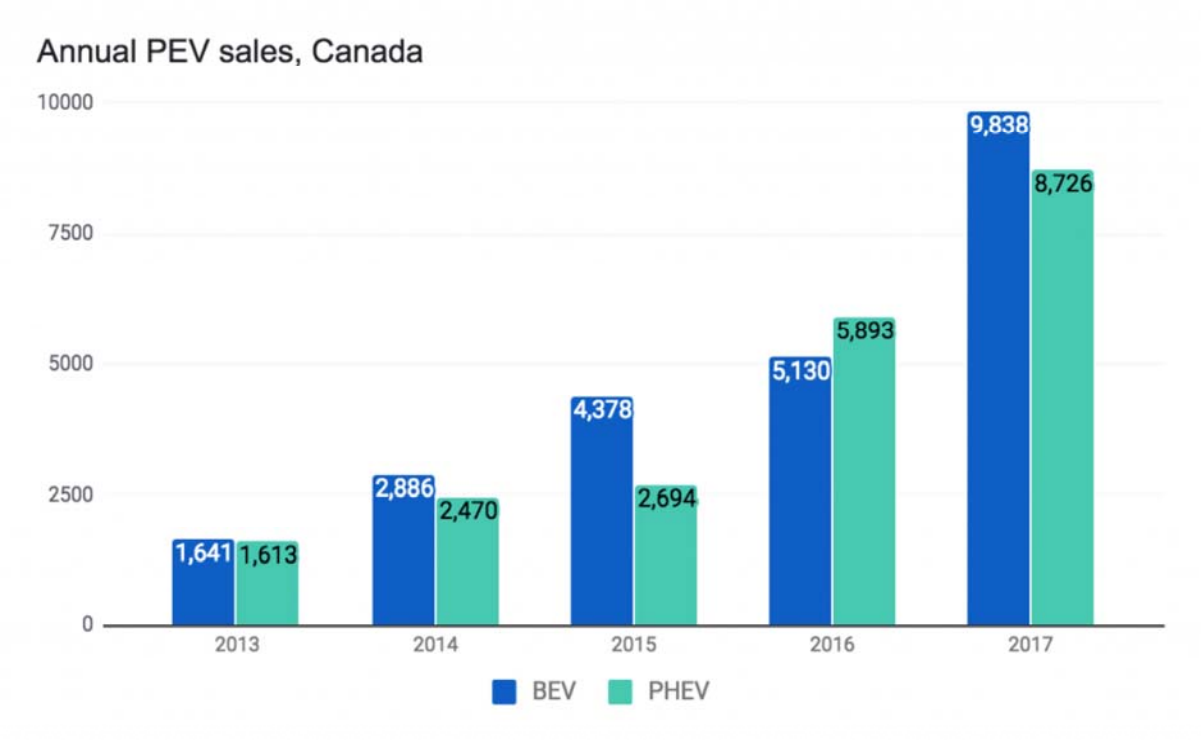
Canadian electric vehicle sales reached an all-time high in 2017 with every previous sales record being continuously broken throughout the year. Comparing 2017 final numbers with the previous year reveals just how dramatic the increase in electric vehicle uptake was.

Plug-in electric vehicle (PEV) sales numbers for 2017 ran up to approximately 18,560 vehicles, an increase of 68% over the previous year.

Comprising the number of PEVs are two types of EVs, Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs). National BEV sales increased at nearly double the rate of PHEV sales. A total of 9,840 BEVs were sold in Canada in 2017, an increase over the previous year of 92%. PHEV sales across the Country totalled 8,730, an increase of 48% over the previous year.

Annual Sales Growth

	2016	2017	Change
BEV	5,130	9,840	+92%
PHEV	5,893	8,730	+48%
PEV	11,023	18,560	+68%



Consistent monthly increases led to a huge increase in annual growth

Supporting the growth in annual numbers were consistently strong sales each and every months, this is not a fluke. Monthly averages were up, Monthly highs were up, even Monthly lows had increased by quite a bit.

Monthly EV sales figures by type

	2016	2017	Change
BEV			
BEV Monthly High	670 (Sept)	1,350 (Sept)	**101%**
BEV Monthly Low	190 (Feb)	380 (Jan)	**100%**
BEV Monthly Avg.	430	820	**91%**
PHEV			
PHEV Monthly High	650 (Aug)	1,130 (Oct)	**74%**
PHEV Monthly Low	220 (Jan)	430 (Feb)	**95%**
PHEV Monthly Avg.	490	730	**49%**
PEV			
PEV Monthly High	1,330 (Sept)	2,240 (Sept)	**68%**
PEV Monthly Low	430 (Feb)	820 (Jan)	**91%**
PEV Monthly Avg.	920	1,550	**68%**

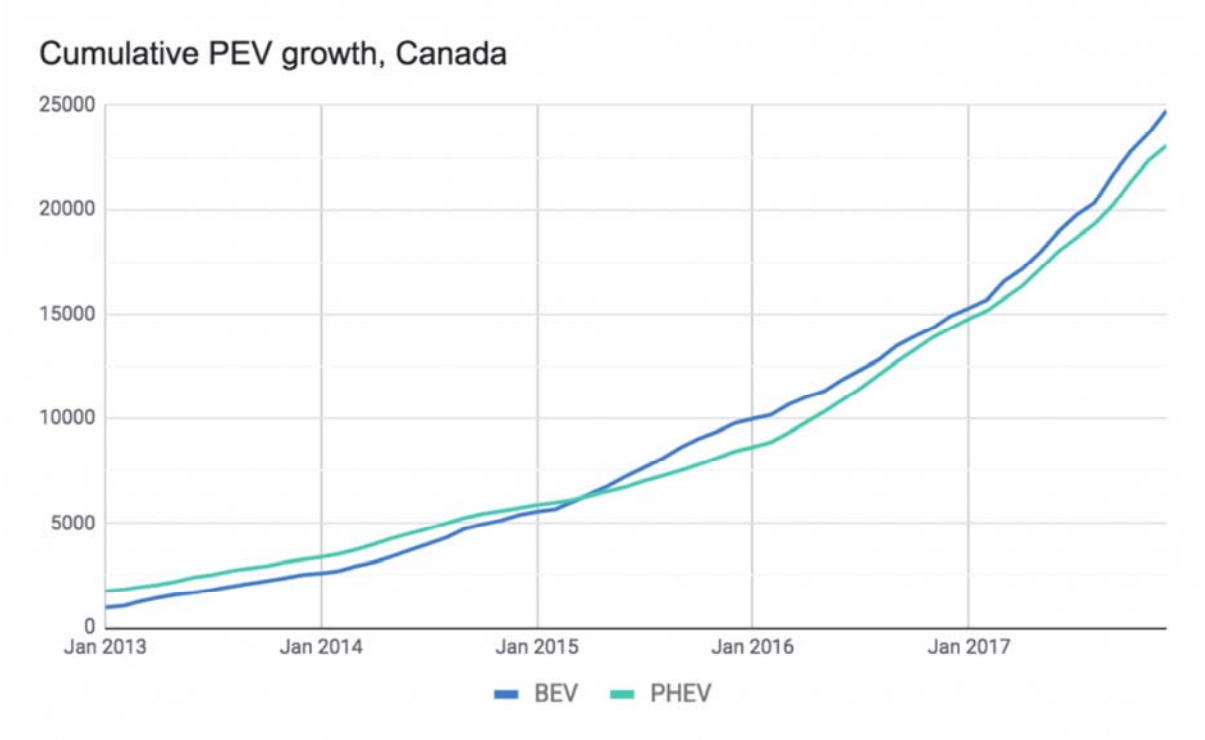
Year over year EV sales by Month, Canada

Cumulative electric vehicle growth in Canada

Cumulative growth for electric vehicles on the road increased by 64% at year-end. Approximately 30,000 PEVs were on the road by year-end 2016, compared to 47,800 by year-end 2017. The largest increase of 66% was among all-electric BEV models, which now total 24,750 vehicles on the road. PEV models increased by 61% to 23,050 vehicles on roads across the Country. This represents the single highest rate of increase in any one year since, well – forever.

Annual Cumulative Growth (2017 vs 2016)

	2016	2017	Change
BEV	14,900	24,750	+66%
PHEV	14,300	23,050	+61%
PEV	29,200	47,800	+64%



Provincial EV sales figures, 2017

From sea to shining sea, EV uptake has finally and officially caught on across Canada. The big three Canadian Provinces led the Nation in overall sales. However, size isn't everything, some less-populated Provinces led in the overall increase.

In 2016, Ontario increased its electric vehicle targets and announced new support programs. In 2017, it appears that those measures are having an impact. In terms of new EVs sold, Ontario has taken the first place seat from neighboring Quebec for total annual sales for the first time. Ontario's annual PEV growth has increased by 120%, which translates to 7,500 vehicles compared to 3,400 in 2016. Quebec is still the province with the most number of PEVs; however, Ontario is closing the gap due to its strong sales growth.

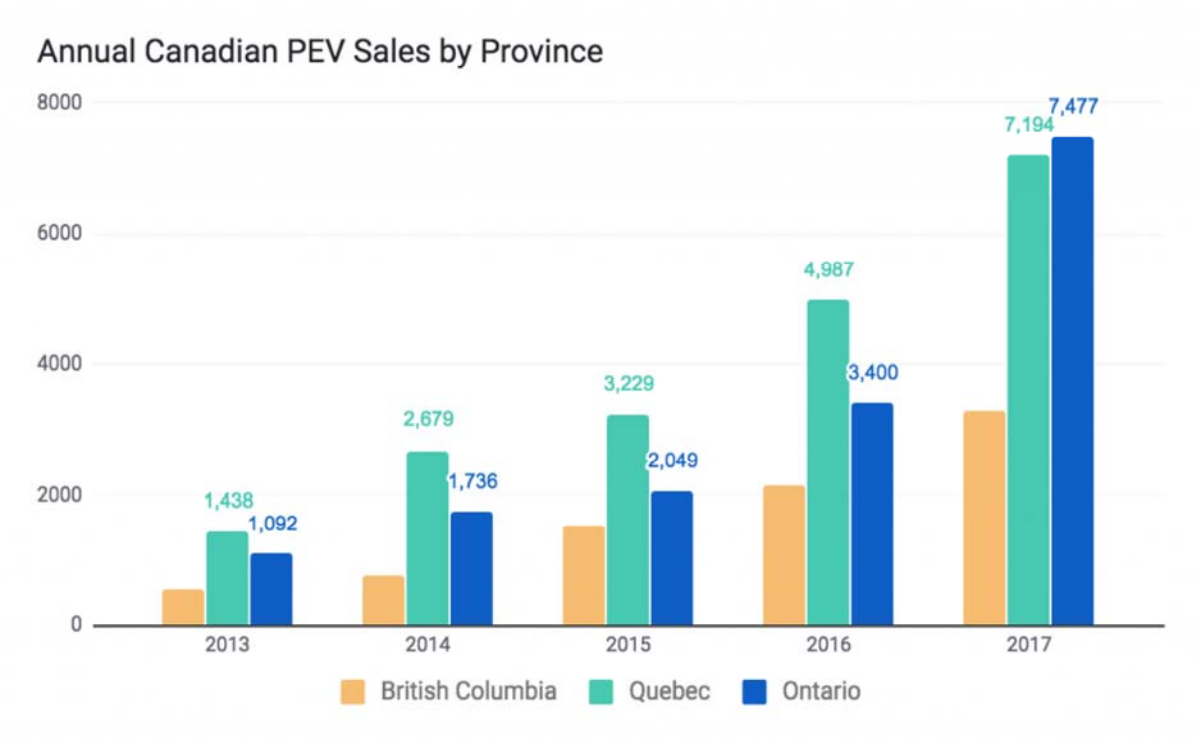
Quebec had EV sales exceed 2% of all vehicle sales for the last four months of the year and in total 7,200 new PEVs met Quebec roadways, a 44% increase over 2016 sales of 5,000 vehicles. British Columbia saw a higher than average increase in the annual rate of adoption in 2017 of 53%. Their PEV sales for 2017 were approximately 3,300 vehicles vs 2,100 the previous year.

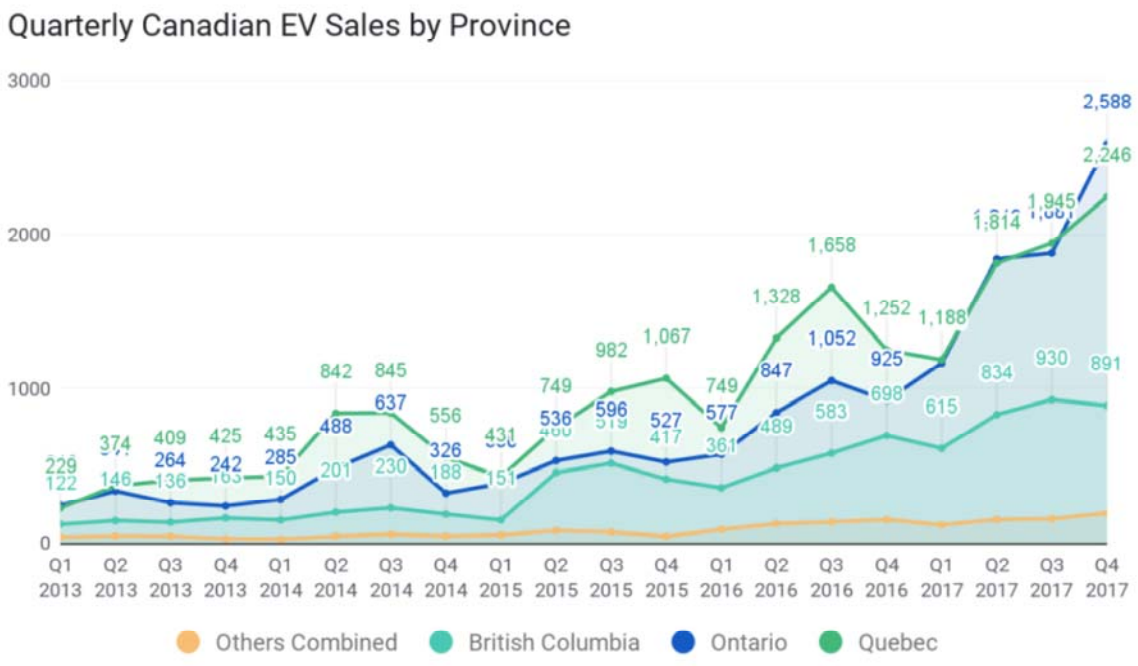
The highest rate of increase for PEV adoption occurred in New Brunswick, with a 124% rate of increase. A total of 53 electric vehicles hit the road for the first time in that Province compared to 24 in the previous year.

Annual Cumulative Growth (2017 vs 2016)

	2013	2014	2015	2016	2017	'16 – '17 Change
Ontario	1,092	1,736	2,049	3,400	7,477	**120%**
Quebec	1,438	2,679	3,229	4,987	7,194	**44%**
British Columbia	567	769	1,546	2,132	3,270	**53%**
Alberta	94	78	162	342	430	**26%**
Manitoba	28	29	33	58	64	**11%**
New Brunswick	10	18	14	24	53	**124%**
PEV Total	3,254	5,356	7,072	11,023	18,564	**68%**

Appendix 2


Annual Canadian PEV Sales by Province
8000
6000
4000
2000
0
1,438
1,092
2,679
1,736
3,229
2,049
4,987
3,400
7,194
7,477
2013
2014
2015
2016
2017
British Columbia
Quebec
Ontario


Quarterly Canadian EV Sales by Province
3000
2000
1000
0
Q1 2013
Q2 2013
Q3 2013
Q4 2013
Q1 2014
Q2 2014
Q3 2014
Q4 2014
Q1 2015
Q2 2015
Q3 2015
Q4 2015
Q1 2016
Q2 2016
Q3 2016
Q4 2016
Q1 2017
Q2 2017
Q3 2017
Q4 2017
Others Combined
British Columbia
Ontario
Quebec

Splitting PEV sales by type – BEV and PHEV – begins to tell more of the story behind the increase in electric vehicle adoption across Canada. The figures and growth for all-electric BEVs had reached a milestone in 2017. It seems as if the market and manufacturers have finally come to an understanding. With newer models of all-electric BEVs now able to exceed the desired range capacity for consumers, they have begun flying out of dealerships.

2017 is the first year in which BEV sales exceeded PHEV sales across the Country. Not only that but the rate of increase in overall sales is nearly double for all-electric models. Ontario saw a 148% increase in BEVs compared to 98% for PHEVs. Quebec, 73% BEV to 23% PHEV. BC, 68% BEV to 30% PHEV. On average, the BEV market grew at double the rate of the PEV market, which is also growing. In an expanding electric vehicle marketplace, all-electric models are clearly on a break-away.

Annual BEV Sales by Province

	2013	2014	2015	2016	2017	'16 – '17 Change
Ontario	622	1,105	1,303	1,486	3,682	**148%**
Quebec	544	1,109	1,744	2,116	3,653	**73%**
British Columbia	413	575	1,180	1,303	2,194	**68%**
Alberta	38	42	104	159	226	**42%**
Manitoba	12	16	21	26	31	**19%**
New Brunswick	3	7	4	4	16	**300%**
BEV Total	1,641	2,886	4,378	5,130	9,838	**92%**

Annual PHEV sales by Province

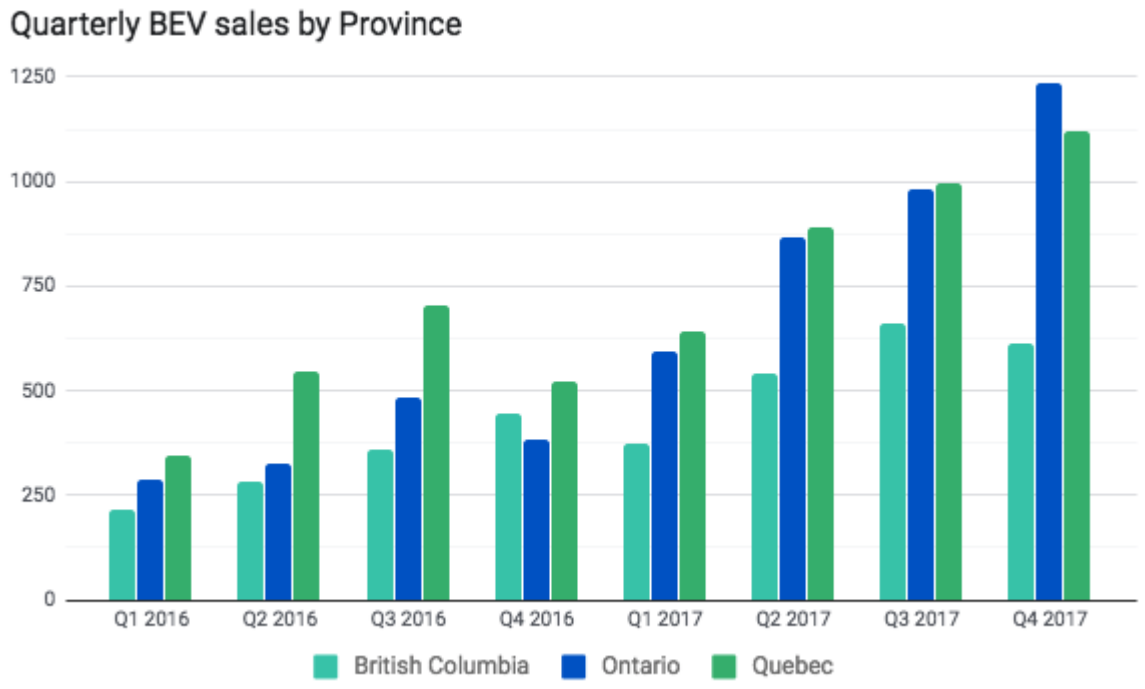
	2013	2014	2015	2016	2017	'16 – '17 Change
Ontario	470	631	746	1,914	3,795	**98%**

Quebec	894	1,570	1,485	2,871	3,541	**23%**
British Columbia	154	194	366	829	1,076	**30%**
Alberta	56	36	58	183	204	**11%**
Manitoba	16	13	12	32	33	**4%**
New Brunswick	7	11	10	20	37	**89%**
PHEV Total	1,613	2,470	2,694	5,893	8,726	**48%**

Quarterly BEV sales by Province

	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Ontario	289	328	485	384	596	867	982	1,237
Quebec	346	546	704	520	641	893	997	1,122

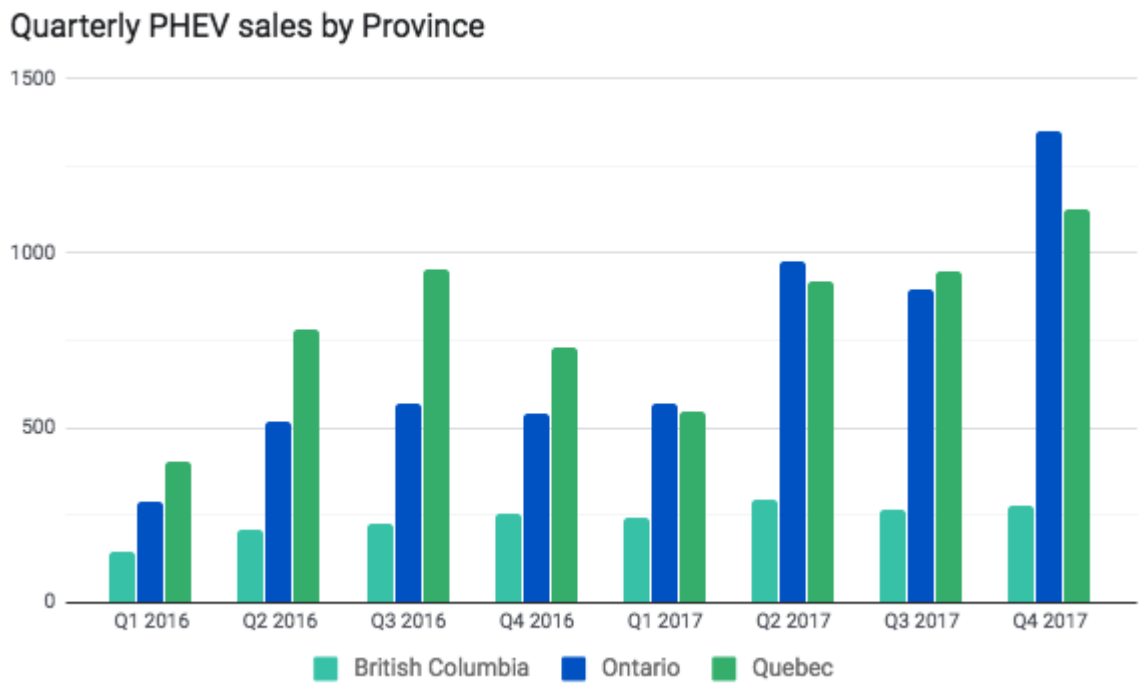
British Columbia	217	281	358	447	374	543	662	615
BEV Total	892	1,199	1,611	1,428	1,668	2,371	2,723	3,076



Quarterly PHEV sales by Province

	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Ontario	288	519	567	541	570	975	899	1,351
Quebec	403	782	954	732	547	921	948	1,124
British Columbia	144	208	225	251	241	291	268	276
PHEV Total	882	1,591	1,820	1,600	1,419	2,273	2,190	2,844

Appendix 2



Electric Vehicle models which contributed to growth

2017 saw more EV models come to market than ever before. Typically the market was overwhelmingly receptive to new vehicle models, often outselling updates to models which had been on the market for a number of years already. It seems consumers were waiting for new technology and specific features, namely longer range at a reasonable price.

Point in case is the Chevrolet Bolt EV which came to market with model-year 2017. There were over 2,100 Bolt EVs sold to Canadians, making it the most popular BEV model on the market.

The Bolt EV was so popular and fit the market so well that it beat out competitor models like the Tesla Model X, Model S, Nissan Leaf, and Hyundai Ioniq BEV. Each of these existing models managed to hold their own. The Tesla Model X and S increased sales by 770 and 200 units respectively. The Ford Focus also increased EV model sales by some 400 units. New model entries, Hyundai Ioniq and Volkswagen eGolf sold 890 and 530 vehicles respectively.

Appendix 2

BEV model sales, Canada (2016, 2017)

	2016	2017	Change
Chevrolet Bolt EV	3	**2,107**	
Tesla Model X	1032	**1,803**	75%
Tesla Model S	1466	**1,675**	14%
Nissan LEAF	1572	**1,380**	
Hyundai IONIQ	0	**890**	
Kia SOUL	708	**644**	
Ford Focus	123	**537**	337%
Volkswagen eGolf	0	**532**	

The Chevrolet Volt continues to dominate the plug-in hybrid section of the market. Increasing sales 24% over last year to 4,300 or by 830 units. New entries to the market include the Prius and Prime, counted here together account for some 730 new plug-in electric vehicles.

PEV model sales, Canada (2016, 2017)

	2016	2017	Change
Chevrolet VOLT	3,508	**4,340**	24%
Chrysler Pacifica	5	**838**	
Toyota Prius Prime	0	**734**	
VOLVO XC90	534	**471**	
AUDI A3	332	**453**	36%

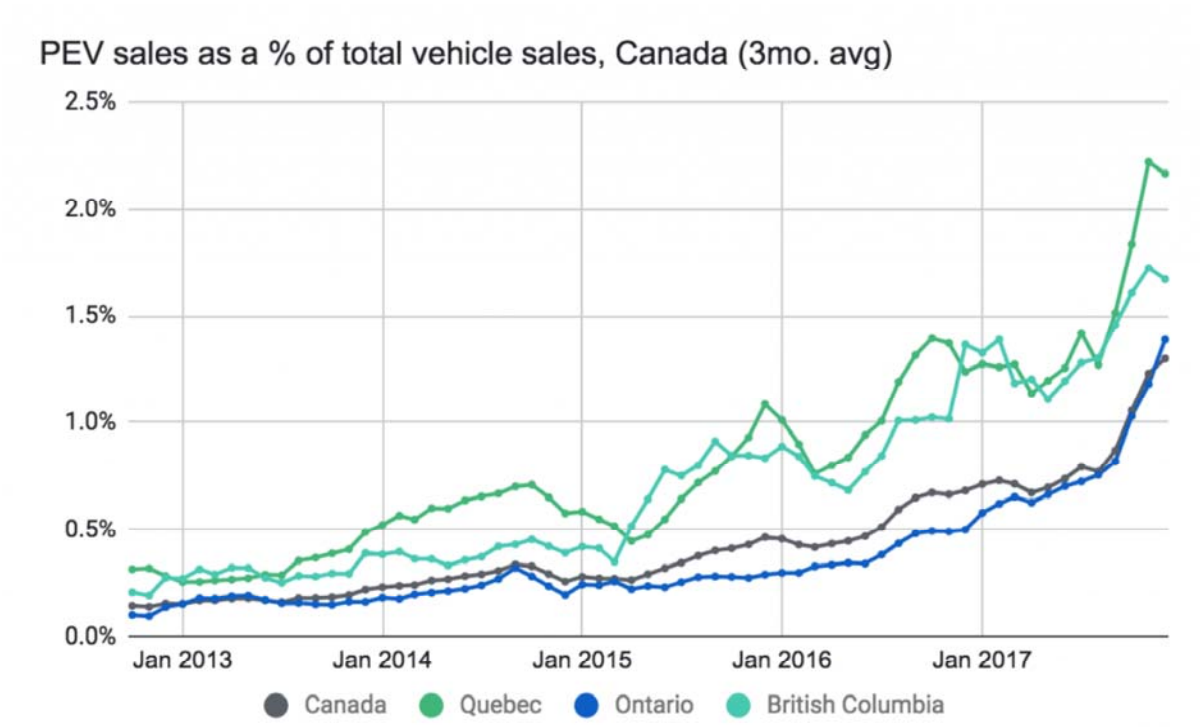
Ford C-Max	237	**353**	49%
Ford Fusion	99	**266**	169%

Sales targets and forecasts

There are a growing number of electric vehicles on the road, there are also a huge number of ICE vehicles already on the road. Considering the 100-year head-start of combustion engine technology and supporting infrastructure and the comparatively small number of EV sales doesn't look as bad after all. To understand the rate of EV adoption, we track the number of EVs sold as a percentage of all vehicle sales.

The overall vehicle market across Canada grew by 4.8% in 2017, from 1,980,000 to 2,080,000 vehicles. Of that, the portion of passenger cars decreased by 1.7% in 2017, from 660,000 to 650,000. Remember, the plug-in EV market grew by 68% in that same time period.

In December 2017, electric vehicles sales peaked at 1.4% of all vehicle sales in Canada, a 0.6% increase in market share from December 2016. Ontario saw the largest market share increase of PEV sales to 1.6%, an increase of 1% from the end of December 2016. Quebec leads in market share with an average of 2.2% of all vehicles sold in Quebec being an electric vehicle. British Columbia saw an expanding vehicle and electric vehicle market which leaves total adoption even compared to last year, an average of 1.9%.



Canadian EV Sales by Province

2011 - 2017

fleetcarma.

	Province	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	
	BEV	598	5,861	113	35	10	77	4		8,486	11	9,502	49	2	24,748
1	Tesla Model S	305	1,522	37	7	1	34	2		3,213	2	1,591	17		6,731
2	Nissan Leaf	58	1,717	43	9	4	26	1		1,285	6	3,317	13	1	6,480
3	Tesla Model X	167	882	9	2	2	3	1		1,295		469	5		2,835
4	Chevrolet Bolt	10	327	3	4		1			590		1,173	2		2,110
5	Kia Soul	1	432		2					359		915			1,709
6	Smart ForTwo	11	245	2						592		345			1,195
7	Ford Focus	8	143	1	1		3			385		359	4		904
8	Hyundai Ioniq	14	113	10	5	3	5			315	1	420	4		890
9	Mitsubishi iMiev	12	135	5	4		5			133	1	460	1		756
10	Volkswagen eGolf	1	100	2						162		267			532
11	BMW i3	1	181							111		62	1		356
12	Chevrolet Spark		5		1					15	1	114		1	137
13	Fiat 500	2	48							1		3			54
14	Tesla Roadster	8	9	1						27		7	1		53
15	Toyota Rav4		2							3			1		6

	Province	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	
	PHEV	591	2,801	121	91	21	56	2	1	8,158	5	11,137	64	0	23,040
1	Chevrolet Volt	155	1,066	48	53	10	20	1		4,199	4	8,037	26		13,619
2	Ford C-Max	46	156	14	7	3	5			472		748	5		1,451
3	Toyota Prius	33	104	10	4	2	3			326		539	4		1,022
4	Volvo XC90	133	200	8	9		13		1	407		224	10		1,005
5	Chrysler Pacifica	13	76	2	3					537		211	1		843
6	Ford Fusion	29	91	8	3	1	1			288		396	4		819
7	Audi A3	11	181	5	2	2	1	1		397		209			809
8	Porsche Cayenne	67	173	9	3	1	6			368		171	7		805
9	BMW i3		232		1	1				335		221			790
10	BMW X5	43	147	7	3	1	1			239		70	3		514
11	BMW i8	12	165	1	1					225		76			480
12	BMW 330	7	40	2						71		11	1		132
13	Fisker Karma	9	24							40		27			100
14	BMW 530	1	22							59		17			99
15	Kia Optima	3	10	1						31		49			94
16	Cadillac ELR	2	12	2	1					26		40			83
17	Hyundai Sonata	3	6							32		31			77
18	Mini Cooper Countryman		16							27		16			59
19	Porsche Panamera	4	21	1			6			15		3			50
20	Mercedes GLE550	1	21							10		11	1		44
21	Mercedes S550E	8	17	1						12					38
22	Hyundai Ioniq	1	4							12		19			36
23	Porsche 918	4	6	1						9		3	1		24
24	BMW 740	1	6							11		3			21
25	Cadillac CT6	1	1							5		4			11
26	McLaren P1	3	2							3		1			9
27	Volkswagen Jetta	1	2							1		1	1		6

https://www.fleetcarma.com/electric-vehicle-sales-canada-2017/

Province	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	CANADA
BEV	598	5,861	113	35	10	77	4		8,486	11	9,502	49	2	24,748
PHEV	591	2,801	121	91	21	56	2	1	8,158	5	11,137	64	0	23,040
ALL EVs	1,189	8,662	234	126	31	133	6	1	16,644	16	20,639	113	2	47,788

Common questions:

The numbers above are derived from multiple sets of input data. These are summarized below.

What is the source of the data?
IHS, formerly R.L. Polk & Company registration data.

Matthew Klippenstein's Canadian EV sales:
https://docs.google.com/spreadsheets/d/1dLFJwZVdvNLRpmZqPznlzz6PB9eHMe5b-bai_ddRsNg/edit#gid=25

Statistics Canada, new motor vehicle sales:
http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0790003&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=

Automaker Datasets
Some data is provided by automakers.

What does the registration data include?
Registration data includes new vehicle sales, and vehicles bought out of Province or Country.

Editor's Note:
In cases where a new dataset is received that enables further accuracy, these posts will be updated to include that new data.

Appendix 3

FBC APPLICATION FOR APPROVAL OF RATE DESIGN AND RATES FOR ELECTRIC VEHICLE DIRECT CURRENT FAST CHARGING SERVICE

(Provided in electronic format only due to document size and in order to conserve paper)

Diane Roy
Vice President, Regulatory Affairs

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www.fortisbc.com

December 22, 2017

British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC
V6Z 2N3

Attention: Mr. Patrick Wruck, Commission Secretary and Manager, Regulatory Support

Dear Mr. Wruck:

Re: FortisBC Inc. (FBC)

Application for Approval of Rate Design and Rates for Electric Vehicle (EV) Direct Current Fast Charging (DCFC) Service (the Application)

FBC, in accordance with sections 59 to 61 of the *Utilities Commission Act*, hereby applies to the British Columbia Utilities Commission (the Commission) for approval of a new Rate Schedule 96 (RS 96) for EV Charging Service at FBC-owned EV charging stations.

FBC plans to have the EV DCFC charging stations ready to be in-service by the end of December 2017 and available for EV DCFC Charging Service upon approval of RS 96. FBC respectfully requests a Commission decision on an interim rate for RS 96 by January 12, 2018 to enable FBC to begin providing EV DCFC Charging Service to customers under a Commission-approved rate.

If further information is required, please contact David Perttula at 604-592-7470.

Sincerely,

FORTISBC INC.

Original signed:

Diane Roy

Attachments

cc (email only): Registered Parties to FBC's PBR Annual Review for 2018 Rates

FORTISBC INC.

Application for Approval of Rate Design and Rates for Electric Vehicle Direct Current Fast Charging Service

Volume 1 - Application

December 22, 2017

Table of Contents

List of Appendices

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EXECUTIVE SUMMARY

With this Application, FortisBC Inc. (FBC or the Company) is applying to the British Columbia Utilities Commission (BCUC or the Commission) for approval of a $9.00 per half hour electric vehicle (EV) charging rate for service at FBC-owned direct current fast charging (DCFC) stations, and related approvals. It is expected that the proposed rate will recover the incremental costs of service associated with the DCFCs on a net present value basis over the 10 year life of the stations.

These stations are being installed as part of the Accelerate Kootenays project and will be located along the Highway 3 corridor in Greenwood, Christina Lake, Castlegar, Salmo and Creston, British Columbia (BC).

Although EVs are at a relatively early stage of market adoption, vehicle manufacturers are beginning to introduce models with significantly more highway range and that are priced at a level that targets mass market adoption. Despite this, the main barriers to the mass adoption of EVs are limitations with battery range and a relative lack of public refuelling infrastructure. FBC's deployment of five DCFC stations in the West Kootenay region (the Project or the EV DCFC Stations Project), coupled with existing BC Hydro-owned stations in the Similkameen and Okanagan regions, will help enable highway EV travel both within and through FBC's service territory.

This is FBC's first application for an EV charging rate specific to DCFC stations, with this initiative intended to support and encourage greenhouse gas (GHG) emission reductions in the transportation sector. As discussed further below, the EV charging initiative is consistent with government policy contained in the *Greenhouse Gas Reduction (Clean Energy) Regulation* (GGRR), the *Clean Energy Act* (CEA) and climate action objectives. Section 1 of the Application provides an introduction, including the legislative and policy context within which the Application is being filed, as well as the specific approvals sought and recommended regulatory review process. Section 2 provides a background and overview of the DCFC installations. Section 3 provides a review of the cost of service analysis for the DCFC stations, including the proposed rate to recover these incremental costs. An overview of the other EV rate structures in effect in other jurisdictions is also provided, as well as a discussion regarding the proposed treatment of any carbon credits that FBC is able to monetize as a result of the EV charging service being provided. Finally, Section 4 provides the Application conclusion.

1. INTRODUCTION, POLICY CONTEXT AND APPROVALS SOUGHT

1.1 *INTRODUCTION*

FBC is constructing five EV DCFC stations in five communities along the Highway 3 corridor in the West Kootenay area in BC. These stations are being installed as part of the Accelerate Kootenays project in conjunction with several partner organizations. FBC anticipates that these stations will be fully deployed and EV DCFC service (Charging Service or DCFC Service) will be available to customers by January 12, 2018. FBC also anticipates the development of other stations over the coming years to which the DCFC Service tariff and rates will apply. The total cost for FBC of the five stations is $215 thousand net of CIAC. FBC is proposing both an interim and a permanent time-based rate of $9.00 per half hour charging session prorated to the second of time spent at the station.

The five DCFC stations provide infrastructure that enhances the electrification of transportation and will provide the following benefits:

- Support a publicly accessible, conveniently located network of charging stations in BC and within FBC's service territory;
- Provide opportunities to increase the electrification of transportation, thereby reducing carbon emissions as per the mandate and policies of both the federal and provincial governments; and
- Contribute to providing sufficient infrastructure for enabling long distance EV travel in BC.

A fast charging station is a direct current charger for EVs that can charge most EVs in under 30 minutes, which is crucial for longer trips and to allow for travel between cities.

BC is active in the deployment of EV charging stations. According to the Plug In BC website, there are currently over 1000 charging stations in BC[1]. However, only a small number of these (approximately 30) are fast charging stations[2]. There were just over 200 fast charging stations in Canada nine months into 2016, which was 33 percent higher than the previous year[3]. There are currently only four fast charging stations located in FBC's service territory (all located in the Okanagan and Similkameen areas), which means traveling within or through FBC's service territory is difficult for EVs.

[1] Plug In BC, Charging Stations, Accessed November 14, 2017, Available here: http://pluginbc.ca/charging-stations/
[2] Plug In BC website, maps of public charging stations as of December 1, 2017: https://www.plugshare.com/
[3] Fleetcarma DC Fast Charging in North America maps. Retrieved November 13, 2017 from http://www.fleetcarma.com/electric-vehicle-charging-2016-maps/

The EV DCFC Stations Project is being undertaken by FBC to reduce GHG emissions in British Columbia in support of the GGRR[4]. Section 4 of the GGRR sets out GHG reduction initiatives under several electrification prescribed undertakings that encourage the use of electricity as a means to reduce GHG emissions. Through the Project, FBC will provide for EV DCFC Service within its service territory and, as such, encourage the use of electricity as an energy source for vehicles instead of other sources of energy that produce more GHG emissions such as gasoline or diesel fuels.

FBC is seeking approval from the BCUC for the EV DCFC Service rate, and corresponding Electric Tariff Rate Schedule 96 (RS 96). Further, FBC seeks approval of a deferral account to record net revenues that may be realized from the sale of carbon credits arising from the EV Charging Service.

In the sections below, FBC describes the legislative context of Order in Council (OIC) 101-2017, the GGRR and the CEA, provides a description of how approval of a rate for the EV DCFC Charging Stations Project supports legislation and policy in BC, and sets out the approvals FBC is seeking. This is followed by a description of the Project and FBC's DCFC Service and FBC's proposed Rate Schedule 96 – Electric Vehicle Charging Rate.

1.2 *PROVINCIAL LEGISLATIVE AND POLICY CONTEXT*

The provincial government has enacted a number of pieces of legislation that support energy efficiency and conservation and the use of clean and renewable energy sources, including the Clean Energy Vehicle (CEV) Program as a component of BC's Climate Leadership Plan[5]. BC's Climate Leadership Plan outlines that the transportation sector accounts for 37 percent of GHG emissions in BC[6].

The Climate Leadership Plan and the CEV Program are intended to encourage and accelerate the adoption of CEVs in BC for their environmental and economic benefits.

In chronological sequence the first piece of provincial legislation pertaining directly to GHG emission reductions in the transportation sector was the *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act* (enacted in 2008 but with an effective date of January 1, 2010), followed by the *Renewable and Low Carbon Fuel Requirements Regulation* in 2009, both of which recognize that electricity is a low carbon transportation energy source that can play an important role in lowering GHG emissions in BC's transportation sector.

[4] The Regulation was initially established on May 15, 2012 by OIC 295/2012 (B.C. Reg. 102/2012) and, after several intervening amendments was amended to include an electrification section on March 22, 2017 by OIC 101/2017 (B.C. Reg. 114/2017).

[5] Climate Leadership Plan, August 2016. https://climate.gov.bc.ca/app/uploads/sites/13/2016/10/4030_CLP_Booklet_web.pdf

[6] Climate Leadership Plan, August 2016, page 18, https://climate.gov.bc.ca/app/uploads/sites/13/2016/10/4030_CLP_Booklet_web.pdf

On April 18, 2010, the provincial government enacted the CEA. One of the key features of the CEA is the establishment of a number of legislated provincial energy objectives.[7]

As indicated in footnote 4, the GGRR was initially enacted in May 2012. In its initial form and also in several amendments in subsequent years the GGRR established a number of prescribed undertakings pertaining to natural gas for vehicles and natural gas fueling infrastructure. However, in March 2017 further support for electricity as an energy source for GHG emission reductions came in the form of "electrification" amendments to the GGRR. OIC 101-2017 established a number of prescribed undertakings pertaining to electrification in various sectors of the provincial economy, including the transportation sector.

Section 4, the electrification section of the GGRR establishes a number of measures to promote the use of electricity for the purposes of reducing greenhouse gas emissions. Projects or programs respecting technology that may enable the utility's customers to use electricity instead of other sources of energy that produce more greenhouse gas emissions are considered to be a prescribed undertaking for the purposes of section 18 of the CEA. Specifically, section 4(3) of the GGRR establishes several prescribed undertakings in subsections (a) through (e). Subsections (c) and (e) as follows, are those most pertinent to FBC's DCFC EV Charging Service initiative:

> (c) a project, program, contract or expenditure for research and development of technology, or for conducting a pilot project respecting technology, that may enable the public utility's customers to use electricity instead of other sources of energy that produce more greenhouse gas emissions;
>
> (e) a project for the construction, acquisition or extension of a plant or system, that the public utility reasonably expects is necessary to meet the public utility's incremental load-serving obligations arising as a result of an undertaking defined in paragraph (a), (b), (c) or (d), if the public utility reasonably expects any one such project to cost no more than $20 million.

The development of EV DCFC stations contributes toward the achievement of the provincial energy objectives. Deployment of EV charging stations promotes the use of EVs in BC and supports the use of clean or renewable resources, reduces BC GHG emissions, encourages individuals to switch to lower GHG emission fuel sources, encourages communities to reduce GHG emissions and use energy efficiently, and encourages economic development and the creation and retention of jobs.

The EV DCFC stations are, in effect, a pilot project for FBC in that they represent FBC's first foray into owning and operating fast charging technology for EVs. It is also possible to consider the EV DCFC stations as being an extension of FBC's system that is required to serve the incremental load growth created by the growing EV market. The EV DCFC Stations Project is consistent with the intent of these prescribed undertakings, particularly considering that these

[7] *CEA*, s. 2.

stations will enable customers to use electricity for transportation rather than more carbon-intensive fuel sources. These considerations with respect to Section 4 (3) of the GGRR and the strong alignment with government policy discussed above confirm the merits of the FBC's EV charging initiative and the value of establishing a reasonable rate for the service. The economic analysis, as further discussed in Section 3 of the Application, demonstrates the basis for FBC's proposed EV DCFC Service rate and that revenues from the Project are reasonably expected to match the cost of service on a present value basis over the life of the Project.

Though in relation to another utility, BC Hydro, the Minister of Energy, Mines and Petroleum Resources recently reconfirmed government support for the use of electricity in the transportation sector in a letter dated August 24, 2017[8] (see Appendix A). Among other things the letter set out expectations for BC Hydro to work with government to:

> Provide leadership in advancing government's climate action strategies, including through:
>
> - fuel switching and electrification initiatives for transportation, oil and gas, and other sectors;
> - initiatives under the *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act*, to further reduce emissions in the transportation sector;
> - policies and programs to increase the energy efficiency of buildings;

Together, these policies and legislation clearly support EV adoption and the establishment of enabling infrastructure such as charging stations in BC, giving due recognition to the resulting positive environmental and economic impacts.

Please refer to Appendix I for excerpts of online sources referenced in footnotes throughout the Application.

1.3 *APPROVALS SOUGHT*

The purpose of this Application is to establish the rate for EV Charging Service that will allow FBC to provide EV DCFC Service in its service territory and to establish the regulatory treatment for recovery of Project costs in electricity rates.

FBC is seeking approval from the Commission for:

1. The proposed Rate Schedule 96 – Electric Vehicle Charging, on an interim basis, pursuant to section 90 of the *Utilities Commission Act* (UCA or the Act), effective

[8] August 24, 2017, Government Mandate Letter to BC Hydro, BC Hydro Fiscal 2017 to Fiscal 2019 Revenue Requirement Application Proceeding, Exhibit B-23, Attachment 1, page 3.

January 12, 2018, pending a final decision on this Application. RS 96 is attached as Appendix J;

2. Rate Schedule 96 – Electric Vehicle Charging on a permanent basis, pursuant to sections 59 to 61 of the Act, to take effect shortly after the Commission's decision in this Application[9]; and

3. The establishment of an Emissions Regulation deferral account to attract interest at FBC's short term interest (STI) rate to record net revenue realized from the monetization of carbon credits, as set out in section 3.2.8. The balance of the deferral account will be amortized in customers' rates in the subsequent years' revenue requirement.

These approvals will allow FBC to proceed with providing EV DCFC Service by January 12, 2018, which is when FBC will make the EV DCFC charging stations available for service.

A Draft Form of Order setting out the detailed approvals sought has been included as Appendix K-2.

1.4 *RECOMMENDED REGULATORY REVIEW OF THE APPLICATION*

FBC proposes the regulatory process and timetable set out in Table 1-1 below. With the strong alignment between the proposed DCFC Service and provincial energy objectives, FBC does not consider the Application to be contentious. As such, FBC believes that a written hearing process with one round of Information Requests from the Commission and interveners will provide for an appropriate and efficient review of the Application.

FBC plans to have all five EV DCFC Stations ready to be in-service on or before January 12, 2018 and available for DCFC Service upon approval of RS 96. FBC respectfully requests a Commission decision on the Interim RS 96 Rates by January 12, 2018 to enable FBC to begin providing DCFC Service to customers at that time. If the Commission is unable to issue an interim approval of RS 96 by January 12, 2018 as requested, FBC will defer the commencement of service until the effective date in the interim order. If that is the case, the other dates in the proposed regulatory timetable in Table 1-1 can be adjusted as necessary to accommodate the actual interim order date.

Draft Procedural and Draft Final Orders are included as Appendix K-1 and Appendix K-2 respectively.

[9] The practical difficulty of addressing of any variance between revenues collected under an interim rate and those that would have been collected under the permanent rate determined in this proceeding is discussed in section 3.3.10.

Table 1-1: Proposed Regulatory Timetable

ACTION	DATE (2018)
BCUC Approval of Interim Rate Schedule 96	Friday, January 12
BCUC Issues Procedural Order	Friday, January 19
Intervener and Interested Party Registration	Friday, February 2
Intervener and Commission Information Request (IR) No. 1	Tuesday, February 13
FBC Response to IR No. 1	Friday, March 2
Intervener Written Final Argument	Friday, March 16
FBC Written Reply Argument	Wednesday March 28

2. PROJECT DESCRIPTION

2.1 *BACKGROUND*

EVs are a broad category of vehicle which includes any vehicle which is charged by being plugged in and includes plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs). There are three levels of charging offering different amounts of power for charging EVs.[10] The more power a charging station provides, the faster the vehicle is charged. These three levels consist of:

- Level 1 (120 volt): Regular outlet, also known as "trickle charge", best used when parked overnight or long-term;
- Level 2 (240 volt): Typical for at home, at work, or short to medium-term parking, approximately 4 hours to charge most BEVs; and
- Level 3 DC Fast Charging (DCFC): Best for longer trips, approximately 30 to 60 minutes to charge most BEVs.

A PHEV will run on a battery for the extent of its electric range (typically under 100 km[11]) until the battery is depleted, at which time the gasoline engine takes over for the remainder of the distance travelled until the battery is recharged. PHEVs can be charged by Level 1 or Level 2 chargers, but typically not by Level 3 DC fast chargers. A BEV is fully electric and runs solely on the rechargeable battery for the full distance travelled. In addition to being able to use Level 1 or Level 2 chargers, BEVs are the only class of EV capable of using a Level 3 DCFC.

Customer adoption of EVs offers a strategic opportunity for utilities to improve the use of the electric grid. Additionally, the potential GHG reductions associated with the electrification of transportation are substantial, with personal transportation estimated to be responsible for approximately 14 per cent of BC's GHG emissions.[12] The first phase of the provincial CEV program which ran from 2011 to 2014 helped support the purchase of 950 electric vehicles and the development of over 1,000 charging stations, with a resulting 57,000 tonnes of direct GHG emissions reductions.[13]

Although EVs are at a relatively early stage of market adoption, there were approximately 42,000 plug-in vehicles sold in Canada between 2010 and the end of September 2017. After

[1] Fleet Carma Electric Vehicle Charging Guide. Retrieved November 24, 2017 from https://www.fleetcarma.com/electric-vehicle-charging-guide/

[11] PlugNdrive Electric Cars Available in Canada. Retrieved November 24, 2017 from https://plugndrive.ca/electric-cars-available-in-canada

[12] FACTSHEET: Clean Energy Vehicle Program/Innovative Clean Energy Fund. Retrieved December 6, 2017 from https://news.gov.bc.ca/factsheets/factsheet-clean-energy-vehicle-programinnovative-clean-energy-fund

[13] Vancouver Courier Province announces $7.5M in incentives for clean-energy vehicles. Retrieved November 24, 2017 from http://www.vancourier.com/news/province-announces-7-5m-in-incentives-for-clean-energy-vehicles-1.1801798

Ontario, BC is on track for the second highest increase in 2017 EV sales with a projected 49 percent increase over 2016 sales.[14] Notably, BC has shown comparatively higher consumer demand for BEVs over PHEVs as compared to the rest of Canada, with BEVs comprising approximately 67 percent of all EVs sold in BC between 2010 and September 2017.

FBC believes that one of the main barriers to the mass adoption of EVs for personal transportation is the issue of "range anxiety"[15] coupled with the relative lack of public charging infrastructure, particularly of the Level 3 DCFC variety. Indeed, as previously mentioned in Section 1, there are currently only four fast charging stations located in FBC's service territory, all of which are located within the Okanagan and Similkameen portions of FBC's service territory. As a result, intercommunity EV travel within or through FBC's service territory can be problematic for customers looking to use highway grade (Level 3 DCFC) charging resources. A survey of a number of stations in the San Francisco Bay area showed that BEV owners typically prefer the convenience of DC fast-charging options as compared to Level 1 and 2 AC charging options. The survey found that EV drivers prefer DC fast-charging 12 to 1.[16]

FBC began investigating the use of charging stations and potential impacts (i.e. service requirements, design/engineering considerations, rate design), as well as exploring how to incent the efficient use of existing infrastructure for EV charging facilities. In 2016, FBC, in partnership with the City of Kelowna, participated in the design and installation of two Level 2 EV charging stations in downtown Kelowna. The stations are owned by FBC and operated by the City of Kelowna, and have provided useful information about both the infrastructure and installation requirements as well as the customer uptake of public Level 2 EV charging resources.

FBC also entered into a partnership with the Community Energy Association to support a community-driven, collaborative strategy to build a clean transportation network in the Kootenay region of BC. This is a 2-year, $1.5 million initiative of the Regional Districts of East Kootenay, Central Kootenay and Kootenay Boundary with support from Columbia Basin Trust, the Federation of Canadian Municipalities, the Province of BC, FBC, BC Hydro, and Powertech Labs. The Accelerate Kootenays project, facilitated by the Community Energy Association, will create an EV charging station network comprised of both Level 2 and Level 3 DCFC EV stations in the West and East Kootenays so EV travel to and within the region is convenient and reliable. Through this partnership, FBC entered into a contribution agreement with the Community Energy Association to provide $40,000 in contributions in exchange for access to charging data as well as branding at 20 Level 2 stations planned for deployment throughout FBC's West Kootenay service territory.

[14] Fleet Carma Electric Vehicle Sales In Canada Q3 2017. Retrieved November 24, 2017 from https://www.fleetcarma.com/electric-vehicle-sales-in-canada-q3-2017/

[15] https://en.wikipedia.org/wiki/Range_anxiety

[16] Green Car Reports Electric Car Drivers Will Pay for DC Fast Charging 12 to 1 over Level 2. Retrieved November 24, 2017 from https://www.greencarreports.com/news/1100804_electric-car-drivers-will-pay-for-dc-fast-charging-12-to-1-over-level-2

In 2017, FBC also elected to participate in the DCFC component of the Accelerate Kootenays project. Through this initiative, FBC will construct, own and operate five EV DCFC stations located in Creston, Salmo, Castlegar, Christina Lake, and Greenwood. FBC will make the capital investment with the supporting funding provided through the Community Energy Association. A key benefit to FBC from this support includes additional research and insight into the infrastructure requirements necessary to support EV DCFC charging stations, as well as an improved understanding of customer uptake of these public charging resources. A map of the locations of the FBC EV DCFC stations is provided below.

Figure 2-1: Map of DCFC Station Locations

2.2 *PROJECT DESCRIPTION*

As previously discussed, the Project scope includes the construction and operation of five FBC-owned EV DCFC stations. The stations are hosted on municipal property under an initial 10-year no cost lease to FBC with an optional 5 year renewal at the end of the lease term.

The scope of the Project includes:

- Design and construction of the system extensions required to serve the DCFC EV stations;
- Site host lease agreements with the municipalities of Creston, Salmo, Castlegar, Christina Lake and Greenwood for siting of the DCFC EV stations; and
- Installation and commissioning of five publicly accessible 50 kW EV DCFC stations including the necessary civil and electrical construction.

A picture of a DCFC station site is provided below in Figure 2-2:

Figure 2-2: Rendering of DCFC Station Site

The EV stations are being purchased from a Canadian company, AddÉnergie. The stations are expected to be installed and commissioned in December 2017. It is anticipated that the stations will be placed in-service by January 2018 following BCUC approval of an interim rate for service.

All five EV DCFC stations will be readily accessible from the Highway 3 corridor. The location and status of the stations will be made available on plugshare.com to facilitate customer use. These stations will support intercommunity EV travel in the Kootenay region of BC as enabled by both the FBC-owned EV DCFC stations in the West Kootenays and the BC Hydro-owned EV DCFC stations being deployed in the East Kootenays, which are also being constructed as part of the Accelerate Kootenays initiative.

FBC will own and operate the EV DCFC stations, with maintenance services and network management services provided under contract by FLO Services Inc. (FLO). Specifically, FLO will provide annual maintenance services for the first three years of station operation, with FBC assuming responsibility for maintenance services thereafter. FLO will also provide customer support services for EV drivers using the station, and will also be responsible for providing technical support for diagnosing and remedying any breakdowns or malfunctions of the EV DCFC stations.

Drivers using the EV DCFC stations for EV recharging purposes will have two options for payment transactions with FBC:

1. Creating a membership with the FLO network and linking an appropriate means of payment (credit card, bank account) to that membership; or
2. Scanning a Quick Response Code (QR code) on the station with their mobile phone which will take the customer to a payment portal where they can enter their credit card

details which will allow the station to be activated. The customer's credit card will be charged the appropriate amount once the charging session is complete.

FLO will administer the payment process for the DCFC stations. This includes 24/7 operation of a transactional website enabling users who have created an account with FLO to transfer funds required for use of the charging services, as well the operation of a transactional website enabling users who do not have an account with FLO to make payment with a credit card for use of the charging services. FLO will also provide issuance of payment notification to each customer after use of the charging station. Charging revenues net of network management fees (15% of gross charging station revenues excluding applicable taxes) will be remitted back to FBC on a quarterly basis.

Network management services for the EV DCFC station will be provided by FLO (on behalf of FBC). Additionally, as part of the Network Management Agreement (to be filed upon execution in early January 2018 as Confidential Appendix B), FLO will provide 24/7 customer support services (on behalf of FBC) for customers who may have difficulties using the stations. FLO will also provide technical support for the stations including a first level of support by which FLO will diagnose a breakdown or malfunction within 4 hours and attempt to remedy the issue remotely, as well as a second level of support within 4 business days where an onsite presence is required to diagnose a breakdown or malfunction and attempt to remedy.

3. RATE DESIGN

3.1 *INTRODUCTION*

FBC conducted a review of the rate design for DCFC stations in other jurisdictions in Canada and the United States. The Company established its rate design guided by the BC legislative context, government policy with respect to the GGRR and the CEA, projected EV sales growth in BC, and informed by financial analysis. FBC's review of the rate design for these customers considered the potential rate structure and rate options for DCFC station customers.

FBC is proposing to use a time-based rate structure, as it is easy for customers to understand and simple to administer. The time-based rate also encourages turnover of users of the station location once their vehicle is charged, and increases the availability of the station as customers are discouraged from using these as parking spaces. Given the constraint on using an energy-based volumetric rate at EV charging station meters due to lack of accreditation by Measurement Canada, FBC believes that the time-based rate structure is the most reasonable and practical option at this time.

FBC is proposing a time-based rate of $9.00 per half hour prorated to the second of time spent plugged in at the station. This rate is based on the cost of service analysis of the stations and assumes a reasonable level of demand based on the projected growth sales of EVs in BC over the next 10 years.

Although the time-based rate proposed is intended to cover the cost of service of the stations, net of contributions in aid of construction (CIAC) received from other parties, it is likely that in the early years of operation costs will exceed revenues and the result will be small net deficits, based on the conventional components of cost of service analysis. However, FBC will be eligible under the *Renewable and Low Carbon Fuel Requirements Regulation* (RLCFRR or the Regulation) to receive credits that can be sold to other fuel providers that have not met BC's low carbon fuel requirements. Including the value achieved by monetizing low carbon fuel credits improves the business case. Details are provided in Section 3.2.8. FBC intends to maximize the low carbon fuel credits attributable to the Project and apply them against any deficiency resulting from the Project that has been borne by other general ratepayers. When the potential low carbon fuel credits are considered, the Project may generate a net benefit to general ratepayers even in the early years. It is expected the Project will generate low carbon fuel credits reducing GHG emissions of on average 104 tonnes CO2e annually over the next 10 years by enabling customers to refuel with electricity instead of gasoline to meet their transportation needs.

The section is organized as follows:

Section 3.2: Cost of Service. This section provides a description of the cost of service for the stations and cost of service assumptions.

Section 3.3: DCFC Rate Structures Considered. This section provides a discussion of rate structures considered for FBC's EV DCFC Service; and

Section 3.4: DCFC Rate Proposal. This section include the assumptions used by FBC to develop the rate, rate options, FBC's recommended rate structure and rate and treatment of variance between interim and permanent rates.

3.2 *COST OF SERVICE*

The cost of service components for the stations consist of power purchase expense, operating and maintenance (O&M), property taxes, depreciation, amortization of CIAC, income taxes and earned return, calculated over a 10 year period. Detailed financial schedules have been provided in Appendix C.

Over the 10 year analysis the levelized monthly average cost of service per station is approximately $600 based on the forecast EV charging events demand scenario. Details of FBC's demand assumptions are provided in Section 3.4.1.

3.2.1 Capital Expenditures

Gross capital expenditures of $492 thousand are required to build the five EV charging stations. These expenditures consist of $482 thousand for electrical service, kiosks, stations, civil work, installation and commissioning, and $10 thousand for Project development costs.

A CIAC of $332 thousand is expected from the Community Energy Association through funding from the Columbia Basin Trust and several others, including both the federal and provincial governments, to support the construction of the stations thereby lowering FBC's net total cost. Therefore, net capital expenditures from FBC for the five stations are forecast to be $160 thousand. Additionally, FBC expects to incur $50 thousand for Application costs and $5 thousand for communications and consultation and has included these costs in the determination of the rate.

3.2.2 Depreciation Rate

Station useful life is estimated to be approximately 10 years; therefore, a depreciation rate of 10 percent for charger components has been used. FBC's approved depreciation rates are assumed for the service extension components of the capital expenditures.

3.2.3 Power Purchases

FBC's incremental cost of power purchase is about $50/MWh[17], or 5 cents per kWh. The model assumes a typical half hour charge session will deliver 20 kWh of energy. The 20 kWh was multiplied by the 5 cents per kWh and becomes an input to the cost of service.

3.2.4 Operating and Maintenance

The estimated operating and maintenance cost is $6,150 annually for all five stations and includes maintenance, travel, repairs outside of warranty, and net management. Details have been provided in the Global Network Management Agreement to be filed separately as confidential Appendix B.

3.2.5 Property Taxes

There are no specific property tax exemptions for EV stations. Therefore, FBC EV charging revenues will be subject to the 1% in lieu property taxes but there is no property tax on the land itself since it is being leased.

3.2.6 Income Taxes

The income tax rate applied is the currently enacted 2018 rate of 27%. The EV charging units attract an accelerated capital cost allowance rate of 30% on a declining balance basis which results in an income tax recovery in the first few years.

3.2.7 Inflation

Inflation is estimated at 2 percent for the purpose of this analysis. This compares reasonably with the Conference Board of Canada (CBOC) near-term forecast. Inflation is applied to O&M, property taxes and power purchase costs.

3.2.8 Carbon Credits

The provincial government has identified the transportation sector as being a major contributor to GHG emissions in BC. In order to reduce GHG emissions, the RLCFRR was introduced with the goal of reducing the carbon intensity of transportation fuels by ten percent by 2020. Carbon intensity is the amount of carbon dioxide equivalent emitted (CO2e) per unit of energy consumed, and is measured in tonnes.

The Regulation has implemented maximum allowable carbon intensity limits for transportation fuels, with which all fuel suppliers must comply in each reporting period. Fuel suppliers, including suppliers of electricity for EV charging, must submit reports in each reporting period which detail their compliance with the Regulation.

[17] FBC's 2016 Long Term Electric Resource Plan identifies a levelized value of about $50/MWh over twenty years and a levelized unit energy cost for market purchases of about $51/MWh (page 42).

All fuel with a carbon intensity that exceeds the limits set by the Regulation will generate debits, while fuel with a carbon intensity that falls below the limits of the Regulation will generate credits. At the end of each compliance period, fuel suppliers need to ensure that they have at least as many credits as debits.

All fuel suppliers who are in a debit position, meaning that the carbon intensity of the fuel they supplied exceeds the limit mandated by the Regulation during the reporting period, must pay a penalty of $200 per tonne of CO2e. Alternatively, these fuel suppliers may obtain carbon credits from another supplier who supplies lower carbon fuels and has generated a net credit position in each reporting period.

The carbon intensity of electricity falls below the maximum carbon intensity limit set by the RLCFRR for the reporting period. Therefore, FBC will earn carbon credits which, subject to verification and approval by the Ministry of Energy, Mines and Petroleum Resources, it may transfer to fuel suppliers who are not compliant with the maximum carbon intensity limits set by the RLCFRR.

With FBC's assumed demand projections for these stations, FBC will generate low carbon fuel credits of 104 tonnes of CO2e annually on average, and assuming a price at the high end of $170 per tonne, would receive on average over the ten years $17,700 per year which FBC is proposing be amortized into FBC customer rates. In the first year the monetized value of the carbon credits could be as much as $6,000 while in the tenth year, based on forecast demand growth, the value could be six times higher than in the first year. As a frame of reference, each 20 kWh charging session has the potential to generate between $1.00 and $3.25 in carbon credits depending on negotiated sale prices for the credits of between $50 and $170 per tonne.

As a supplier of low carbon fuels FBC will be in a position to monetize carbon credits. FBC proposes to establish an Emissions Regulation Deferral Account[18] to record, net of administration costs, any revenue realized from the sale of carbon credits and to refund the balance of the account in the subsequent year's revenue requirements. The monetization of these credits has not been included in the cost of service analysis in this Application due to the forecast uncertainty.

[18] FBC has included in this section various items that are recommended by the Commission's Regulatory Account Filing Checklist. One item requested by the Commission is to "Identify any alternate treatments that were considered, including an overview of what the accounting treatment would be in the absence of approval of the request to establish a regulatory account, and explain why these alternate treatments may not be appropriate." FBC considered two alternatives – one to see the net revenue recorded as Other Revenue in the year(s) that the transactions occur and returned to customers by way of the Flow-through deferral account in the following year(s) for the benefit of all customers, and the other to apply the net revenue captured in the deferral account to the EV Charging Rate either on an annual basis or from time to time. FBC considers it appropriate that the benefits of the carbon credits accrue to ratepayers in general, who, as explained in section 3.4.6, assume the risk of over- or under-collection of costs. In addition, as explained in section 3.4.4, FBC does not contemplate changes to the rate over the analysis period. FBC does not believe either of these alternatives provide the benefits of transparency, consistency with the rate calculation, and a short timeline for return to customers that are afforded by FBC's proposed treatment. Furthermore, the proposed deferral account treatment is consistent with FortisBC Energy Inc.'s Emissions Regulation deferral account which also captures monetized carbon credits.

3.3 *DCFC RATE STRUCTURES CONSIDERED*

Charging station owners (which can include utilities) generally charge based on delivered energy, time, or session, or a hybrid of more than one model. EV charging rate structures employed in BC generally consist of time-based or energy-based structures.

3.3.1 Time-Based ($ / hour)

For time-based rates, the charging fee is based on the length of time a station is occupied (i.e. the time connected to the charger). Charging a rate for the amount of time the space is occupied generally encourages turnover and increases availability so that charging stations are used by those who need them for EV charging and not simply as parking spaces. Hourly fees are simple to understand by customers, and mirror existing rate structures for parking meters. As described in an information bulletin issued by Measurement Canada on September 16, 2016, time-based EV changing is impacted by the *Weights and Measures Act* as described below:

> Where an electric vehicle charging station is only intended to be used for the purpose of providing a prepaid service including energy from the charging station on the basis of time, the device would be subject to the legal requirements of the WMA. However under section 4 of the Weights and Measures Regulations, parking meters, clocks, watches, chronometers, and other timing devices have been given an exemption from the approval and device certification requirements prescribed in section 8 of the WMA. Therefore, no requirements apply.

A copy of the information bulletin is provided as Appendix D.

3.3.2 Energy-Based ($/ kWh)

For energy-based rates, the charging fee is based on energy (per kWh) and are considered to be more equitable between different models of vehicles with different on-board charging speeds because users would only pay for energy received regardless of the length of time to charge. This option sometimes incorporates time-of-use[19] (TOU) premiums to promote off-peak charging.

An energy-based approach, however, may hamper efficient use of the station as users are not necessarily incented to vacate the station once a charging session has been completed. Further, energy meters internal to the EV DCFC stations are not currently accredited by Measurement Canada, and as such FBC is only considering time-based rate options[20].

[19] TOU pricing simply means that customers are billed based on the time of day that the electricity is consumed. https://www.fleetcarma.com/tou-pricing-smart-charging/

[20] https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm04839.html

3.3.3 DCFC Rate Structures in BC

There are a number of different rate structures in BC including both energy-based rates on a per kWh for non-utility station owners, and time-based rates in other cases. Some examples follow.

Bakerview EcoDairy's EV rate is $0.35 per kWh and recovers only electric utility charges including demand, energy and basic charges along with some O&M. A copy of the EcoDairy application is provided in Appendix E[21].

Another example is the City of Vancouver in which it implemented a time-based rate of $16.00 per hour or $8.00 per half hour (Appendix G), plus the applicable city parking rates.

In the case of the British Columbia Electric Vehicle Infrastructure Project, the rate is $0.35 per kWh and is not intended to fully cover the full costs of providing the DCFC service. Details for this Project are provided in Appendix H.

3.3.4 Rate Structures in North America

North American public utility rate structures for electric vehicle charging are still developing. At present, only a handful of regulated utilities in North America have been approved for investment in EV chargers or have specific electric vehicle charging tariffs for service to the EV owner, although high interest in this area may bring about changes over time. Activity is concentrated in California, which has ambitious EV policies and mandates. Recognizing the need for infrastructure to promote greater adoption of EVs, California is increasingly looking to utilities to invest in chargers as part of utility rate base.

The State of California has granted approval for San Diego Gas and Electric, Pacific Gas and Electric (PGE) and Southern California Edison (SCE) to build 12,500 charging stations by mid-2017. Many rates are energy-based and incorporate TOU premiums. Below are two California examples:

SCE has 1,500 Level 1 and Level 2 stations approved at an investment of approximately $22 million.[22] Its customers currently have the option of adding their EV charging to their existing SCE meter and service, or opting for one of three non-residential, separately-metered TOU rate options.

PGE received approval for ownership of EV supply infrastructure to support up to 7,500 EV Level 2 charging stations in multi-unit dwellings, disadvantaged communities and workplaces at expenditures of up to $130 million[23]. PGE offers five, TOU rate plans for residential customers.[24]

[21] Appendix E: Bakerview EcoDairy Application

[22] $22 million includes both the utility infrastructure and rebates for consumer charging stations.

[23] PGE Public Utilities Commission of the State of California Decision Directing Pacific Gas and Electric Company to Establish and Electric Vehicle Infrastructure and Education Program. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M171/K213/171213824.PDF

[24] https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_EV.pdf

3.4 *DCFC RATE PROPOSAL*

As stated, FBC is proposing a time based rate of $9.00 per half hour prorated to the second of time spent plugged in at the station. The following section expands on the analysis and assumptions used to determine the rate.

3.4.1 Demand Assumptions

To understand current demand, the Company reviewed the historical consumption of the existing BC Hydro-owned Keremeos and Penticton DCFC stations and observed recent data from July 1, 2017 to September 30, 2017. These stations experience an average station usage of approximately 0.5 charges per day. The data supporting the 0.5 charges per day was taken from July to September 2017, which are summer months. Considering that EV adoption is on a strong growth curve, that EV car batteries perform 20 – 25 percent less efficiently in the winter (colder) months and that during the winter months commuters are more likely to use passenger compartment heating, FBC has assumed that these EV charging stations would experience an average of one use per day in 2018.

To estimate EV DCFC usage in FBC's service territory, and to gain a broader perspective of what the future EV sales growth projections are for BC, FBC reviewed the following EV sales studies that forecast exponential growth in the number of electric vehicle within BC by 2024 and 2030. Powertech Labs' report (EV Technology and Market Overview[25]) provides a relevant perspective of BC EV sales projections based on studies from Navigant Research and Simon Fraser University (SFU). The October 2016 Powertech Labs report was commissioned for the Township of Langley, Metro Vancouver and the City of Abbotsford. The Navigant Research report forecasts cumulative BC EV sales of between 56,000 - 67,000 by 2024 which translates to a compound annual growth rate of 22.8 percent[26], whereas the SFU report provided sales projections of between 56,000 to 120,000 EV sales by 2024 and a range of between 224,000 to 380,000 EV sales by 2030. These forecast sales projections represent a 10 to 22 fold increase from the current number of EVs in the province. FBC has used the more conservative estimate from the Powertech Labs report of compound annual growth rate of 22.8 percent to escalate demand in its analysis.

For the cost of service analysis, FBC has assumed one charge per day starting in 2018 and escalated this by 22.8 percent annually. Over the ten year period, this averages 3.0 charge events per day, or 1,088 annually, and is a 6 fold increase by 2027.

As a comparison to FBC's 1,088 projected charge sessions; the City of Vancouver administrative report to Vancouver City Council used 1,500 charge sessions per year (Appendix G) and EcoDairy used 997 per year (Appendix E).

[25] Appendix F
[26] Appendix F, Page 17

3.4.2 Electric Consumption per EV Charging Event

FBC has assumed consumption of 20 kWh per charge event based on reviewing the two BC Hydro-owned Keremeos and Penticton DCFC stations, a City of Vancouver report which estimated 25 kWh per charge event, and information provided on the Plug In BC website[27] which notes that a typical charge is 20 kWh. For BEVs, assuming a 30 kWh (Nissan Leaf) battery size, an 80% charge would mean 24 kWh of energy would be needed per charging session. It is important to note, though, that EV manufacturers are developing EVs with increasingly large battery packs. Indeed, the recently released Chevrolet Bolt as well as the Tesla Model 3 are equipped with battery packs ranging from 50 kWh to 75 kWh, while Nissan has recently announced that the 2018 Leaf will come equipped with a 40 kWh battery with a 60 kWh battery option planned for 2019. As such, FBC believes its assumption of 20 kWh per charge event is a reasonable estimate for the time being as it reflects more of a current technology state for BEVs with smaller battery packs.

3.4.3 Transaction Fees

A transaction fee of 15 percent for global management services is payable to FLO and is added to the EV rate before the transaction fee, including but not limited to payment card access and other services.

3.4.4 Proposed Rate

FBC based the rate calculation on the levelized cost of service. Using a levelized approach allows FBC to set an EV charging rate that remains flat over the 10 year analysis period yet collects the incremental cost of service over that period. The levelized cost of service is determined using FBC's weighted average cost of capital as the discount rate[28] and is the present value of the annual cost of service over the 10 year period. Having a flat rate over the analysis period rather than a rate that follows the cost of service profile will allow customers to have stability and consistent rates as opposed to having rates that vary each year with the cost of service and forecast demand.

As discussed in Section 3.4.1, FBC expects demand to increase over the 10 year analysis period by approximately 23 percent per year. When the levelized demand over the analysis period is used as the denominator with the levelized cost of service, a rate of $9.00 per charging event is derived. FBC provides detailed calculations in Appendix C, rows 14 through 31, which demonstrates that the charging rate collects the incremental cost of service over the 10 year analysis period based on FBC's assumptions.

FBC provides the rate calculation below.

[27] Appendix H – Page 2

[28] The Discount Rate has been assumed to be 5.88 percent, equivalent to the Company's after-tax weighted average cost of capital for 2018.

Table 3-1: DCFC Service Rate Calculation

Line No.	Particulars	Amount	Reference
1	Present Value of the Cost of Service	$ 278,302	Appendix C, Line 12 x 1000
2	Number of Stations	5	Appendix C, Line 14
3	PV COS per Station	$ 55,660	Line 1 / Line 2
4	Present Value Charge Events	7,342	Appendix C, Line 20
5	Cost of Service based Rate	$ 7.58	Line 3 / Line 4
6	Transaction Fee	15%	
7	Total Charging Fee	$ 8.92	Line 5 / (1 - Line 6)
8	Rounded up	$ 9.00	

In terms of competitiveness, a $9.00 per half hour charging session correlates to an EV rate (excluding transaction fees) of 38 cents per kWh, 38 cents per kWh is comparable to the 35 cents per kWh[29] other BC hosts charge as EV refueling rates[30].

3.4.5 Comparison of Rate to Gasoline

In an attempt to gauge further how competitive the EV charging rate might be under different demand scenarios relative to the cost of gasoline, FBC prepared a sensitivity analysis that calculates new charging rates based on diverging demand scenarios. FBC then applied the charging rates to a Nissan Leaf. The Nissan Leaf is a common 100 percent battery powered electric vehicle and, as such, is used as the benchmark vehicle for the EV to gasoline comparison. The analysis assumes that the Nissan Leaf requires an 80 percent charge (24 KWh) and that the range from that charge equals 138 km. The analysis then estimates the cost per km and compares it to the cost per km of a similar gasoline vehicle that consumes 10 litres of gas per 100 km and assuming gas is purchased at $1.35 per litre (based on Vancouver prices from bcgasprices.com).

To derive charging rates for this analysis FBC varied the demand escalation rate from 22.8 percent annually in the reference case to a lower rate of 10 percent annually and a higher rate of 30 percent annually for sensitivity scenarios 2 and 3 respectively.

Below is a summary of the EV refuelling sensitivities comparison to gasoline analysis, and results for different EV rates.

[29] Appendix H
[30] Ibid

Table 3-2: EV Refuelling Rate Sensitivity Compared to Gasoline

Sensitivity Review

Sensitivites	1	2	3
Description	Demand growth at 22.8% per year	Demand growth at 10% per year	Demand growth at 30% per year
EV Rate ($/half hour - or 20 Kwh)	$ 9.00	$ 15.00	$ 7.00
KWh Output per 30 mins	20	20	20
KWh Charge Required for Nissan Leaf @ 80%	24	24	24
Charge Cost	$ 10.80	$ 18.00	$ 8.40
EV Range (km)	138	138	138
Cost/KM	0.078	0.130	0.061
Gas Equiv @ $1.35/L & 10 L/100 km	0.135	0.135	0.135
EV (Advantage) $/KM	(0.057)	(0.005)	(0.074)
Fill on EV	$ 10.80	$ 18.00	$ 8.40
Fill on Gas	$ 18.63	$ 18.63	$ 18.63
Savings per fill	$ (7.83)	$ (0.63)	$ (10.23)
KM Driven in Year	15,000	15,000	15,000
(Savings) from EV	$ (851)	$ (68)	$ (1,112)

The results of the sensitivity analysis demonstrate that in all three cases the EV rates would be competitive with gasoline. This competitive advantage is because the EV cost to refuel is less than a gasoline driven vehicle over the same driving distance of 138 kilometres. The EV refuelling cost advantage is between $0.63 and $10.23 per 138 km. FBC considers that a rate of $9.00 per half hour charge provides a reasonable cost advantage over gasoline to promote continued EV adoption in BC. While FBC recognizes that the adoption of EVs by drivers will be influenced by many considerations, the Company does not believe that a rate of $15.00 per half hour charge would provide enough of a cost advantage and may result in reduced use of FBC's EV DCFC stations and possibly reduced adoption of EVs within FBC's service territory. In addition, a $15.00 EV rate would not encourage mass EV adoption because most EV charging is expected to occur at home or work at lower rates.

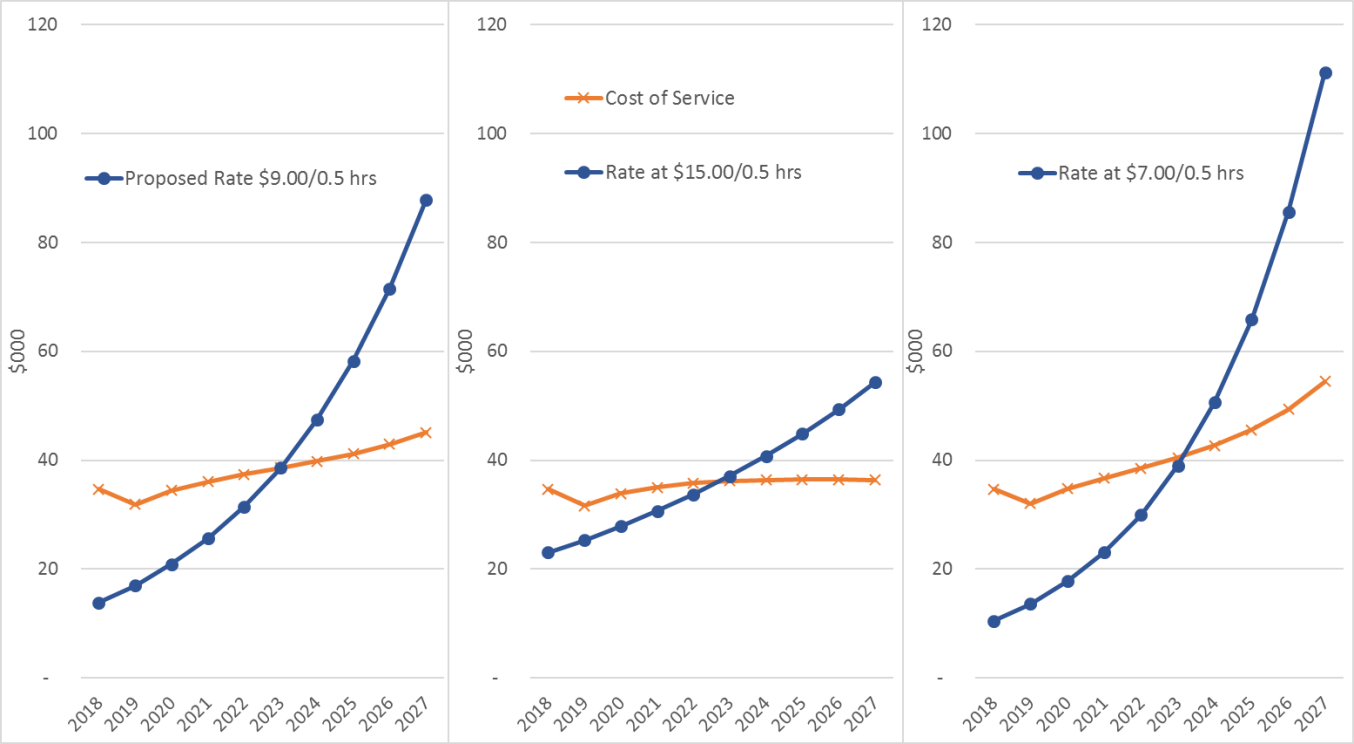
3.4.6 EV Revenues versus Cost of Service and Rate Impact Assessment

To assess the potential impact on FBC's other electric customers of FBC's proposed EV charging rate, the Company compared the forecast cost of service with the revenue stream at the proposed rate and rates derived from the Sensitivity Review above. Due to the levelization of the rate, there will be some (early) years where the EV charging revenue will be less than the

cost of service; in these years all other FBC customers will bear the costs in excess of revenues. Conversely, in years where the demand revenue is greater than the cost of service, all other FBC customers will benefit from the excess of revenues. However, the proposed rate and the rates derived from the sensitivity analysis above result in revenues that match the cost of service on a present value basis.[31]

The figures below shows the under and over recovery of the cost of service in each year using the proposed rate and each of the sensitivity scenarios described above.

Figure 3-1: Revenue vs. Cost of Service



The following table shows the minimum (excess revenue) and maximum (revenue deficit) rate impact that all of FBC's other electric customers will experience over the ten year analysis period from the EV charging stations.

Table 3-3: Rate Impact Sensitivity

	Proposal 23% escalation	Sensitivity 10% escalation	Sensitivity 30% escalation
Max Rate Change	0.006%	0.003%	0.007%
Min Rate Change	-0.004%	-0.002%	-0.006%

[31] Please note again that the benefit of revenues from the sale of low carbon fuel credits are not considered in these rate impacts so there is the potential for smaller shortfalls in the early years and greater surpluses in the later years.

Note that the impact of carbon credits is excluded in the analysis determining surplus/deficiency as the revenues from monetizing the credits are uncertain.

3.4.7 Electric Tariff Rate Schedule 96

FBC proposes to include in its Electric Tariff a new rate schedule for electric vehicles, Rate Schedule 96 (RS 96), Electric Vehicle Charging. RS 96 would be available for electric vehicle charging at FBC owned charging stations and includes the rate per half hour of charging for electric vehicle charging customers, with the provision that the actual amount billed will be pro-rated based on the number of seconds that the vehicle is plugged in. RS 96 also sets out the terms for billing and payment which differ from FBC's other rate schedules and terms and conditions. Customers taking service under RS 96 are billed and will make payment at the time of charging. RS 96 will be excluded from general rate increases from FBC's revenue requirements but will be reviewed on a periodic basis.

FBC's proposed RS 96 is included as Appendix J. No other changes to FBC's Electric Tariff are required.

3.4.8 Interim and Permanent Rates

FBC has requested approval of RS 96 and a rate of $9.00 per 30 minute charging event. FBC expects these EV charging stations to be in-service and available for use on or about January 8, 2018; consequently FBC plans to offer the charging service at that time. Approval of RS 96 is required prior to offering the charging service. FBC recognizes that the permanent rate approved by the Commission at the conclusion of this proceeding may differ from the interim rate of $9.00. However due to the nature of the service, FBC will not have the ability to track users of the charging service and would not in any event consider it appropriate to attempt to charge or refund customers on a retroactive basis for this type of service once a permanent rate is determined. FBC proposes that when the Commission issues a decision on the permanent rate it will simply take the place of the interim rate. Disposition of any material revenue variances corresponding to the difference between the interim and permanent rate will be addressed in the compliance filing following the Commission's decision.

4. CONCLUSION

The potential GHG reductions associated with the electrification of vehicles are substantial and align with the GHG reduction initiatives that are currently the focus of legislators at all levels of government. As such, FBC believes it has an important role to play in fostering the growth and development of EV charging infrastructure to support transportation electrification in BC.

FBC's EV Charging initiative for the five DCFC stations in the Highway 3 corridor, is consistent with the intent of GGRR prescribed undertakings to reduce GHG emissions in the transportation sector, and similar objectives of the Province's low carbon fuel requirements, particularly pertaining to the use of electricity to achieve these goals.

FBC has developed a proposed rate of $9.00 per half hour for DCFC Service that it believes finds an appropriate balance between supporting the growth and development of EV use in its service territory and recovering the cost of service associated with the DCFC Service. FBC anticipates the development of other stations in the coming years to which the proposed DCFC Service tariff and the $9.00 per half hour rate would apply. FBC believes its proposed DCFC rate is reasonable when compared to other DCFC rates, such as those employed at the Bakerview EcoDairy, as well as the rates set by the City of Vancouver and other BC hosts for DCFC stations. The $9.00 per half hour rate also provides a reasonable level of fuel cost savings for EVs compared to comparable gasoline-fueled vehicles.

In summary, given the potential benefits associated with FBC's EV DCFC Stations, as well as the alignment with government policy regarding GHG reduction strategies, FBC believes its proposed DCFC Service tariff and the proposed rate of $9.00 per half hour are appropriate and should be approved.

Appendix A

GOVERNMENT LETTER TO BC HYDRO

BC Hydro
Power smart

Fiscal 2017 to Fiscal 2019
Revenue Requirements Application

Attachment 1

Government Mandate Letter

BRITISH COLUMBIA

AUG 24 2017

Ref.: 101514

Mr. Kenneth Peterson
Chair
BC Hydro and Power Authority
18th Floor, 333 Dunsmuir Street
Vancouver, BC V6B 5R3

Email: kenneth.peterson@bchydro.com

Dear Mr. Peterson:

On behalf of Premier John Horgan and our new government, thank you for your service to the people of British Columbia. I look forward to working with you in the months and years to come to help deliver on government's priorities, and provide effective programs and services to the people of our province.

This Mandate Letter lays out the principles of this government and you are to take these into consideration when revising your Service Plan for the *Budget 2017 Update*. It is expected that BC Hydro and Power Authority (BC Hydro) will manage its programs and initiatives within its existing budget targets, unless otherwise directed.

Going forward, you are to begin the process of working with me as the Minister responsible to develop strategic actions through the 2018 Mandate Letter process for *Budget 2018*. I will provide further direction. The Ministry of Finance will provide guidance on preparation for *Budget 2018*.

Our government made three key commitments to British Columbians.

Our first commitment is to make life more affordable. We expect all public service organizations to work to contain costs, and to be conscious of the impact of every decision on the daily cost of living of families and businesses.

Our second commitment is to deliver the services that people count on. In many cases, critical programs and services are delivered by Crown Corporations, and Ministers will work with Board Chairs to ensure your organizations remain focused on maintaining and improving levels of service to citizens.

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Ministry of Energy, Mines and Petroleum Resources

Office of the Minister

Mailing Address:
PO Box 9052, Stn Prov Govt
Victoria, BC V8W 9E2

Telephone: 250 953-0900
Facsimile: 250 356-2965

Our third key commitment is to build a strong, sustainable, innovative economy that works for everyone. Our government believes that public sector organizations have a role to play in supporting broad-based economic growth in every region of the province.

To support true and lasting reconciliation with First Nations in British Columbia, our government will be fully adopting and implementing the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), and the Calls to Action of the Truth and Reconciliation Commission (TRC). Please ensure that going forward your organization incorporates the UNDRIP and TRC as appropriate, given the specific mandate and context of your organization.

As the Minister responsible for BC Hydro, I expect that BC Hydro will work with the Ministry of Energy, Mines and Petroleum Resources (Ministry) to:

- Participate fully in the British Columbia Utilities Commission review of Site C and impact on BC Hydro ratepayers associated with completing, suspending or terminating the project;
- Freeze BC Hydro rates and develop a refreshed plan to keep electricity rates low and predictable over the long-term while making significant investments to expand the system and maintain aging infrastructure;
- Continue to deliver your planned capital projects on time and on budget to maintain the reliability of the system;
- Conduct an immediate and comprehensive review of BC Hydro's activities, performance and organizational structure to identify potential efficiencies that could benefit ratepayers, and ensure that the organization is positioned to deliver on BC Hydro's objectives and government's priorities;
- Support the creation of a roadmap for the future of BC energy that will drive innovation, expand energy efficiency and conservation programs, generate new energy responsibly and sustainably, and create lasting good jobs across the province;
- Provide leadership in advancing government's climate action strategies, including through:
  - fuel switching and electrification initiatives in the transportation, oil and gas, and other sectors;
  - initiatives under the *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act*, to further reduce emissions in the transportation sector;
  - policies and programs to increase the energy efficiency of buildings;
- Provide comprehensive quarterly and annual performance reports to the Deputy Minister of Energy, Mines and Petroleum Resources on the status of BC Hydro finances and forecasts, as well as other initiatives and directions approved by the BC Hydro Board and the Minister of Energy, Mines and Petroleum Resources. This will include regular report backs on Site C progress in accordance with previous standing directions from government. As and when appropriate, also update the Deputy Minister of Energy, Mines and Petroleum Resources on other emerging trends and issues as they occur;

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- Identify further opportunities for clean energy in British Columbia to support BC's economic growth and meet the needs of customers;
- Perform system upgrades where necessary to ensure that BC Hydro is well-positioned to connect future customers in a timely and cost-effective manner;
- Continue to implement the five-year safety plan to ensure the safety of the BC Hydro workforce and the public; and
- Maintain or improve customer satisfaction by providing timely and responsive service.

As the Board Chair of a Crown Agency, your primary accountability to government is through me as the Minister responsible. My expectation is that regular dialogue and engagement between the Ministry and your organization will continue, starting with regular meetings between us over the coming weeks and months. Included in these meetings will be regular meetings between your communications staff and Government Communications and Public Engagement staff responsible for the communication of ministry-related matters.

The Crown Agencies Resource Office (CARO) has lead responsibility for overseeing and maintaining the Public Sector Organizations Governance Framework. CARO has now integrated with the Board Resourcing and Development Office (BRDO) which provides leadership in the merit-based appointment of qualified and competent individuals to the Crown Agencies. All Crown Corporations and other public agencies are asked to work closely with this Office on Board member appointments, all governance matters including orientation and training of Board members, and on accountability to government generally.

I look forward to regular meetings to discuss progress on your strategic priorities and to ensure you and your organization are supported in delivering your mandate on behalf of the people of British Columbia.

Sincerely,

Michelle Mungall
Minister

Kenneth Peterson
Chair
BC Hydro

Date: AUG. 24 2017

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cc: Honourable John Horgan
Premier

Mr. Don Wright
Deputy Minister to the Premier and Cabinet Secretary

Mr. Dave Nikolejsin
Deputy Minister
Ministry of Energy, Mines and Petroleum Resources

Ms. Lori Wanamaker
Deputy Minister
Ministry of Finance

Mr. David Galbraith
Associate Deputy Minster and Secretary to Treasury Board
Ministry of Finance

Ms. Lynne Holt
Executive Lead
Board Resourcing and Development Office

Mr. Bill Adsit, Director
BC Hydro

Mr. Len Boggio, Director
BC Hydro

Mr. Jamie Brown, Director
BC Hydro

Mr. James P. Hatton, Director
BC Hydro

Ms. Valerie Lambert, Director
BC Hydro

Ms. Janine North, Director
BC Hydro

Mr. John Ritchie, Director
BC Hydro

Appendix B

NETWORK MANAGEMENT AGREEMENT

FILED CONFIDENTIALLY

CONFIDENTIAL Appendix B – Network Management Agreement, will be submitted upon execution in early January 2018.

Appendix C
FINANCIAL SCHEDULES

FortisBC Inc.
EV - Electric Vehicle Charging Stations (DCFC)
January 2018
($000s), unless otherwise stated

Line	Particulars	Reference	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1	**Cost of Service**											
2	Power Purchase Expense		2	2	3	4	4	6	7	9	11	14
3	Operation & Maintenance	Line 39	6	6	6	7	7	7	7	7	7	7
4	Property Taxes	Line 44	-	-	0	0.3	0.3	0.4	0.4	0.4	0.4	0.4
5	Depreciation Expense	Line 70	32	32	32	32	32	32	32	32	32	32
6	Amortization Expense on CIAC	Line 84	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)
7	Income Taxes	Line 127	2	(2)	0	2	3	4	4	4	5	5
8	Amortization		4	5	5	5	5	5	5	5	4	4
9	Earned Return	Line 109	10	10	9	8	8	7	6	5	5	4
10	**Incremental Annual Revenue Requirement**	Sum of Line 2 to Line 9	**35**	**32**	**34**	**36**	**37**	**39**	**40**	**41**	**43**	**45**
11	PV of Revenue Requirement (After-tax WACC of 5.88%)	Line 10 / (1 + Line 111)^Yr	33	28	29	29	28	27	27	26	26	25
12	**Total PV of Annual Revenue Requirement**	Sum of Line 11	***278***									
13												
14	Stations		5									
15	PV of Rev Requirement per Station ($)	Line 12 x 1000 / Line 14	55,660									
16												
17	Charge Events per day		1.0	1.2	1.5	1.9	2.3	2.8	3.4	4.2	5.2	6.4
18	Charge Events per year	Line 15 x 365	365	448	550	676	830	1,019	1,252	1,537	1,887	2,318
19	PV of Charge Events per year	Line 18 / (1 + Line 111)^Yr	345	400	464	538	624	723	839	973	1,128	1,309
20	Sum of PV of Charge Events per year	Sum of Line 19	7,342									
21	**$ Charge per Event to recover Cost of Service**	Line 15 / Line 20	**7.58**									
22	Transaction Fee percentage		15%									
23	**$ Charge per Event to recover Cost of Service + Txn Fee**	Line 21 / (1 - Line 22)	***8.92***									
24												
25	**Revenue Proof**											
26	$ Charge per Event to recover Cost of Service	Line 21	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58
27	Charge Events per day	Line 17	1.0	1.2	1.5	1.9	2.3	2.8	3.4	4.2	5.2	6.4
28	Stations	Line 14	5	5	5	5	5	5	5	5	5	5
29	Annual Revenue	Line 26 x Line 27 x Line 28 x 365 / 1000	14	17	21	26	31	39	47	58	72	88
30	PV Annual Revenue	Line 29 / (1 + Line 111)^Yr	13	15	18	20	24	27	32	37	43	50
31	Sum PV Annual Revenue	Sum of Line 30	***278***									
32												
33												
34	**Operation & Maintenance**											
35	Labour Costs		-	-	-	-	-	-	-	-	-	-
36	Non-Labour Costs		6	6	6	7	7	7	7	7	7	7
37	Total Gross O&M Expenses	Line 35 + Line 36	6	6	6	7	7	7	7	7	7	7
38	Less: Capitalized Overhead	Overhead Rate of 0%	-	-	-	-	-	-	-	-	-	-
39	**Net O&M Expenses**	Line 37 + Line 38	6	6	6	7	7	7	7	7	7	7
40												
41	**Property Taxes**											
42	General, School and Other		-	-	-	-	-	-	-	-	-	-
43	1% in Lieu of General Municipal Tax[1]	1% of Line 10	-	-	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
44	**Total Property Taxes**	Line 42 + Line 43	-	-	0.35	0	0	0	0	0	0	0
45	1 - Calculation is based on the second preceding year, e.g. 2019 is based on 2017 revenue											
46												

FortisBC Inc.
EV - Electric Vehicle Charging Stations (DCFC)
January 2018
($000s), unless otherwise stated

Line	Particulars	Reference	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
47	**Capital Spending**											
48	Project Capital Spending[2]		492	-	-	-	-	-	-	-	-	-
49	AFUDC		-	-	-	-	-	-	-	-	-	-
50	Total Annual Capital Spending & AFUDC	Sum of Line 48 to 51	492	-	-	-	-	-	-	-	-	-
51	Cost of Removal		-	-	-	-	-	-	-	-	-	-
52	Contributions in Aid of Construction (CIAC)		(332)	-	-	-	-	-	-	-	-	-
53	Total Annual Project Cost - Capital	Line 50 + Line 51	160	-	-	-	-	-	-	-	-	-
54												
55	**Total Project Cost (incl. AFUDC)**	**Sum of Line 50**	**492**									
56	**Net Project Cost (incl. Removal and/or CIAC)**	**Sum of Line 53**	**160**									
57	2 - Excluding capitalized overhead; First year of analysis includes all prior year spending											
58												
59	**Gross Plant in Service (GPIS)**											
60	GPIS - Beginning[3]	Preceding Year, Line 64	492	492	492	492	492	492	492	492	492	492
61	Additions to Plant[4]		-	-	-	-	-	-	-	-	-	-
62	Retirements		-	-	-	-	-	-	-	-	-	-
63	Net Addition to Plant	Sum of Line 61 to 62	-	-	-	-	-	-	-	-	-	-
64	GPIS - Ending	Line 60 + Line 63	492	492	492	492	492	492	492	492	492	492
65	3 - Additions in 2018 (when work complete and placed in-service) is shown in the opening balance of 2018 (CPCN addition to plant to Jan 1 of following year)											
66	4 - Includes capitalized overhead											
67												
68	**Accumulated Depreciation**											
69	Accumulated Depreciation - Beginning	Preceding Year, Line 73	-	(32)	(65)	(97)	(129)	(162)	(194)	(227)	(259)	(291)
70	Depreciation Expense[5]	Line 60 @ 2.67%	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)
71	Retirements		-	-	-	-	-	-	-	-	-	-
72	Cost of Removal		-	-	-	-	-	-	-	-	-	-
73	Accumulated Depreciation - Ending	Sum of Line 69 to 72	(32)	(65)	(97)	(129)	(162)	(194)	(227)	(259)	(291)	(324)
74	5 - Depreciation & Amortization Expense calculation is based on opening balance x composite depreciation rate; The composite rate of all assets addition to plant is 2.67%											
75												
76	**Contributions in Aid of Construction (CIAC)**											
77	CIAC - Beginning	Preceding Year, Line 80	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)
78	Additions		-	-	-	-	-	-	-	-	-	-
79	Retirements		-	-	-	-	-	-	-	-	-	-
80	CIAC - Ending	Sum of Line 77 to 79	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)
81												
82	**Accumulated Amortization of Contributions in Aid of Construction (CIAC)**											
83	Accumulated Amortization of CIAC - Beginning	Preceding Year, Line 86	-	22	44	66	87	109	131	153	175	197
84	Amortization (over 15.2050878713057 yrs)	Line 77 @ 6.58%	22	22	22	22	22	22	22	22	22	22
85	Retirements		-	-	-	-	-	-	-	-	-	-
86	Accumulated Amortization of CIAC - Ending	Sum of Line 83 to 85	22	44	66	87	109	131	153	175	197	218
87												

FortisBC Inc.
EV - Electric Vehicle Charging Stations (DCFC)
January 2018
($000s), unless otherwise stated

Line	Particulars	Reference	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
88	**Rate Base and Earned Return**											
89	Gross Plant in Service - Beginning	Line 60	492	492	492	492	492	492	492	492	492	492
90	Gross Plant in Service - Ending	Line 64	492	492	492	492	492	492	492	492	492	492
91												
92	Accumulated Depreciation - Beginning	Line 69	-	(32)	(65)	(97)	(129)	(162)	(194)	(227)	(259)	(291)
93	Accumulated Depreciation - Ending	Line 73	(32)	(65)	(97)	(129)	(162)	(194)	(227)	(259)	(291)	(324)
94												
95	CIAC - Beginning	Line 77	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)
96	CIAC - Ending	Line 80	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)	(332)
97												
98	Accumulated Amortization of CIAC - Beginning	Line 83	-	22	44	66	87	109	131	153	175	197
99	Accumulated Amortization of CIAC - Ending	Line 86	22	44	66	87	109	131	153	175	197	218
100												
101	Net Plant in Service, Mid-Year	(Sum of Lines 89 to Line 99) / 2	155	144	134	123	113	102	92	81	71	60
102	Adjustment to 13-month average	6	-	-	-	-	-	-	-	-	-	-
103	Unamortized Deferred Charges, Mid-Year		-	-	-	-	-	-	-	-	-	-
104	Cash Working Capital	Line 64 x FBC CWC/Closing GPIS %	1	1	1	1	1	1	1	1	1	1
105	**Total Rate Base**	**Sum of Line 101 to 104**	**155**	**145**	**134**	**124**	**113**	**103**	**92**	**82**	**71**	**61**
106												
107	Equity Return	Line 105 x ROE x Equity %	6	5	5	5	4	4	3	3	3	2
108	Debt Component	7	5	4	4	4	3	3	3	2	2	2
109	**Total Earned Return**	**Line 107 + Line 108**	**10**	**10**	**9**	**8**	**8**	**7**	**6**	**5**	**5**	**4**
110	Return on Rate Base %	Line 109 / Line 105	6.70%	6.70%	6.70%	6.70%	6.70%	6.70%	6.70%	6.70%	6.70%	6.70%
111	After- Tax Weighted Average Cost of Capital (WACC)	8	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%
112	6 - (Line 63 + Line 70 + Line 78) x [(Days In-service/365)-1/2]											
113	7 - Line 105 x (LTD Rate x LTD% + STD Rate x STD %)											
114	8 - ROE Rate x Equity Component + [(STD Rate x STD Portion) + (LTD Rate x LTD Portion)] x (1- Income Tax Rate)]											
115												
116	**Income Tax Expense**											
117	Earned Return	Line 109	10	10	9	8	8	7	6	5	5	4
118	Deduct: Interest on debt	Line 108	(5)	(4)	(4)	(4)	(3)	(3)	(3)	(2)	(2)	(2)
119	Add: Depreciation Expense	Line 70	32	32	32	32	32	32	32	32	32	32
120	Add: Amortization of Deferred Charges		4	5	5	5	5	5	5	5	4	4
121	Deduct: CIAC Amortization	Line 84	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)
122	Deduct: Overhead Capitalized Expenses for Tax Purposes		-	-	-	-	-	-	-	-	-	-
123	Deduct: Capital Cost Allowance	Line 136	(16)	(27)	(20)	(15)	(12)	(9)	(7)	(6)	(5)	(4)
124	Taxable Income After Tax	Sum of Line 117 to 123	5	(6)	0	5	8	10	11	12	12	13
125	Income Tax Rate		27%	27%	27%	27%	27%	27%	27%	27%	27%	27%
126												
127	**Total Income Tax Expense**	Line 124 / (1 - Line 125) x Line 125	**2**	**(2)**	**0**	**2**	**3**	**4**	**4**	**4**	**5**	**5**
128												

FortisBC Inc.
EV - Electric Vehicle Charging Stations (DCFC)
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Line	Particulars	Reference	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
129	**Capital Cost Allowance**											
130	Opening Balance	Proceeding Year, Line 137	144	117	97	81	69	60	53	47	42	37
131	Additions to Plant	Line 50	-	-	-	-	-	-	-	-	-	
132	Add: Cost of Removal	Line 51	-	-	-	-	-	-	-	-	-	
133	Less: AFUDC	[9]	-	-	-	-	-	-	-	-	-	
134	Less: CIAC	Line 52	-	-	-	-	-	-	-	-	-	
135	Net Addition for CCA	Sum of Line 131 through 134	-	-	-	-	-	-	-	-	-	-
136	**CCA (Composite CCA Rate @ 30%)**	**[Line 130 + (Line 135/2)] x CCA Rate**	**(16)**	**(27)**	**(20)**	**(15)**	**(12)**	**(9)**	**(7)**	**(6)**	**(5)**	**(4)**
137	Closing Balance	Line 130 + Line 135 + Line 136	144	117	97	81	69	60	53	47	42	37
138	9 - Includes AFUDC of Capital and Cost of Removal											

Appendix D

INFORMATION BULLETIN – EV CHARGING

Measurement Canada | Mesures Canada
An Agency of Industry Canada | Un organisme d'Industrie Canada

Information

2016-09-16

Applicability of federal measurement statutes to electric vehicle charging stations

Recent initiatives have been introduced by some federal departments, provincial governments and regional municipalities to install advanced transportation technologies such as electric vehicle charging stations or electric vehicle charging stations, as part of a growing trend to invest in clean technology alternatives for consumers. Many of the electric vehicle charging stations being installed are designed with measurement systems involving new technology, which has raised questions about the applicable federal measurement statutes administered and enforced by Measurement Canada under which these devices would be subject.

With respect to the statutory regulation of electric vehicle charging stations, the determination of the application of either the Electricity and Gas Inspection Act[link 1] (EGIA) or *the* Weights and Measures Act[link 2] (WMA) will be largely dependent on the intended use of the measuring device., For example:

a) Where an electric vehicle charging station is only intended to be used for the purpose of providing a prepaid service including energy from the charging station on the basis of time, the device would be subject to the legal requirements of the WMA. However under section 4 of the *Weights and Measures* Regulations, parking meters, clocks, watches, chronometers, and other timing devices have been given an exemption from the approval and device certification requirements prescribed in section 8 of the WMA. Therefore, no requirements apply.

b) Where an electric vehicle charging station is used to supply electricity sold on the basis of energy (KWh) or time related demand (kW) the device would be considered to meet the legal definition of a "meter" under the *Electricity and Gas Inspection Act* and would be subject to the legal requirements contained therein (i.e., use of defined units of measurement, and mandatory meter type approval, initial verification, reverification and sealing). An owner of a device supplying electricity would also need to be registered with MC as a contractor under the EGIA, and would be subject to the legal requirements and responsibilities that pertain to contractors and meter owners.

If you have questions regarding this bulletin, please contact the Senior Program Officer responsible for electricity measurement. [link 3].

[link 1] http://laws-lois.justice.gc.ca/eng/acts/E-4/index.html
[link 2] http://laws-lois.justice.gc.ca/eng/acts/w-6/
[link 3] http://www.ic.gc.ca/eic/site/icgc.nsf/eng/h_07026.html

Appendix E

BAKERVIEW ECODAIRY EV CHARGING SERVICE UCA PART 3 EXEMPTION APPLICATION

Commission Secretary BCUC:EX

From: Peter Torenvliet <peter@nutrivagroup.com>
Sent: Tuesday, November 24, 2015 8:23 AM
To: Commission Secretary BCUC:EX
Cc: AnandSanghera, Ashita BCUC:EX
Subject: EcoDairy Exemption EV Charging Station
Attachments: 4EVC200101-LFUS-NA-RevA_Terra51ChargeStation-WEB.pdf; EcoDairy-Exemption -EV Charging Service Providers-R1.pdf; DCFC LEASE 26Jun14 -EcoDairy-signed.pdf

Good morning,

Please see the attached application "EcoDairy-Exemption –EV Charging Service Providers-R1.pdf" with accompanying files, as well as the information below in this email. I've also include a signed copy of the lease agreement which forms Appendix C of the Application. If you require anything else please let me know and I will be happy to provide it.

APPLICANT INFORMATION
Name of Applicant: Peter Torenvliet, Site Operations Manager
Company Name: Bakerview EcoDairy, Ltd
BC Business Registration No.: 84382 6678RC0001
Year Registered: 2009
Full Address: 1356 Sumas Way, Abbotsford, BC V2S8H2
Phone:604-557-1481
Publically or Privately Held Business: Private
Owner/CEO (name and address): William Vanderkooi, 4590 Udy Rd V3G 3A3
Board Chair (name and address): n/a
Name of Parent Company if applicable and address: BHV Holdings, Ltd. 1356 Sumas Way, Abbotsford, BC, V2S 8H2

EV CHARGING STATION SPECIFICS
Installed EV Charging Station Location (address): 1356 Sumas Way, Abbotsford, BC
In-Service Date of the Installed EV Charging Station: May 12, 2015
Compliance/Safety Certification of Installed EV Charging Station: BC Safety Authority Inspection # ELIN-374010-2015
Attach Photo and Information Brochure for the EV Charging Station: ABB Terra 51 manual attached to email

Kindest Regards,

Peter Torenvliet
Farm Operations Manager
Bakerview EcoDairy
604.217.1424

Application for Exemption to Part 3 of the Utilities Commission Act for Electric Vehicle Charging Service Providers

EcoDairy seeks an exemption to Part 3 of the Utilities Commission Act for the provision of public electric vehicle charging services by a business entity other than a registered public utility.

Electric Vehicles (EVs) began selling in British Columbia in 2011 and represent a cleaner and more sustainable alternative to the incumbent car technology, internal combustion engines, which utilize fossil fuels. EVs have zero tailpipe emissions and electricity production in BC is predominantly from ultra-low emission sources. Also, displacing imported gasoline with locally produced electricity has a net economic benefit to the province since BC is a net importer of oil in the range of $5-6 billion per annum. However, similar to their fossil fueled counterparts, EVs also require a network of rapid public charging stations to enable long range driving.

In April 2015, the Province of British Columbia launched phase 2 of the Clean Energy Vehicle Program, which will invest funding in vehicle point-of-sale incentives, charging infrastructure, and education and outreach. The Program will help meet the Province's commitment to greenhouse gas (GHG) emissions reduction targets, while supporting the development of a low carbon economy. Transportation accounts for 38% of the GHG emissions in British Columbia and 84% of the criteria air contaminants, most of which are funneled down the Lower Fraser Valley, creating one of the three most polluted air sheds in Canada as deemed by the Canadian Council of Ministers of the Environment. There are currently over 1700 electric vehicles on B.C.'s roads, and the new Clean Energy Vehicle Program will stimulate increased uptake of electric vehicles. Public charging infrastructure will both help stimulate this increased uptake (by reducing range anxiety) and support the growing number of electric vehicle drivers travelling in and through B.C. There are currently 692 public level 2 (240V) charging stations across British Columbia and 13 direct current (DC) fast charging stations with plans for another 17 more by March 31, 2016. The new Clean Energy Vehicle Program is expected to support an additional 200 public level 2 stations and an additional 20 DC fast charging stations.

EcoDairy is participating in the BC Hydro led EV Smart Infrastructure project, where prospective station hosts such as EcoDairy lease a charging station from BC Hydro to operate and provide fast EV charging services to the public. EcoDairy will be the first private sector fast charging station host/operator participating in the project. Currently, the other 12 station hosts are municipalities, which have an exemption under the Utilities Commission Act, permitting them to resell electricity within their geographical boundaries without needing to register as a public utility. The private sector business model , along with the municipal model , is essential to achieving one of the main goals of the project, to demonstrate viable business models for public EV charging.

EcoDairy in partnership with Science World is a one-of-a-kind demonstration dairy farm in Abbotsford BC committed to inspiring young minds to discover the science and technology behind where their food

comes from. Showcasing innovations in agriculture such as anaerobic digestion and a voluntary milking system, the EcoDairy experience was designed by Science World British Columbia's team of world-class curators.

The EV Smart Infrastructure project is a predominantly government funded project where a major deliverable is the deployment of the first 30 DC fast charging stations across the province. The federal funding comes from the Government of Canada's ecoENERGY Innovation Initiative and the provincial funding comes from phase 1 of the Clean Energy Vehicle Program. One of the project objectives is to plant a seed network of critical EV infrastructure to incent confidence in the EV market. Another goal is to demonstrate potential viable business models for public EV refueling infrastructure.

If the exemption to the Utilities Commission Act is granted for EV charging services providers then EcoDairy will implement a $0.35/kWh fee for the provision of EV charging services to the public. The proposed price was presented by BC Hydro as a pricing guideline for all DC fast charging services under the EV Smart Infrastructure project. The cost was determined by a cost of recovery approach, assuming a somewhat mature EV market where DC fast charging stations were to host 2-3 charging events per day over the course of a year.

Appendix A - Critical EV Infrastructure (DC Fast Charging) Pricing Guidline

35¢/kWh was chosen to represent an attainable operational cost breakeven state within the 5-year lease term of the charging stations based on the following assumptions:

1. Electric vehicle (EV) market uptake within 5 years of the beginning of the project (March 2013) could result in an average of 2-3 customers (charging sessions) per day over the course of a year.
2. An average of 10kWh per charging session
3. Annual operating costs as presented in Table 1 below
4. Worst case scenario for utility demand charges: In the case of 12 – charge session or less in a given year, no more than 1 – charge session will occur per month.
5. Market pricing "goal posts" were used to ensure efficient utilization of DC fast chargers: higher than residential rates and lower than cost of driving with gas (~48¢/kWh @ $1.20/litre of gas).

Table 1- Annual Operating Cost for DC Fast Charger Station

1 - OPERATING COSTS - ANNUAL						
Fixed Annual Costs		**$/unit**	**amount**	**monthly**	**Annual**	**Notes**
Network services	[/year]	$ 261.00	12	$ 21.75	$ 261.00	Annual Greenlots enterprise license
Equipment lease	[/DCFC unit/mo]	$ 1.00	1	$ 1.00	$ 12.00	BC Hydro DCFC Equipment lease
Maintenance				$ 13.33	$ 160.00	see Assumptions tab
Utility - demand charge	[/kW]	$5.19	15	$ 77.85	$ 934.20	Based on 50kW units
Utility - basic charge	[/day]	$ 0.2129	365	$ 6.48	$ 77.71	
Rate Rider (demand & basic)		5%			$ 50.60	
	Ttl Fixed				**$ 1,495.50**	
Variable						
Transaction fees	[/charge session]	$ 0.91				As per Greenlots Agreement
Energy	[/kWh]	$ 0.0934				Medium General Service rate

Note: Maintenance costs are based on labour and materials for two air filter cleanings/changes per year.

The figure below illustrates the breakeven point for operating costs only for a DC fast charging service priced at 35¢/kWh. The breakeven analysis illustrated below does not account for the upfront capital investment.

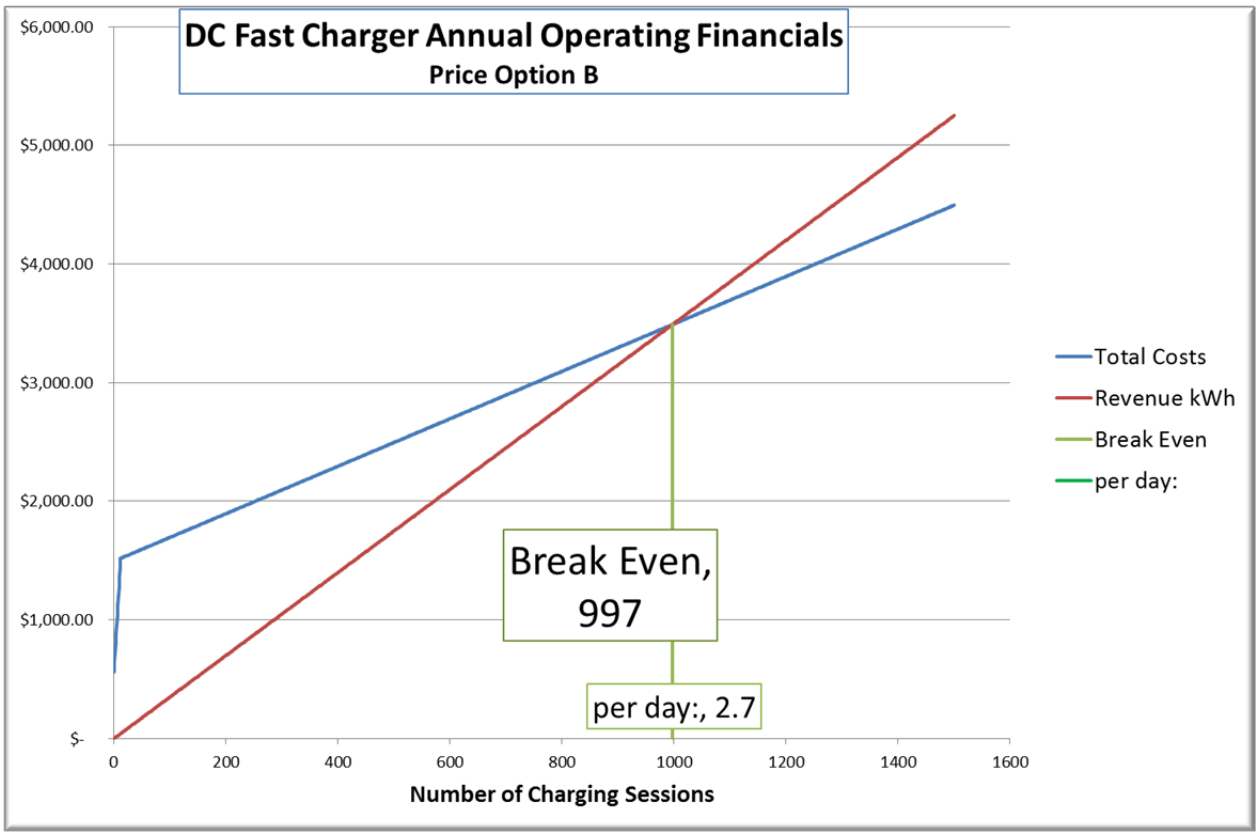


Figure 1- Breakeven Point for 35¢/kWh

Appendix B – DC Fast Charger – Electrical Safety

- DC Fast Chargers are designed for the consumer/commercial markets.
- Fast chargers are electrical products certified by safety labs such as CSA and UL and are accompanied with certification labels recognized and accepted by the BC Safety Authority for its intended use.
- Fast charger installations are conducted by ticketed electricians with the required electrical permit.

Appendix C – BC Hydro's DCFC Lease Agreement with EcoDairy

Electric Vehicle Charging Infrastructure
Terra 51 fast charging station

The Terra 51 Charge Station is an all in one electric vehicle (EV) charging solution. It is an easy to install DC fast charger with output power up to 50 kW.

c UL us LISTED

Terra 51 is compatible with all electric vehicles using the CHAdeMO standard and is the ideal choice when only a single vehicle needs to be charged at any given time. Typical charging times are between 15 and 30 minutes, making the product highly suitable for business and commercial fleet owners, as well as light commercial vehicle fleet owners and utility infrastructure suppliers. Due to its aesthetic design and low noise level during charging, the Terra 51 can be installed centrally in fleet yards, filling stations or in public installations.

Main features

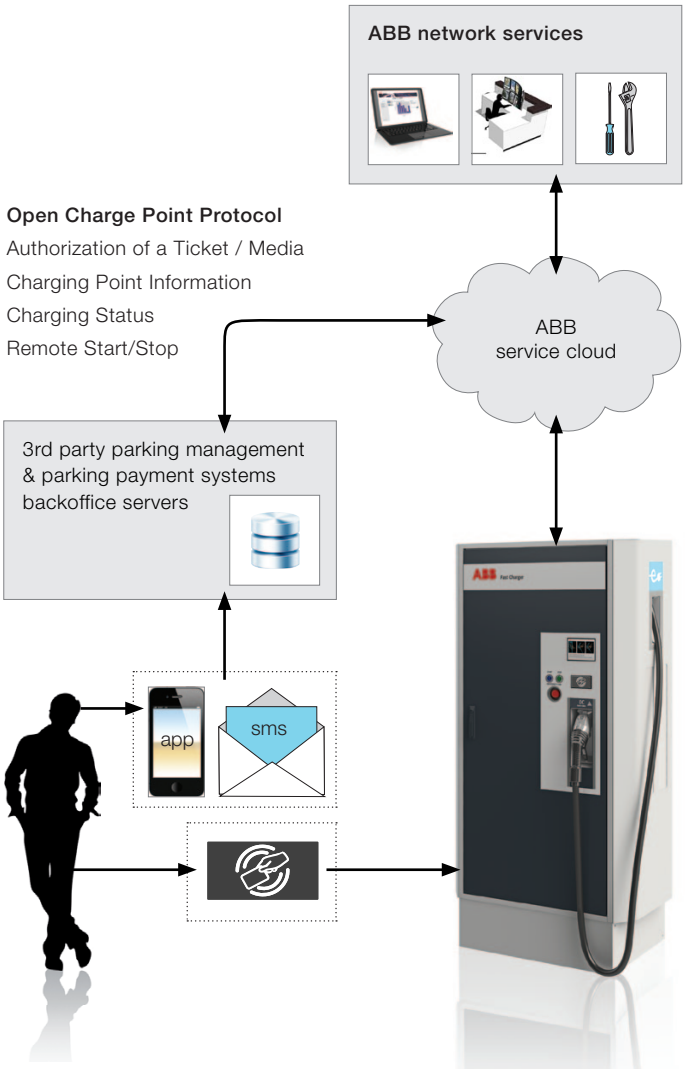
- DC fast charger
  - 50 kW DC charging
- Fastest charging possible: 30 to 80% in 15 minutes
- Web connected & future proof
  - Remote assistance, management and servicing
  - Smart software upgradeability
- Easy to use
  - High resolution display
  - Display of DC charging progress
  - RFID Authorization
- Aesthetic design and powder coated corrosion resistant Type 3R enclosure
- Quick and easy installation
- Low operational noise

Applications

- Highway fuel station operators
- Busy urban areas
- Commercial fleet operators
- EV Infrastructure operators
- EV Charging service providers

Optional features

- Input power limiting software avoids expensive grid upgrades
- Point of sale, back office integration to enable external billing and payment solutions
- Galaxy web based management software
- Statistics module with data per user
- Fleet access management module
- Traffic generation via real-time upload to navigation providers
- Low temperature support: -35 ºC to +40 ºC
- Customized branding possibilities and user interface styling
- Extended cable length to allow placement flexibility



Galaxy web based management allows remote monitoring, maintenance and functional upgrades providing customers with the tools necessary to gather customer usage statistics and reports.

Technical specifications	
System	
Type	Single DC fast-charging station
Operating temperature	-10ºC to +40ºC
	-35ºC to +40ºC (low temp. option)
Storage temperature	-40ºC to +70ºC
Relative humidity	20% to 95%
Environment	Indoor / outdoor
Compliance and safety	UL / CHAdeMO
Input	
AC power connection	3P + PE
Input voltage range	480 V_{AC} +/-10%
Nominal input voltage	480 V_{AC}
Nominal input current	70 A
	32 A – 70 A (Software limit option)
Nominal input power	55 kVA
	22 kVA – 55 kVA (Software limit opt.)
Input frequency	60 Hz
Power factor (full load)	> 0.98
Input over-current protection	Yes
Efficiency	> 92% at nominal output power
Output	
Maximum output power	50 kW
Maximum output current	120 A
Output voltage range	50 – 500 V
Output over-current protection	Yes
Output short-circuit protection	Yes
General	
DC connection standard	CHAdeMO compliant
DC cable length	15 ft std; other lengths upon request
DC plug type	JEVS G105
RFID system	13.56 MHz, ISO 14443A
Network connection	GSM / UMTS modem
	10/100 Base-T Ethernet
Standby power consumption	
Idle	100 VA (nominal)
Climate control	1000 VA (max)
Protection	Type 3R
Operational noise level	< 45 dBA
Dimensions (D x W x H)	
Charge station	23” x 38” x 78”
	600 mm x 960 mm x 2000 mm
Weight	
Charge station	880 lbs / 400 kg

ABB Inc.
Electric Vehicle Charging Infrastructure
16250 W. Glendale Drive
New Berlin, WI 53151
Tel: 262-785-3200
sales.evci@us.abb.com
www.abb.com/evcharging

Power and productivity
for a better world™

DCFC EQUIPMENT LEASE AGREEMENT

THIS AGREEMENT ("**Agreement**") is made with effect as of and from the 25th day of 2014

BETWEEN:

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY, a co continued under the *Hydro and Power Authority Act*, R.S.B.C. 1996, c. 212, h head office at 333 Dunsmuir Street, Vancouver, British Columbia, V6B 5R3

("**BC Hydro**" or "**Lessor**")

AND:

BAKERVIEW ECODAIRY LTD. Located at 1356 Sumas Way, Abbotsford, 8H2.

("**Lessee**")

WHEREAS:

A. Lessor is participating in a pilot project involving the acquisition, installa operation of DC fast charging ("**DCFC**") stations for electric vehicles ("**EVs**") a locations around the province of British Columbia (the "**Program**");

B. The Program is part of the Clean Energy Vehicle Program which is designed tc British Columbians with more affordable clean transportation options;

C. The purpose of the Program is to instil consumer confidence in EV techn removing one of the main barriers to mass adoption, which is the lack of public infrastructure;

D. The DCFC stations will form part of a grid-aware charging network lin centralized data and energy management system;

E. Lessee wishes to participate in the Program and has proposed a suitable locat DCFC station which BC Hydro has approved;

F. Lessor desires to lease to Lessee, and Lessee desires to lease from Lessor, th station comprising certain equipment described herein to be installed and op Lessee's premises at the selected site for the purposes of the Program.

NOW THEREFORE in consideration of the premises and the mutual covenants, ag terms and conditions hereinafter set forth, the Parties hereto agree as follows:

1. Interpretation

(a) **Definitions**. Unless the context otherwise requires, capitalized terms used he have the meaning assigned to such terms when first defined in parentheses.

(b) **Headings**. The headings in this Agreement are included for convenience of ı only and shall not affect the interpretation or construction of this Agreement.

(c) **"Party"** refers to a party to this Agreement, collectively referred to as the "**Pa**

2. Lease; Equipment

Subject to the terms and conditions hereof, Lessor agrees to lease to Lessee, an agrees to lease from Lessor, one DCFC station comprising the DCFC equipment and meeting the specifications described in Schedule A, together with all additio attachments and accessories thereto from time to time (collectively, the "**Equi** but excluding any such equipment, additions, parts, attachments and accessori installed between Lessor's meter and the point of interconnection with the DCF as indicated in Schedule A (collectively, the "**Lessee's Infrastructure**").

Within [**ten (10)**] days after satisfaction of the condition precedent set out in p 3(a)(i) below, Lessor shall complete and deliver to Lessee an updated copy of Sc containing the details applicable to the Equipment and Lessee's Infrastructur updated Schedule A will form an integral part of this Agreement upon its de Lessee.

3. Conditions Precedent

(a) **Lessor**. The obligations of Lessor pursuant to this Agreement are subje following conditions being fulfilled, performed or waived:

(i) The Equipment and Lessee's Infrastructure shall have been delivered to I the supplier(s) thereof in good working order and otherwise in accordance applicable procurement terms; and

(ii) Lessor and Lessee shall have agreed the date upon which the Equipmen delivered to Lessee (the "**Commencement Date**").

Lessee agrees that these conditions are for the sole benefit of Lessor. None conditions shall be waived except by written notice from Lessor to Lessee event that these conditions (or any of them) are not satisfied or waived within set out above then this Agreement shall terminate.

(b) **Lessee**. The obligations of Lessee pursuant to this Agreement are subje following condition being fulfilled, performed or waived:

(i) Lessor shall have delivered written notice to Lessee confirm Commencement Date, as approved in advance by Lessee, acting re together with a completed copy of Schedule A containing the detail Equipment and Lessee's Infrastructure as required by section 2 above.

Lessor agrees that this condition is for the sole benefit of Lessee. This condit only be waived by written notice from Lessee to Lessor. In the event condition is not satisfied or waived within the time set out above then this A shall terminate.

4. Term and Termination

(a) **Term**. Subject to earlier termination or extension in accordance with the p hereof, the term (the "**Term**") of this Agreement is five years, commencin Commencement Date and ending on the day before the fifth anniversary the "**Initial Term**"); however all obligations of the Parties under this Agreem continue until they have been performed in full.

(b) **Extension**. Unless Lessee has delivered to Lessor written notice on or befor that is one month before the end of the Initial Term terminating this Agreem end of the Initial Term, this Agreement shall automatically extend on a n month basis unless and until terminated in accordance with the provisions her

(c) **Termination**. If more than two years after the Commencement Date, Lessee by law to charge and collect fees from end- users of electricity delivere Equipment, then Lessee shall be entitled to terminate this Agreement on not one full calendar month's written notice to Lessor. At any time after the Initi either Party shall be entitled to terminate this Agreement for any reason whats not less than one full calendar month's written notice to the other Party.

5. Rent

The rent for the use of the Equipment is $1 per month for the Term, which shall b Lessee, together with any applicable taxes, in advance on the Commencement Da the first day of each succeeding month throughout the Term, to Lessor at:

333 Dunsmuir Street, 7th Floor
Vancouver, BC V7X 1V5

or at such other place as Lessor may designate in written notice to Lessee fron time. Lessee may prepay the rent for the Initial Term or any portion thereof on a basis. In the event of termination under section 4 above, Lessee shall not be e reimbursement of any rent paid under this Agreement

6. Lease Absolute

This Agreement may not be cancelled or terminated except as expressly provide Lessee's obligation to pay rent and other amounts due or to become due her absolute and unconditional and is not subject to any reduction, delay, set-off, wit defence, claim, counterclaim or recoupment for any reason at all, including an destruction, repossession or theft of the Equipment, loss of use of the Equipme past, present or future claims of Lessee against Lessor under this Agreement or ot

7. Site

The site which has been selected for the installation and operation of the Equi located at:

_____1356 Sumas Way, Abbotsford, BC_____ (the "**Site**").

Lessee represents and warrants to Lessor that Lessee owns, occupies and has full access the Site, that the Site is located entirely within and upon property owne Lessee in fee simple, and that there are no other third parties (such as landlords, t lenders) who have any legal interest in the Site. [**NOTE: if this is not true, consider the fixtures disclaimer/ LTO fixture filings and wheth acknowledgements are required from such third parties.**] Lessee shall not ch location of the Equipment from the Site without the prior written consent of Les consent not to be unreasonably withheld but which may be conditional upon approval of the new location, acting reasonably, and Lessee's agreement to be res for the costs and expenses associated with the move, and/or or other reasonable te

Once installed at the Site and/or affixed to the Equipment, Lessee shall not conceal or alter, any labels, plates, signs or other identification supplied b indicating Lessor's ownership of the Equipment, provided that such labels, plat and identification are in compliance with all applicable laws.

8. Delivery and Installation

Lessor shall arrange for delivery of the Equipment and Lessee's Infrastructure tc on the Commencement Date. Lessor shall also be responsible for engaging individuals, which may include third party contractors, to install and commis Equipment and Lessee's Infrastructure at the Site. Delivery and installatio Equipment and Lessee's Infrastructure shall be for and at Lessor's account and and Lessor shall use reasonable efforts to complete installation within 10 da Commencement Date or such later date as the Parties may agree in writing; however, that if in Lessor's estimation such expenses will or are reasonable exceed a maximum aggregate amount of $50,000, then Lessor may suspend its ob under this section and any related provisions upon written notice to Lessee unt and Lessee mutually agree to an alternate site and amend this Agreement accor reflect the new site and any associated delays. In the event Lessor and Lessee a to agree on a mutually acceptable site within thirty (30) days after delivery of notice to Lessee provided pursuant to this section (or such longer period as the Pa agree in writing), then this Agreement shall terminate.

9. Acceptance

Upon receipt of written notice from Lessor confirming the completion of instal the Equipment and Lessee's Infrastructure, Lessee shall inspect the Equipn Lessee's Infrastructure and shall, within ten (10) days after receipt of notice of co of installation, deliver written notice to Lessor if Lessee rejects any of the Equipment or Lessee's Infrastructure or otherwise asserts that such Equipment or

Infrastructure is unsatisfactory. Any such notice shall contain sufficient detail r the asserted defects in order to permit Lessor to verify, respond to and, if require same. In the event that Lessee fails to deliver any such notice within the time p Lessee will be conclusively deemed to have accepted the Equipment and Infrastructure and to have acknowledged that such Equipment and Lessee's Infra is as ordered, satisfactory to Lessee and in good condition and repair suitable for of Lessee.

10. Use and Operation; Security

Lessee shall make the Equipment available for use and operation to provide EV services to end-users as contemplated by the Program throughout the Term in ac with all applicable laws, including without limitation any applicable provi Lessor's Electric Tariff pursuant to which Lessee will purchase the electricity ther such electricity to the end-users of the EV charging service at the DCFC station a and the Lessor's operating order pertaining to the Equipment which Lessor wil and deliver to Lessee and which must be approved by Lessee, acting reason **"Operating Order"**). Lessee shall be responsible for any costs, charges and associated with any system used by the Lessee to track and/or monitor the pro the EV charging service, and for payment of all electricity charges (including changes) incurred by Lessee and owing to Lessor pursuant to the Lessor's Elect in accordance with the applicable terms and conditions thereof. Lessee shall inspect and monitor the Equipment and Lessee's Infrastructure, in any event not daily on weekdays. Lessee shall ensure the Site is properly lit, patrolled by se otherwise available), and otherwise employ all reasonable measures to en Equipment is reasonably secure at the Site, including any measures identified i by Lessee and Lessor in the Site selection or design process or set out in the C Order. Lessee shall report any misuse or loss of, damage or required repai Equipment to Lessor in writing within 24 hours of becoming aware ther immediately after becoming aware thereof in case of any dangerous or er situation (which may initially be provided orally, to be followed by written notific

11. Data, Metering and Pricing

Lessor shall assist Lessee, and Lessee will work together with Lessor, to develo structures and options for the EV charging service to determine the appropriate accordance with the principles of the Program, provided however such pricing include a charge to end-users for electricity in accordance with section 10 abc Parties acknowledge that Lessee's incremental revenues from providing and char users for the EV charging service shall not materially exceed its incremental providing the EV charging service, and the Parties will re-evaluate, and if r Lessee will adjust, the pricing structure from time to time to ensure this is the c Equipment shall contain a separate meter so that the EV charging service provic DCFC station is separately metered. Lessor shall be entitled to collect and anal and payment data and Lessee will cooperate with Lessor from time to time to e activities which demonstrate Lessor's ability to remotely control the Equipm

Lessor shall report and share the results of its analysis with Lessee on a periodic l upon reasonable request.

12. Condition; Repairs and Maintenance

Lessee shall routinely monitor and inspect the condition of the Equipment and Infrastructure and shall, at its own cost and expense, be responsible for maintenance or upkeep to comply with any warranty requirements identified by l the Operating Order and to keep the Equipment and Lessee's Infrastructure clean shall report any additional service, repairs or maintenance required to Lesso designated contractor) in writing within 24 hours of becoming aware thereof, a make arrangements for such service, maintenance or repairs with Lessor's de contractor(s) to provide or procure any and all parts and labour required to se repair the Equipment or keep it in good mechanical working order (normal wear and solely cosmetic repairs excepted). In the event that such service, mainte repairs are not covered by applicable third party warranties or funded by insurance, Lessee shall obtain Lessor's written approval of the estimated costs service, maintenance or repairs in advance, and Lessor shall pay for such maintenance or repairs (excluding any solely cosmetic repairs that do not a functionality of the Equipment or Lessee's Infrastructure), provided that the act thereof do not materially exceed the approved estimate, and subject to:

(a) a Program-wide annual maximum amount of $15,000 per fiscal year, alloca first need basis (subject to paragraph (b) below);

(b) a per Site annual maximum amount of $3,000 per fiscal year; and

(c) termination of the Program by, or lack of available funding from, federal sources.

In the event that the annual thresholds above are exceeded (or met), Lessor may c required service, repairs or maintenance to the next fiscal year, or, at Lessee's req perform the required service, repairs or maintenance at Lessee's cost and expense.

Lessee may not alter or modify the Equipment or Lessee's Infrastructure without written consent of Lessor.

Except for Lessee's Infrastructure (and all additions, parts, attachments, accesse replacements thereto or thereof), all additions, parts, attachments, accesso replacements of the Equipment, whether by substitution, repair, alteration, ad improvement, shall immediately become the property of Lessor and part of the Ec for all purposes thereto.

13. Warranty Disclaimer

LESSOR DISCLAIMS AND SHALL NOT BE LIABLE FOR ANY WARR EXPRESS OR IMPLIED, IN RESPECT OF THE EQUIPMENT OR LI INFRASTRUCTURE INCLUDING BUT NOT LIMITED TO IMPLIED WARR OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PU

Notwithstanding the foregoing, Lessor shall at its expense enforce, for its (Lessee's benefit, any warranties provided by the Equipment suppliers or manufac third party contractors responsible for installation or maintenance or performing a work or services in respect of the Equipment, and shall assign any warranties pro the suppliers or manufacturers of, or third party contractors responsible for instal maintenance or performing any other work or services in respect of, Infrastructure to Lessee. Lessee agrees to cooperate with Lessor in such regard. thirty (30) days after the Commencement Date, Lessor shall deliver to Lessee cop supplier or manufacturer warranties in respect of the Equipment and Infrastructure, as well as copies of any warranties provided by third party contr respect of the installation, maintenance or performance of other services relate same.

14. Insurance

Lessee shall obtain and maintain at its expense continuously throughout the Term:

(a) Comprehensive public liability insurance in respect of claims by third pa personal injury, death, or property damage arising from the use or operatic Equipment and Lessee's Infrastructure as contemplated by this Agreemei amount not less than two million dollars ($2,000,000) per incident, which sh Lessor as an additional insured; and

(b) Broad form insurance covering loss of or damage to the Equipment for whic is legally liable or responsible, in an amount equal to the full replacement val Equipment..The policy shall include a waiver of the insurer's rights of sul against Lessor.

The insurance shall be in such form and with such limits and providers as are ac to Lessor, acting reasonably, shall provide at least thirty (30) days advance writt to Lessor of any cancellation or change in amount of coverage. Lessee shall Lessor, upon Lessor's request, with a certificate evidencing such insurance; hov failure to request or provide such evidence shall relieve Lessee from any obli maintain such insurance required in accordance with the terms hereof. If Lesse obtain or maintain the insurance as required hereunder, Lessor may, but sha required to, obtain such insurance itself and the cost of the insurance shall b account of Lessee and due on demand by Lessor.

Lessor shall self-insure liabilities to Lessee for personal injury, death, or property for which Lessor is legally liable or responsible pursuant to the provisions he shall, prior to the Commencement Date, provide a letter of self-insurance to that Lessee which shall be acceptable to Lessor and Lessee, acting reasonably.

15. Possession and Surrender or Return

Notwithstanding Lessor's retention of title, Lessee shall have possession and cont Equipment throughout the Term. Upon the expiry or earlier termination

Agreement, Lessee shall return the Equipment to Lessor, free of all Encumbra defined below), by surrendering possession and notifying Lessor in writing Equipment is ready for pick-up.

Lessor shall be responsible for removing the Equipment within ninety (90) d receipt of such notice and for terminating the electrical connection in accorda applicable laws. In the event that (i) Lessee has terminated this Agreement pri end of the Initial Term; or (ii) Lessor has terminated this Agreement as a result of breach or default at any time, all costs and expenses for removing the Equipr related electrical work shall be for the account of Lessee at its expense. Otherwi other circumstances, such removal and related electrical work shall be for and at account and expense. In any event, Lessor shall not have any obligation to unde restoration of the Site upon removal of Equipment or to remove any of Infrastructure upon the termination or expiry of this Agreement, all of which sh and at Lessee's account and expense should it wish to do so.

16. Access and Inspection

Lessor and its authorized contractors and representatives shall have access to th any and all times on reasonable notice to Lessee for purposes of inspecting the E or carrying out any required repairs or maintenance, or for purposes of allowi prospective lessees to inspect the Equipment prior to the termination or expir Agreement. Lessor will use reasonable efforts to accommodate any reasonable re Lessee to reschedule planned access where it is not an emergency situation access would conflict or interfere with Lessee's or other activities at the Site.

17. Encumbrances

Lessee shall keep the Equipment free and clear of all security interests, lie assessments, charges, fees, fines, levies and encumbrances of every nature whatsoever ("**Encumbrances**") and shall cause the same to be released or di promptly upon notice thereof. Lessee shall, or Lessor at Lessee's expense ma pay and discharge when due all Encumbrances assessed on the Equipment or aris or in connection with the possession, use or operation of the Equipment, together interest or penalties thereon, imposed by a governmental authority, whether o same shall be assessed against or in the name of Lessor or Lessee. However, Le not be required to pay or discharge any such Encumbrance so long as it shall, in g and by appropriate legal proceedings, contest the validity thereof in any re manner which will not affect or endanger the title and interest of Lessor to the Eq provided that Lessee shall reimburse Lessor for any damages or expenses result such failure to pay or discharge. Any amounts owed by Lessee to Lessor pursua provision shall be payable by Lessee to Lessor with the next instalment of rent, failure to reimburse same shall be subject to the same consequences, includin limitation interest on overdue payments, as failure to pay any instalment of rent.

18. Title; Personal Property

Lessee's Infrastructure procured and installed by Lessor at its expense pursuar Agreement shall become the property of Lessee upon completion of installat Lessor hereby conveys, sells, assigns and transfers Lessee's Infrastructure and title and interest in and to Lessee's Infrastructure to Lessee effective as of and fı time.

Lessor represents and warrants that it has or will have full and unencumbered tı Equipment and the right to lease it to Lessee in accordance with the terms Agreement. The Equipment is, and shall at all times be and remain, the sole and ε property of Lessor; and Lessee shall have no right, title or interest therein or there the right of possession and use in accordance with the terms of this Agreement. limiting the foregoing, the Equipment shall be deemed to be personal property c and shall not, by reason of attachment, affixation or connection to Lessee's Infras the Site or any land or building thereon, become or be deemed a fixture or appur the Site or such land or building or to Lessee's Infrastructure or any other property located on the Site, and shall at all times be severable therefrom despite that all or any part of the Equipment may be resting upon, imbedded in, att affixed to the Site.

Lessee shall take such steps as may be required to prevent any person from acqu rights in any Equipment by reason of the Equipment being claimed or deemed t property. In addition, Lessee shall use all reasonable efforts to obtain and d Lessor such waivers, in registrable form (if necessary), as Lessor may reasonabl from the owners, landlords and mortgagees of any real property upon wl Equipment may be located.

19. Capacity and Authority

Lessee represents and warrants to Lessor that the end-users of the EV charging se not tenants of Lessee (or are not being offered or making use of the EV charging s their capacity as tenants of Lessee), and that Lessee has the capacity and authority into this Agreement and perform its obligations as contemplated hereunder, i providing the EV charging service to public customers as contemplated Agreement and the Program.

Lessor represents and warrants to Lessee that Lessor has the capacity and aut enter into this Agreement and perform its obligations as contemplated hereunder.

In the event that any of the foregoing becomes untrue at any time throughout the a result of a change in applicable laws, regulations or policies (excluding internal of either Party), either Party shall be entitled to terminate this Agreement upo notice to the other.

20. Signage and Parking Policies

Lessor shall provide and install station signage and other informational and ed signage developed for the Program regarding the Equipment, the Program a

Lessor shall contact and coordinate with governmental entities that have jurisdic the roads, highways and freeways surrounding the Site to install way-finding si such roads, highways and freeways directing drivers to the Site. Lessee shall prc install way-finding signage on the Site and on any roads surrounding the Site over has authority . Lessee shall create and enforce reasonable parking policies for th facilitate and encourage appropriate use of the EV charging service.

21. Announcements and Publicity

Lessor shall work and coordinate with the province of British Columbia and a municipalities to promote the DCFC station and the Program . Lessee may pro DCFC station and the Program in any media releases, publications, events, and web-based material provided however that the Lessee shall:

(a) acknowledge the support and funding provided by the province o Columbia and the support of Lessor in any such promotional material o and

(b) provide the province of British Columbia and Lessor an opportunity to on and approve any such promotional materials or events in adva reasonable notice thereof, which shall, in any event, not be less than notice.

Notwithstanding the foregoing, in the event that the content of any such pro material, release, publication, speech or material relating to the province o Columbia and Lessor has previously been approved by the province of British C and Lessor, Lessee shall not be required to seek further approval for or provide subsequent releases, publications, speeches or materials using the same content, u province of British Columbia or Lessor has subsequently delivered written Lessee withdrawing such prior approval or indicating a desired change to p approved content.

22. Liability; Indemnity

(a) Lessor shall not be liable for, and Lessee shall release, indemnify and hold Lessor and its directors, officers, employees, consultants, agents, contrac representatives (collectively, the "**BCH Indemnified Parties**", and each **Indemnified Party**") from and against any and all costs, expenses, damages, losses and liabilities of every nature and kind whatsoever, including without l reasonable legal fees on a solicitor and own client basis, suffered or incurred b (or those for whom it is responsible at law) or arising out of or in connection v party claims, actions, causes of action, suits, or proceedings at any time su incurred by, or brought or made against the BCH Indemnified Parties (or any one of them), relating to Lessee's possession, use or the operation of the Equi Lessee's Infrastructure, including without limitation the manufacture, selection, supply, installation, possession, repair, maintenance, use, operation or retur Equipment or Lessee's Infrastructure, whether or not arising as a result of any f error, omission, breach or default of Lessee or those for whom it is responsibl

except to the extent directly caused or contributed to by the negligence c misconduct of a BCH Indemnified Party.

(b) Without limiting paragraph (a) above but subject to paragraph (c) below, the li any BCH Indemnified Party under this Agreement or relating to Lessee's posses or the operation of the Equipment or Lessee's Infrastructure shall be limited to a expenses, damages, injuries, losses and liabilities suffered or incurred by Less extent directly caused or contributed to by the negligence or wilful misconduct c Indemnified Party.

(c) Neither Party shall be liable to the other for any loss of profit, loss of revenues pure economic loss under any circumstances whatsoever.

23. Default and Remedies

If Lessee fails to pay any rent or any other amount payable hereunder within ten (after the same is due and payable, or if Lessee fails to observe, perform or disch other obligation under or provision of this Agreement required to be observed, p or discharged by Lessee within ten (10) days after receiving notice thereof from L if Lessee becomes bankrupt or insolvent or makes an assignment for the bene creditors or has a trustee or receiver appointed that has authority to take posse control of the Equipment, or if any proceedings under bankruptcy, ins restructuring or creditor protection legislation are commenced by or against Le Equipment or any material part thereof is seized, confiscated, sequestered or attac a distress is levied thereon, or if Lessor in good faith believes and has com reasonable grounds to believe itself insecure, that the prospect of payment or perf by Lessee hereunder is about to be impaired or that the Equipment is or about to b in jeopardy, then Lessor shall have the right to exercise any one or more of the f remedies:

(a) To declare the entire amount of rent hereunder immediately due and payabl notice or demand to Lessee;

(b) To sue for and recover all rents and other payments then accrued or t accruing;

(c) To cure any default of Lessee at Lessee's cost and expense and recover such pursuant to paragraph (b) above;

(d) To take possession of and/or remove the Equipment, without demand o without any court order or other process of law, and for that purpose e premises where the Equipment is located, and Lessee hereby waives an damages occasioned by such taking of possession or removal or entering any for such purposes;

(e) To terminate this Agreement immediately with or without notice; or

(f) To pursue any other remedy available at law or in equity.

Notwithstanding any repossession or any other action taken by Lessor, Lessee sha remain liable to Lessor for the full performance of all obligations on the part of l be performed under this Agreement. Lessor's remedies hereunder are cumula may be exercised concurrently or separately.

24. Dispute Resolution

If any dispute arises under or in relation to this Agreement, that dispute shall be re and finally resolved by arbitration by a single arbitrator pursuant to and in ac with the *Commercial Arbitration Act* (British Columbia). The place of arbitratior Vancouver, British Columbia. The decision of the arbitrator shall be final and bi the Parties. Notwithstanding the foregoing, the Parties are entitled to seek measures of protection, including injunctions and other equitable relief or remed a court of competent jurisdiction pending commencement or completion arbitration, and may also seek from a court of competent jurisdiction any equital or remedy that the arbitrator does not have the jurisdiction to grant.

25. Security Interests

Without limiting the title retention provided for above or any other security obt Lessor, Lessee grants to Lessor a security interest in all Equipment and all proc defined in the *Personal Property Security Act* (BC)) thereof as security for the and performance of all present and future indebtedness, obligations and liab Lessee to Lessor under this Agreement. Lessee hereby acknowledges having rec executed copy of this Agreement in effect on the date hereof and waives all receive from Lessor a copy of any financing statement, financing statement (tra financing change statement or verification statement filed at any time in respec Agreement.

26. Further Assurance

At its own expense, upon the request of the other Party, each Party shall promptly and deliver, and use all reasonable efforts to promptly require any third parties tc and deliver, such further and other documents and instruments and do such fur other acts and things as the other Party may reasonably require for the pu implementing, giving full effect to and carrying out the intent of this Agreeme purposes of recording or filing to protect the interest of Lessor in the Equipment c in the Lessee's Infrastructure.

27. Time

Time is of the essence of this Agreement.

28. Notices

Any notices required or permitted to be given under this Agreement must be ir and delivered personally or by facsimile addressed to the recipient as follows:

(a) If to BC Hydro:

British Columbia Hydro and Power Authority
333 Dunsmuir Street, 7th Floor
Vancouver, BC V6B 5R3

Attention: Alec Tsang
Senior Technology Strategist, Office of the Chief Technology Officer
Facsimile No.: (604) 623-4185

(b) If to Lessee:

Bakerview EcoDairy Ltd
1356 Sumas Way, PO Box 4110
Abbotsford, BC V2S 8R1

Attention: Peter Torenvliet
Facsimile No.: (604) 557 - 1480

or to such other address or number as a Party may from time to time provid notice to the other. Notices delivered by facsimile shall be deemed to be receiv next business day following the date of transmission.

29. Invalidity and Severability

Each of the provisions contained in this Agreement is distinct and severab determination of illegality, invalidity or unenforceability of any such provisio thereof by a court of competent jurisdiction shall not affect the validity or enforce any other provision hereof and the remainder of this Agreement shall continue in and effect, unless as a result of such determination this Agreement would f essential purposes.

30. Entire Agreement

This Agreement constitutes the entire agreement between the Parties with respe subject matter hereof and supersedes all prior understandings, documents, agreen instruments, whether oral or written. There are no other promises, cc understandings or other agreements, whether oral or written, relating to the subje of this Agreement.

31. Amendment

This Agreement may be amended only by an instrument in writing signed by ea Parties hereto. Further, upon Lessee being permitted by law to charge and co from end users of electricity delivered by the Equipment in Lessee's provisic charging services, and upon request by Lessee, Lessor shall agree to amendmen Agreement related to Lessee's fee structure to end-users that the Lessor deems re For greater certainty, nothing herein affects or in any way amends Lessor's Elect or any provisions thereof, including without limitation, with respect to Lessor' and Lessee's purchase of electricity pursuant thereto.

32. Assignment; Inurement

Lessee shall not assign this Agreement, any rights hereunder or its interes Equipment without the express prior written consent of Lessor, which it may wi its sole discretion. Lessor shall not assign this Agreement, any rights hereunc interest in the Equipment without the express prior written consent of Lessee, ı unreasonably withheld. This Agreement shall inure to the benefit of and be bind the Parties hereto and their respective successors and permitted assigns.

33. Waiver

No failure by a Party to enforce any provision of this Agreement or waiver by any any default, breach or non-observance by the other Party at any time or times in r any covenant, provision, term or condition herein shall be effective against tl unless waived in writing, or operate as a waiver of or affect that Party's rights h in respect of any continuing or subsequent default, breach or non-observance waiver shall be inferred from or implied by anything done or omitted to be dor Party having those rights. The acceptance of rent by Lessor does not waive Less to enforce any provisions of this Agreement.

34. Governing Law; Attornment

This Agreement shall be governed by, construed and enforced in accordance with of the province of British Columbia and the laws of Canada applicable therei Party attorns irrevocably and unconditionally to the exclusive jurisdiction of the the province of British Columbia, and to courts to which appeals therefrom may b

35. Counterparts and Delivery

This Agreement may be executed in counterparts and may be delivered by fac other electronic means such as an email attachment in portable document form each of which shall be deemed to be an original and all of which together shall c one and the same instrument.

IN WITNESS WHEREOF the duly authorized representative(s) of each Party has exec delivered this Agreement as of the date set out above.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

Per:_____

Authorized Representative
Name: Alec Tsang
Title: Senior Technology Strategist

BAKERVIEW ECODAIRY LTD.

Per:_____

Authorized Representative
Name: William Vanderkooi
Title: Chief Executive Officer

SCHEDULE A

DCFC Equipment and Lessee's Infrastructure
(to be completed Lessor after installation)

DCFC Equipment:

Manufacturer: _____

Model: _____

Serial Number: _____

Specifications: (one of the following set of equipment specifications will apply depending on the manufacturer and model listed above)

Table 2. Pow-R-Station DC Quick Charger, Eaton

Technical specifications	
Input voltage	208VAC
Input current	125A 3 phase 3 wire 50/60 Hz
Output voltage	400VDC
Output power	50kW Max
Output current	10A-125A
Connector/cable	CHAdeMO compliant
Cable length	9 foot
Charging station dimensions (H x W x D) in inches (mm)	66.00" x 44.00" x 17.75" (1675 x 1120 x 450)
Charge time	20–30 minutes
Charging station weight	Approximate weight 772lbs (350kg)
Operation	Touch screen interface, start and stop buttons, emergency stop button
Operating environment	Ambient temperature: -10 to 40°C (14 to 104°F) Ambient humidity: 5 to 80% Altitude: 1,000 m (3,281 ft) or lower Atmosphere: Containing no corrosive gas
Enclosure	NEMA Type 3R
Efficiency	90% or greater
Secure connector locking system	
Connector insulation verification system	
Ground fault protection, 500mA	
Integrated overcurrent protection	

Table 2. Terra 51 Fast Charging Station, ABB

Technical specifications	
System	
Type	Single DC fast-charging station
Operating temperature	-10°C to +40°C -35°C to +40°C (low temp. option)
Storage temperature	-40°C to +70°C
Relative humidity	20% to 95%
Environment	Indoor / outdoor
Compliance and safety	UL / CHAdeMO
Input	
AC power connection	3P + PE
Input voltage range	480 V_{AC} +/-10%
Nominal input voltage	480 V_{AC}
Nominal input current	70 A 32 A – 70 A (Software limit option)
Nominal input power	55 kVA 22 kVA – 55 kVA (Software limit opt.)
Input frequency	60 Hz
Power factor (full load)	> 0.98
Input over-current protection	Yes
Efficiency	> 92% at nominal output power
Output	
Maximum output power	50 kW
Maximum output current	120 A
Output voltage range	50 – 500 V
Output over-current protection	Yes
Output short-circuit protection	Yes
General	
DC connection standard	CHAdeMO compliant
DC cable length	15 ft std; other lengths upon request
DC plug type	JEVS G105
RFID system	13.56 MHz, ISO 14443A
Network connection	GSM / UMTS modem 10/100 Base-T Ethernet
Standby power consumption	
Idle	100 VA (nominal)
Climate control	1000 VA (max)
Protection	Type 3R
Operational noise level	< 45 dBA
Dimensions (D x W x H)	
Charge station	23" x 38" x 78" 600 mm x 960 mm x 2000 mm
Weight	
Charge station	880 lbs / 400 kg

Lessee's Infrastructure:

In the case of scenario 1 where the power for the charging station is fed from a dedicated electrical service from BC Hydro, the Lessee's infrastructure includes all electrical equip downstream of the BC Hydro owned meter such as transformers, cabinets containing ele equipment, all equipment contained within the cabinet and conductors leading up to the connection point within the charging station, or

in the case of scenario 2 where the power for the charging station is fed from an existing service, the Lessee's infrastructure includes all electrical equipment such as that describe scenario 1 above and installed for the purpose of supplying power to the charging station upstream and downstream of, but excluding the BC Hydro owned meter.

Appendix F

EV TECHNOLOGY AND MARKET OVERVIEW (POWERTECH LABS INC.)

Powertech Advanced Transportation	REPORT	RPT0001-01406
	EV Technology and Market Overview	

Background Report

EV Technology and Market Overview

October 19 2016

Status: Final
Revision: 01

Josh Power, Township of Langley
Greg Brooks, City of Abbotsford
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Ref# *Proposal 16-4652*	Date: 18-DEC-2015	

RPT0001-01406-D01	EV Technology and Market Overview

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DISCLAIMER

This report was commissioned by the Township of Langley, Metro Vancouver and City of Abbotsford. Interpretation of the results of this study, as expressed in the report, is entirely the responsibility of the consultant authors and does not imply endorsement of specific points of view by the Township of Langley, Metro Vancouver or City of Abbotsford. The findings and conclusions expressed in the report are the opinion of the authors of the study and may not necessarily be supported by the Township of Langley, Metro Vancouver or City of Abbotsford.

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EXECUTIVE SUMMARY

Electric Vehicles have become an increasingly important technology with excellent potential for reducing the cost and environmental impact of transportation. Municipalities in the lower mainland have significant influence over the growth of EV technology through implementing incentives, installing infrastructure and leading by example with their own vehicle fleets. With the potential for a large shift to electric vehicles over the coming years, municipalities must plan carefully to ensure that this new technology is supported in a way that maximizes benefits for citizens and the environment while accounting for future growth and fiscal responsibility.

This report is intended to provide context for broader EV charging infrastructure planning activities in BC. It provides an overview of the EV market, as well as technical information relating to EVs and the charging infrastructure required to support them.

Since late 2010, sales of EVs in North America have totaled over 500,000, with over 20,000 of those having been sold in Canada, and over 4000 in BC. Yearly sales rates have accelerated as a greater number of EV models have become available from various automakers. An analysis of two recent studies suggests that EVs will make up between 3-6% of the vehicle fleet in BC by 2024, and between 13-20% by 2030.

Section 3 provides definitions of various types of EVs, a summary of currently available electric vehicles including basic technical specifications, as well as a summary of EVs that will enter the market in the coming years. Three trends are observed among upcoming products: the advent of affordable Battery Electric Vehicles (BEVs) with significantly improved driving range of 300km or more; the arrival of electric SUVs in the North American market; and a surge of plug-in hybrid electric vehicle (PHEV) versions of a broad number of makes and models.

Section 4 introduces the various means of recharging EVs, including readily available and relatively inexpensive AC charging equipment, less common and more expensive DC fast charging equipment, as well as future technologies such as higher power DC fast chargers, wireless charging and battery swapping. Various technical details and standards pertaining to these charging methods are discussed.

Section 5 provides an overview of emerging “Smart Grid” technologies that have the potential to better integrate EVs into the grid and minimize their impact on electrical infrastructure. “Smart Charging” is a general concept that involves reducing charging rates at certain times to avoid peak loads, and is increasingly supported by a number of available technologies. Vehicle-to-Grid (V2G) is a concept that involves EVs acting as a source of energy, potentially to provide backup power or to support grid operations. V2G has been demonstrated in a number of pilot projects, but broader commercialization of this technology is still in question. Stationary Energy Storage systems can support grid operations by minimizing the impact of significant loads, while also providing the option of zero-emissions backup power for a limited time. Stationary Energy Storage systems are transitioning from a technology demonstration stage to broader commercialization.

Finally, Section 6 provides a brief summary of policies and programs supporting EV adoption in BC. These include purchase incentive, infrastructure deployment programs, and building codes.

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LIST OF ACRONYMS

AC	Alternating Current
BEV	Battery Electric Vehicle
CCS	Combined Charging System, the SAE standard for DC charging
DC	Direct Current
DCFC	Direct Current Fast Charge or Direct Current Fast Charger
DER	Distributed Energy Resource
DR	Demand Response
EREV	Extended Range Electric Vehicle
ESS	Energy Storage System
EV	Electric Vehicle (includes BEVs and PHEVs)
EVSE	Electric Vehicle Supply Equipment
FCEV	Fuel Cell Electric Vehicle
HEV	Hybrid Electric Vehicle
J1772	The SAE standard charging connector for AC charging
kW	Kilowatt
kWh	Kilowatt-hour
L1	Level 1 (AC charging)
L2	Level 2 (AC charging)
PEV	Plug-in Electric Vehicle (includes BEVs and PHEVs)
PHEV	Plug-in Hybrid Electric Vehicle
V2G	Vehicle-to-Grid

1 INTRODUCTION

Electric Vehicles (EVs) represent an excellent opportunity to reduce both the cost and the environmental impact of transportation. Using highly efficient electric motors and onboard batteries for electrical energy storage, EVs avoid the use of non-renewable fossil fuels and their associated air emissions. While it is important to take into account the environmental impact associated with electricity generation, studies have shown that EVs can make sense even in regions with largely coal-based electrical grids, and their "well-to-wheels" emissions are already improving considerably over time as grids around the world shift to cleaner forms of electricity generation[1].

While EVs were relatively common in the early 1900's, the advent of highways and intercity travel highlighted the driving range limitations of EVs, and the remainder of the 20th century was dominated by the internal combustion engine. Although the late 1990's did see a small surge of EV sales thanks to a government mandate in California, it wasn't until December of 2010 that the current generation of EVs began to take off, with the almost simultaneous launch of the Nissan Leaf and the Chevrolet Volt. Since then, over 1 million EVs have hit the road in the world, including over 500,000 in North America. While EVs still only represent about 1% of new vehicle sales in major markets, a diversifying array of EV models with increasing performance and decreasing price has led to steady sales growth across the globe, especially in the US, Europe and China. Some markets with particularly effective government policies have seen much higher penetration of EVs, such as Norway where EVs represent 20-30% of new vehicle sales throughout 2016.[2] Meanwhile, a number of European governments are considering banning the sale of gas-powered cars entirely within the next 10-15 years.[3]

In Canada, government support for EVs has so far come largely in the form of Provincial purchase incentives (in Quebec, Ontario and BC) and through charging infrastructure deployment. Municipal and Regional governments can play an important role in supporting EVs, especially by supporting the deployment of charging infrastructure in both public and private locations. Local governments can also help lead by example by adopting EVs into their own operations.

In order to help inform decision makers at local governments, this report is intended to provide a technical and market overview of electric vehicles and EV charging infrastructure, establishing context for future programs and policy development.

In many places, the reader may notice that information relating to pricing and sales may be discussed in terms of US numbers. While an effort will be made to present information in a Canadian context wherever possible, the automotive industry in Canada is largely influenced by what happens south of the border, and the level of detail of information pertaining to the US market is much greater.

[1] http://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions
[2] http://insideevs.com/norway-ev-sales-surge-in-september-with-volume-deliveries-of-tesla-model-x/
[3] https://electrek.co/2016/10/08/germany-push-europe-wide-ban-on-gas-powered-cars-by-2030-only-ev-sales-onward/

2 THE MARKET

2.1 North American EV Sales to Date

2.1.1 United States

Since the launch of the current generation of EVs in late 2010, the list of available models has increased steadily every year, and there are now almost 30 plug-in vehicles available for sale in North America across at least 15 makes. The US plug-in vehicle market is one of the largest in the world, with annual sales rate having surpassed 100,000 vehicles per year in 2014. The total number of EVs on the road in the US today is over 450,000, as of May 2016.[4]

Sales in the US were initially dominated by a few key models selling on the order of 1000-2000 vehicles per month, followed by a number of so-called "compliance cars" selling fewer than 200 vehicles per month, generally acknowledged to be sold by manufacturers seeking only to comply with California's zero-emissions vehicle regulations. This tendency has reduced in recent years, with a great number of automakers producing EVs in significant numbers:

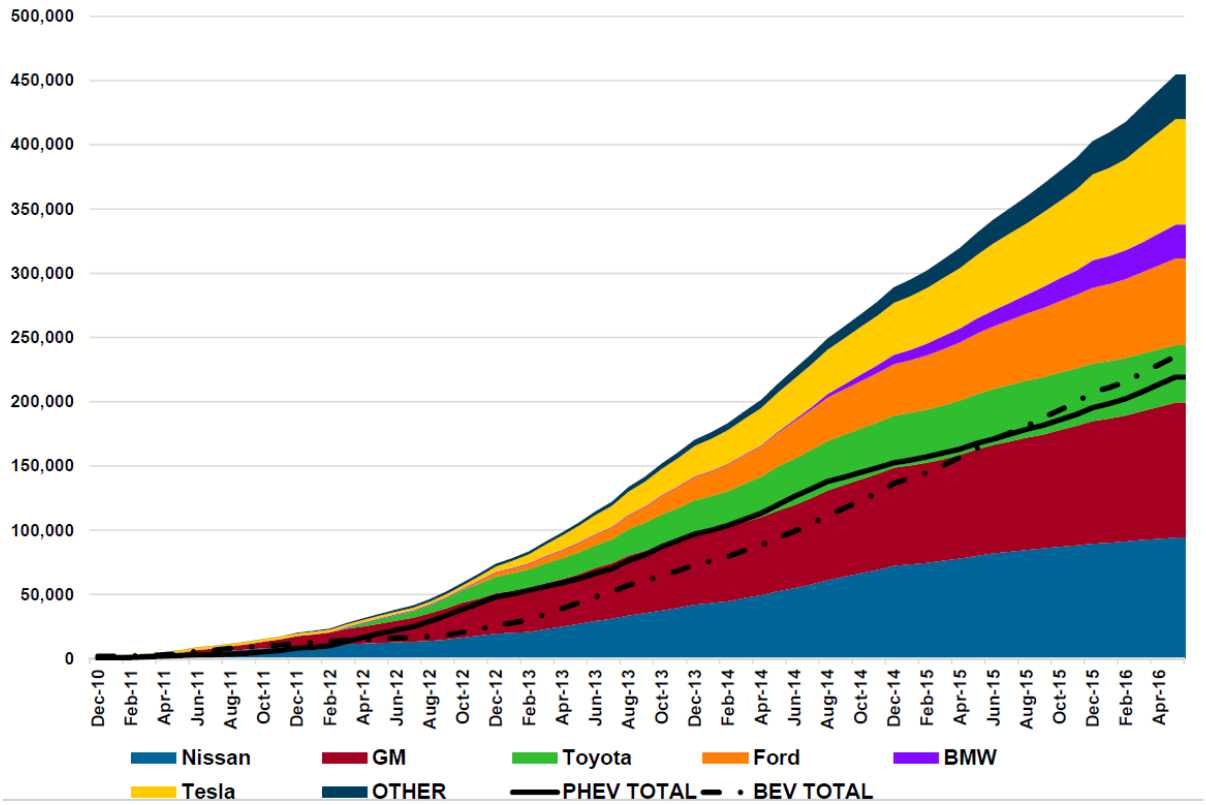


Figure 1 US Cumulative PEV Sales by make up to April 2016. Source: EPRI

[4] http://www.pluginamerica.org/

Cumulatively speaking, the overall number of EVs currently on the road in the US still shows signs of the strong lead in sales established by the Chevrolet Volt and Nissan Leaf (together representing about 40% of EVs currently on the road in North America), followed by the Tesla Model S, the Toyota Prius PHEV, and Ford's two Energi PHEV models (all 6 models collectively representing over 80% of the current EV fleet):

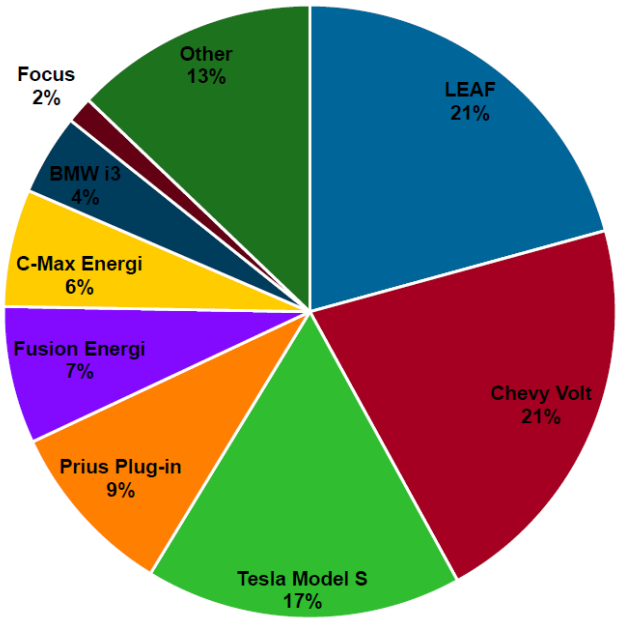


Figure 2: US Cumulative Sales as of May 2016. "Other" includes vehicles such as the Smart ED and the Toyota RAV4-EV. Source: EPRI

Looking specifically at recent sales shows a trend towards greater diversification and a greater number of models taking a significant share of the market, although the overall ranking of models is still fairly similar:

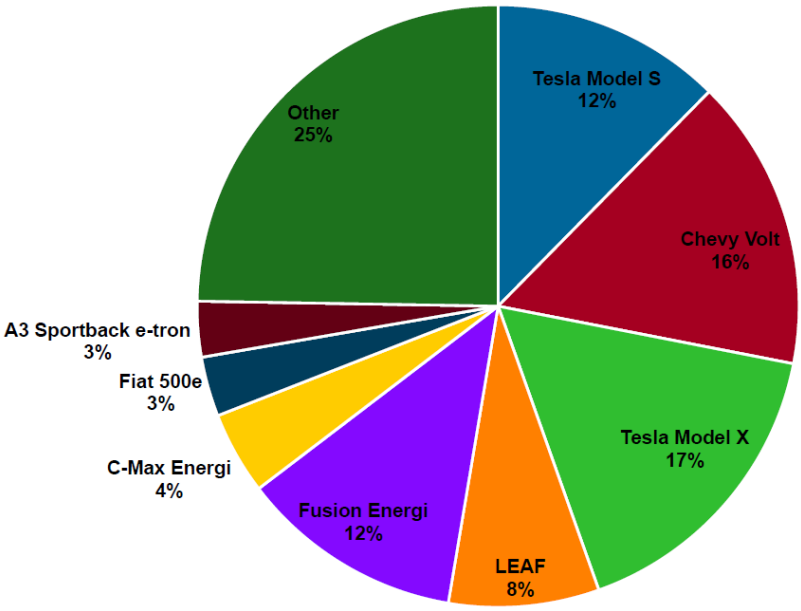


Figure 3: US EV Sales - May 2016. "Other" includes vehicles such as the Fiat 500e, the VW e-Golf, etc. Source: EPRI

2.1.2 Canada and BC

The Canadian EV market is behind the US market in terms of overall sales and diversity of models, although recent trends suggest that it is starting to catch up. With just over 20,000 EVs on Canadian roads today and around 500,000 in the US, cumulative Canadian EV adoption is about 30 % that of the US on a per capita basis. Canadian EV purchases accounted for 0.27% of all new vehicle purchases in 2014, which put Canada in 17th place for EV adoption in 2014 in terms of new vehicle market share, after such countries as the UK (0.58%), France (0.91%), Japan (0.98%), the Netherlands (3.94%) and Norway (13.93%), where very favourable tax incentives for EV purchases have propelled certain EV models into the top selling spots overall for all vehicles in Norway.[5] That said, recent sales data from 2016 shows a significant increase in Canadian EV sales, with sales in the first half of 2016 showing a 77% increase compared to 2014[6] and hitting a market share of 0.61% in July of 2016[7], not far off from the US EV market share of 0.88% for the same month[8]:

[5] Axsen, J., S. Goldberg, J. Bailey, G. Kamiya, B. Langman, J. Cairns, M. Wolinetz, and A. Miele (2015). Electrifying Vehicles: Insights from the Canadian Plug-in Electric Vehicle Study [Early Release]. Simon Fraser University, Vancouver, Canada.
[6] http://www.fleetcarma.com/ev-sales-canada-2016-half-year/
[7] http://www.greencarreports.com/news/1105955_plug-in-electric-car-sales-in-canada-august-2016-volt-laurels
[8] http://insideevs.com/july-was-3rd-best-ev-sales-month-in-u-s-2nd-highest-market-share/

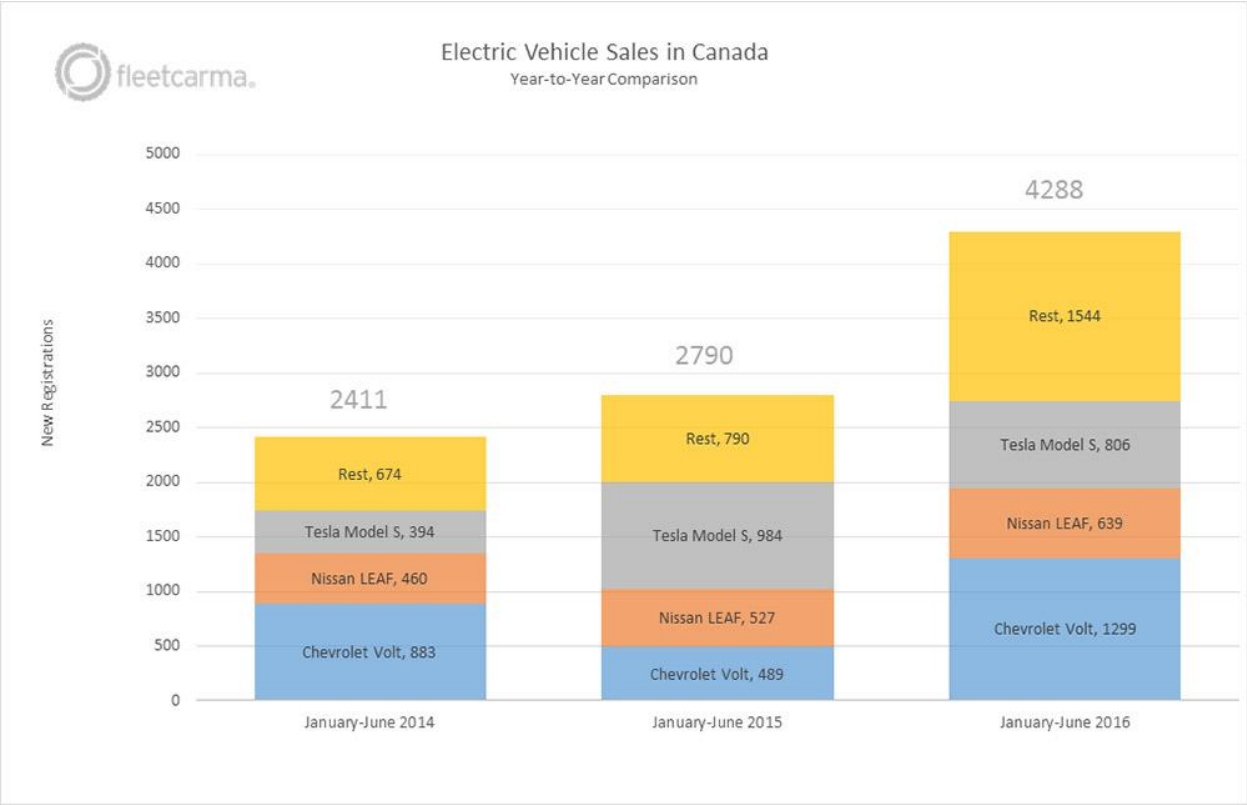


Figure 4: Growth in EV sales in Canada, comparing H1 sales from 2014 to 2016. Source: FleetCarma

One reason cited for this relatively slower adoption in Canada as compared to the US is a lack of federal support programs for EVs in Canada. While BC, Ontario and Quebec have all offered provincial rebate programs (up to $5000, $14000 and $8000, respectively), there is no federal incentive program in Canada that would reinforce the provincial program and support sales in provinces that do not have their own programs. Another potential reason for reduced market share in Canada is a lack of availability of EVs, both in terms of number of distinct models available for sale, as well as a lack of inventory of established models at dealerships.[9] A number of US states try to avoid this type of constrained supply by requiring automakers to sell a minimum number of EVs through a "Zero Emissions Vehicle Mandate". No similar regulations are currently in place in Canada, although it is being considered in Quebec.[10]

[9] Axsen, 2015.
[10] http://ici.radio-canada.ca/nouvelles/Politique/2016/06/02/001-voitures-electrique-cibles-vente-constructeur-projet-loi-quebec.shtml

Compared to the US, Canadian sales numbers show a slightly less diversified market with fewer available EV models, although there are still at least 20 EV models available in Canada. Generally speaking, Canadians show a strong preference for the Chevrolet Volt above all other plug-in vehicles, possibly reflecting benefits of a plug-in hybrid powertrain for colder climates (cold temperatures can exacerbate the range limitations of a pure battery-electric vehicle):

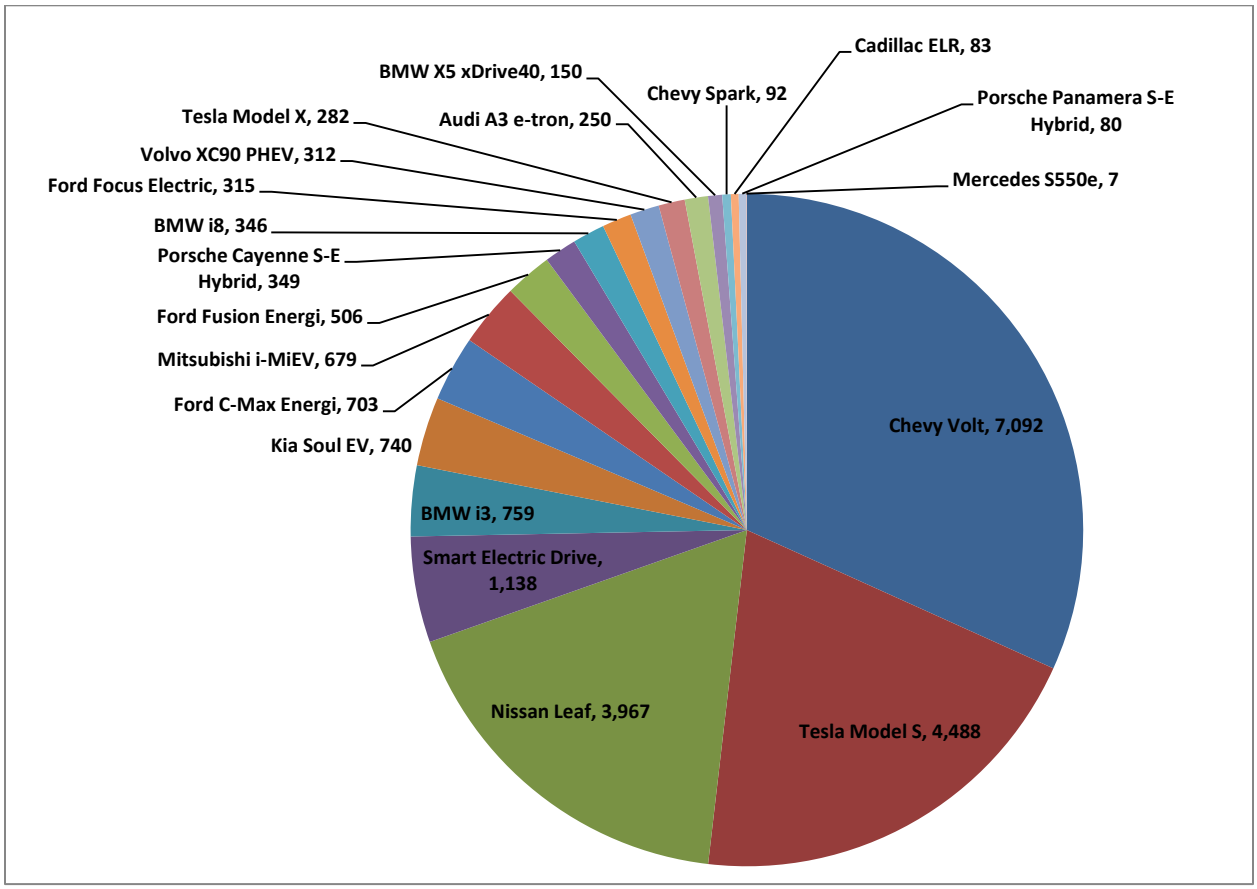


Figure 5: Cumulative Canadian EV sales by model as of July 2016. Source: Matthew Klippenstein, GreenCarReports.

The BC market reverses this tendency somewhat, with a slight preference for pure electric vehicles such as the Nissan Leaf and Tesla Model S as compared to the Chevrolet Volt. These two models represented about 50% of the total EV fleet in BC, which was just over 4000 vehicles as of July 2016:

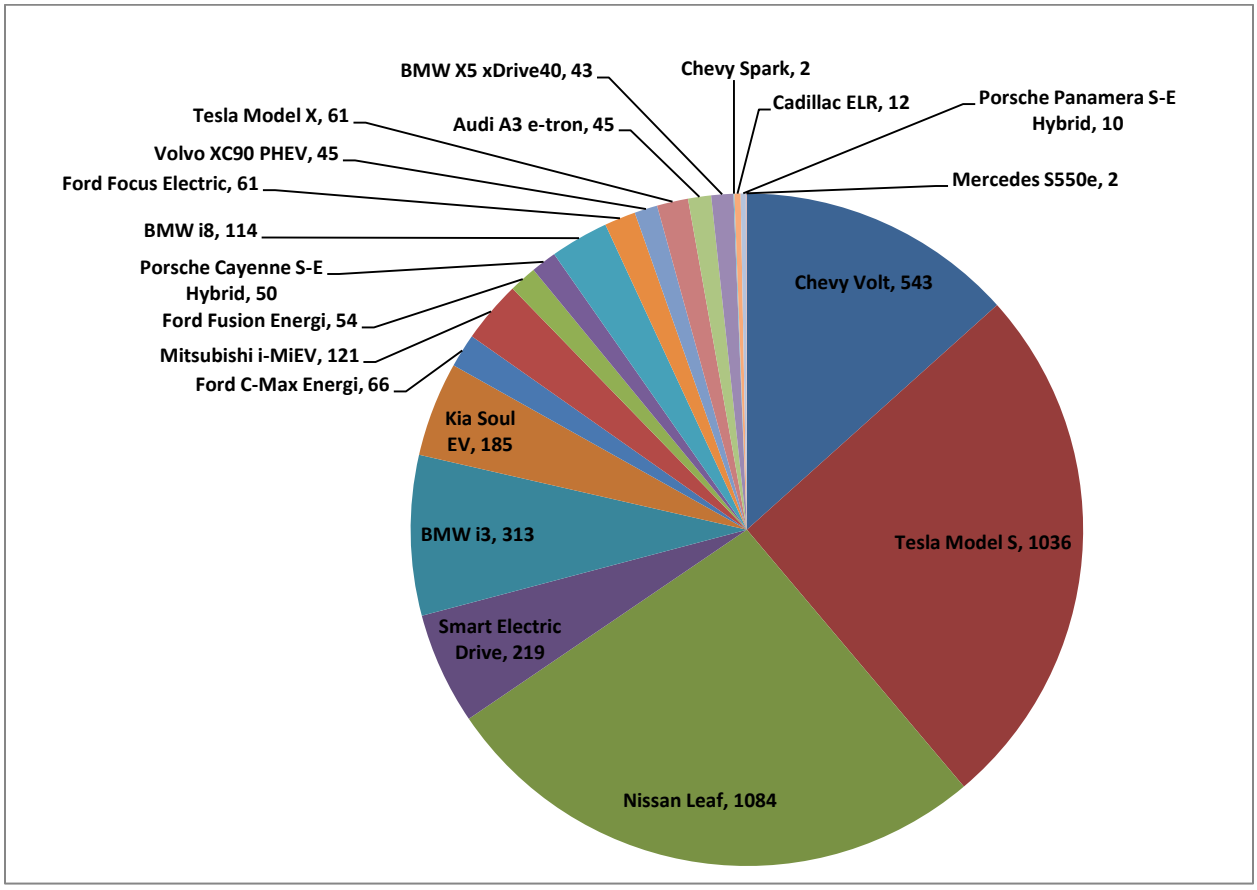


Figure 6: Cumulative BC EV sales by model as of June 2016. Source: FleetCarma.

Looking at a more recent monthly snapshot of EV sales in Canada shows that some of the more recently introduced models are selling in significant numbers. While these models haven't yet made a significant impact to the cumulative sales shown in the figures above, sales for the month of July 2016 show that models such as the all-electric Tesla Model X SUV, and the Audi A3, Volvo XC90 and BMW X5 plug-in hybrids are outpacing some of their predecessors, and contributing to a greater diversity in the Canadian EV market:

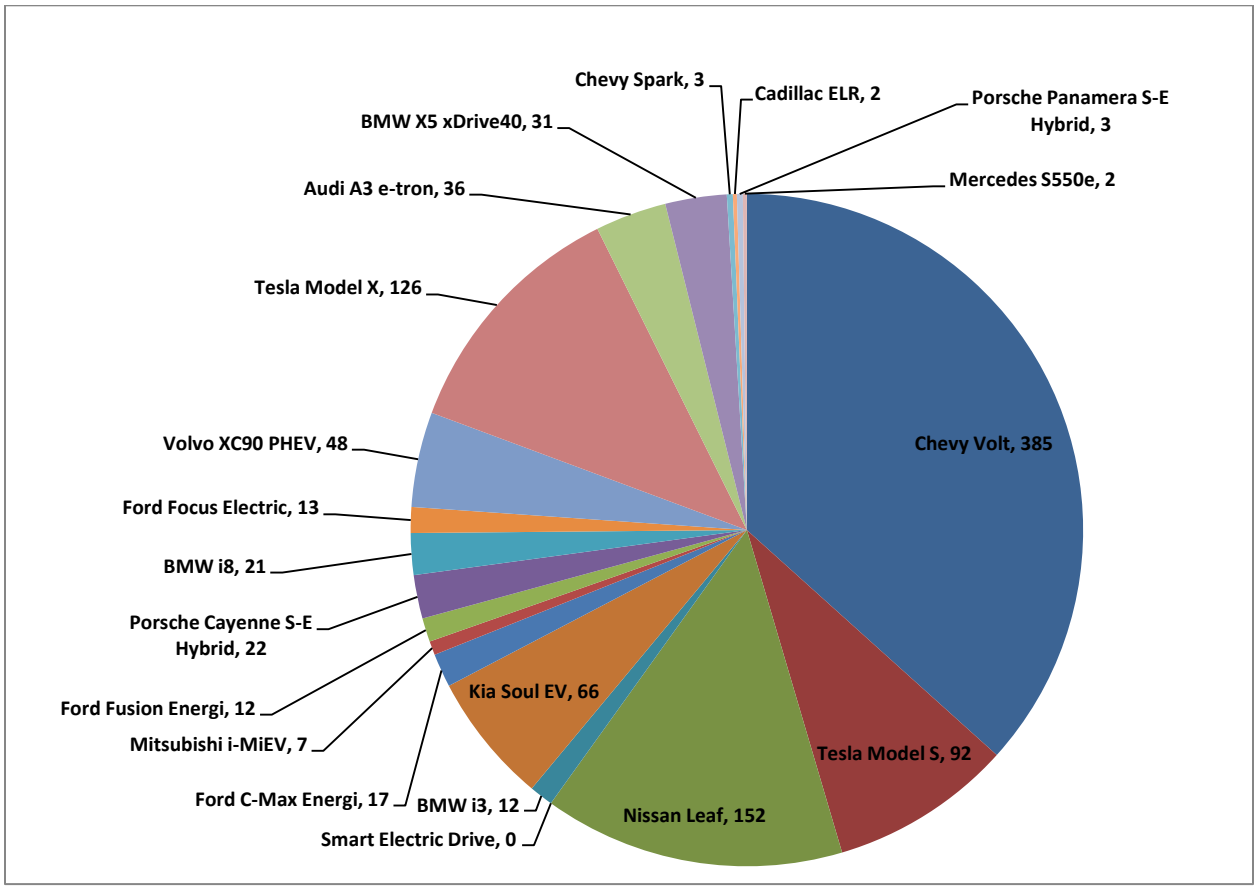


Figure 7: Monthly Canadian EV sales for July 2016. Source: Matthew Klippenstein, GreenCarReports

In 2014, ICBC reported a total of 1700 EVs in BC as of 2014, with 1200 of those being registered in the Lower Mainland.[11] The Lower Mainland has about 70% of BC's registered EVs, while only representing about 60% of BC's population, showing a slightly higher proportion of EV sales per capita, likely thanks to the suitability of EVs for urban and suburban lifestyles.

[11] http://www.icbc.com/about-icbc/newsroom/Documents/population.pdf

2.2 Projected Future Uptake of EVs in BC

Predicting the future growth of EV market share is difficult and a large number of important factors must be taken into account. Factors that may affect sales of EVs include:

1. EV model availability
2. Dealership inventory availability
3. Cost of vehicles, which in turn is largely affected by battery costs
4. Fuel and electricity prices
5. Government rebates and non-financial incentives
6. Availability of charging infrastructure
7. Consumer awareness

Two organizations have recently attempted to take these factors into account in order to assess future market share of EVs, specifically in the Canadian and BC contexts: Navigant Research and Simon Fraser University.

Navigant Research

Navigant Research regularly publishes reports establishing long-term forecasts for EV adoption in various regions, and in Q2 2015 published forecasts specifically for the Canadian market[12]. Navigant expects Canada to begin to catch up with the US EV market, with a compound annual growth rate of between 22.8% in the conservative scenario and 25.7% in the aggressive scenario over the next ten years, leading to annual EV sales of between 74,000 and 91,000 vehicles by 2024, or between 3.7% and 4.6% market share of new vehicle purchases. Cumulatively speaking, this would put the overall EV fleet in Canada somewhere between 350,000 and 420,000 EVs total. Assuming BC and the Lower Mainland still account for similar proportions of the Canadian EV market, this would translate to between 39,000 and 47,000 EVs in the Lower Mainland, about a 35-fold increase over today's numbers, although still only representing less than 4% of passenger vehicles in the region. The following table extrapolates the conservative and aggressive scenarios presented by Navigant to understand how these projections would impact the fleet composition in the Lower Mainland in 2024:

Table 1: BC and Lower Mainland EV sales estimates based on Navigant Research forecast for Canadian EV sales through to 2024.

Year 2024	Canada		BC		Lower Mainland	
	Low	High	Low	High	Low	High
Annual EV sales	**74,000**	**91,000**	12,000	14,500	8,300	10,000
Market Share	3.7%	4.6%	5.4%	6.6%	6.3%	7.8%
Cumulative EV sales	350,000	420,000	56,000	67,000	39,000	47,000
Percent of Fleet	1.8%	2.1%	2.5%	3.1%	3.0%	3.6%

Numbers in bold are directly pulled from Navigant Research's forecast, all other values are derived.

Simon Fraser University

Researchers at SFU's Energy and Materials Research Group (EMRG) have performed a detailed analysis of factors affecting EV sales in BC, including a survey of over 1700 new vehicle owners from BC and elsewhere in Canada, and have incorporated this analysis into an EV sales forecast tool that predicts EV adoption in BC through to 2030[13]. In particular, the researchers found that availability of a diverse range of EV models is crucial in order to ensure significant growth in EV adoption. Fortunately, as will be detailed later in this report, a variety of new EV products are already coming to market in the next few years, and EMRG's more optimistic projection would likely apply. This projection suggests that EV market share of new vehicle purchases will be between 6% and 16% in 2024, and between 20% and 23% by the year 2030:

[12] https://www.navigantresearch.com/wp-assets/brochures/MD-EVGEO-15-Executive-Summary.pdf
[13] Axsen, 2015.

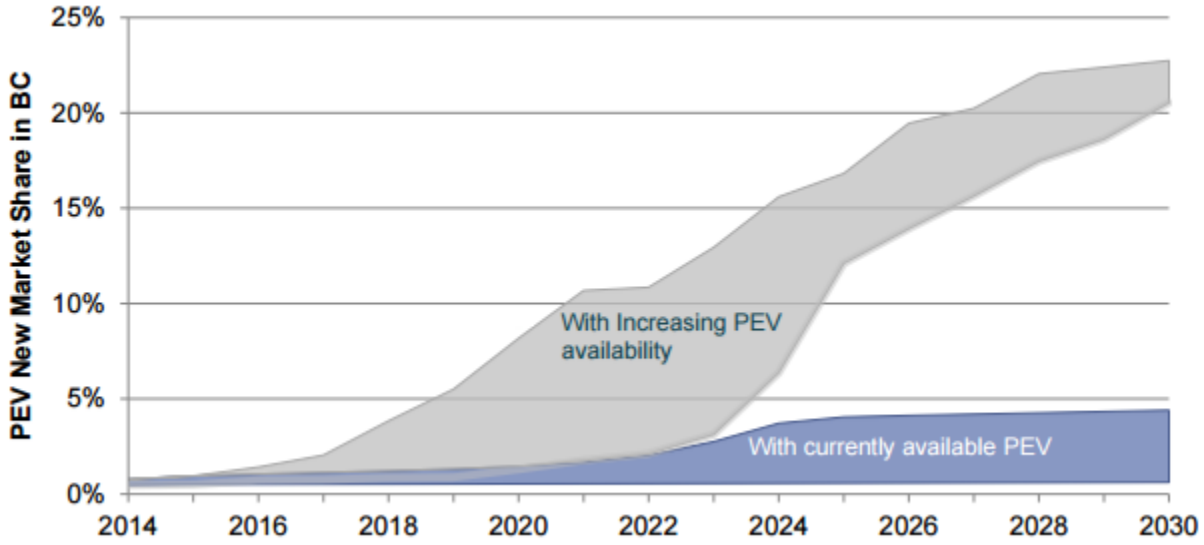


Figure 8: SFU Energy and Materials Research Group's projection for EV adoption in BC[14]

For the purpose of comparison with Navigant's forecasts, values can be taken for the year 2024 and assuming that current market trends continue to increase the availability of new PEV models. In order to map these market share values to an overall fleet size in BC and the Lower Mainland, certain assumptions need to be made regarding year-to-year growth rates and regarding the relative portion of EV sales in the Lower Mainland with respect to the rest of BC. These values are presented in the following table:

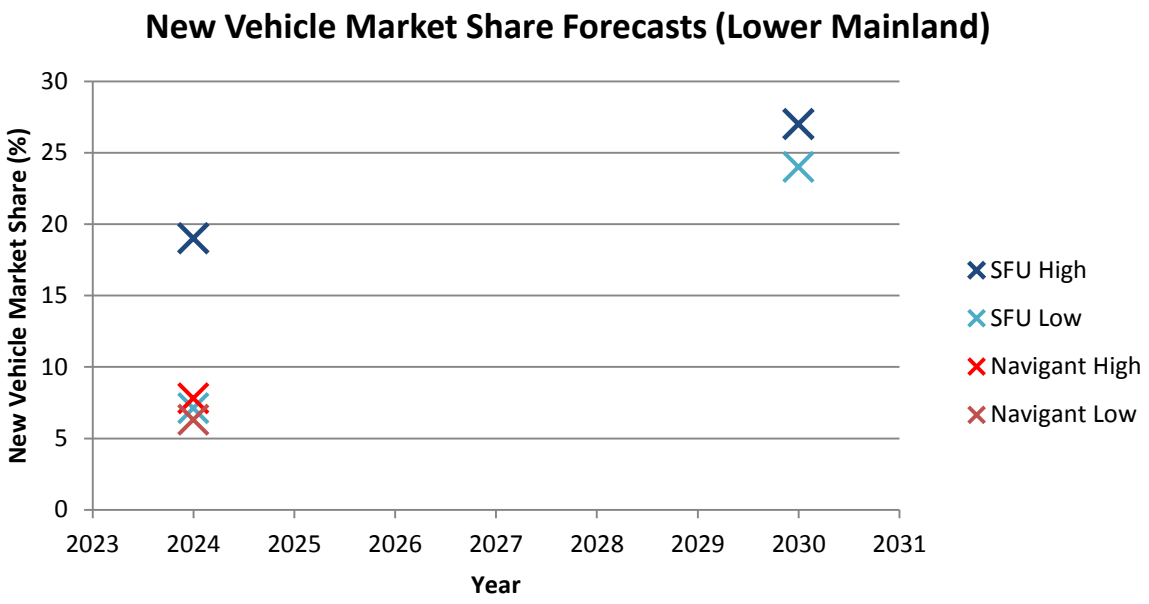
Table 2: BC and Lower Mainland EV sales estimates based on SFU forecast for EV market share in BC.

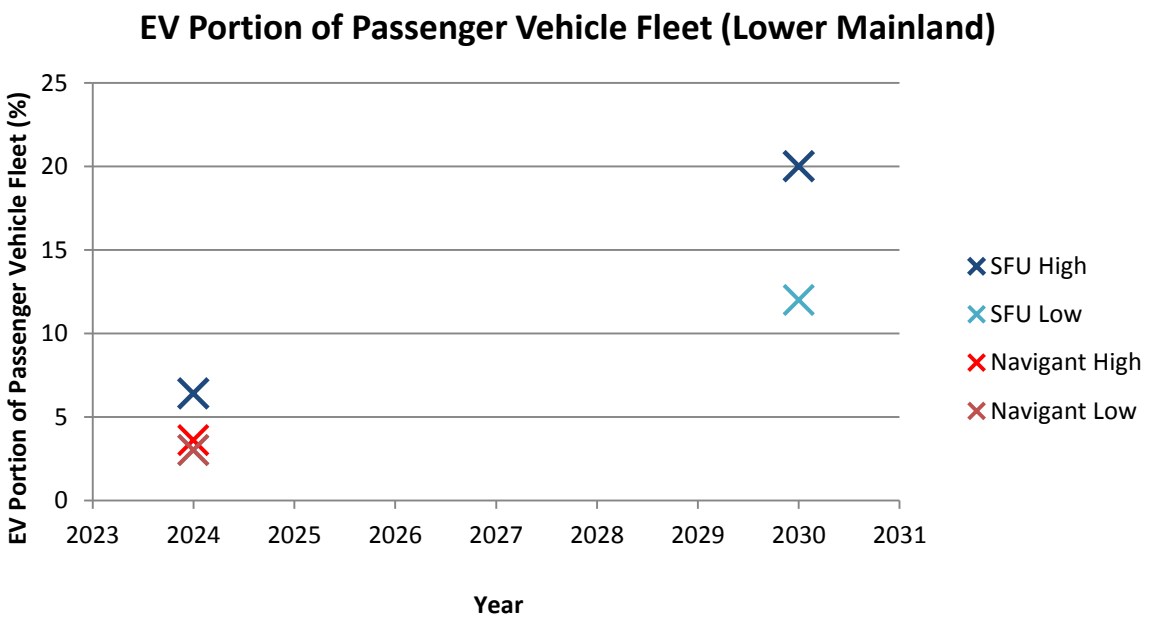
Year		BC		Lower Mainland	
		Low	High	Low	High
2024	Annual EV sales	13,000	35,000	9,300	25,000
	Market Share	**6%**	**16%**	7.1%	19%
	Cumulative EV sales	56,000	120,000	40,000	85,000
	Percent of Fleet	2.6%	5.5%	3.0%	6.4%
2030	Annual EV sales	44,000	50,000	30,000	35,000
	Market Share	**20%**	**23%**	24%	27%
	Cumulative EV sales	224,000	380,000	160,000	270,000
	Percent of Fleet	10%	17%	12%	20%

Numbers in bold are directly pulled from SFU's forecast, all other values are derived.

[14] Axsen, 2015.

The following two figures compare the forecasts of both studies, showing that there is relative agreement between Navigant Research's predictions and the low end of SFU's prediction for 2024. Only SFU's research provided a forecast for the 2030 timeframe.





2.3 Current usage of public EV infrastructure in BC

Beginning in 2013, a large number of public Level 2 and DC Fast Charge stations were installed across BC as part of a number of related initiatives, funded in part by the provincial and federal governments. Under a related initiative, Powertech Labs and FleetCarma developed the evCloud, a web-based platform for collection of usage data from the 4 most popular types of public charging stations in BC. The evCloud has a public facing website intended to support public awareness of EV charging infrastructure (www.fleetcarma.com/evCloud), while also supporting in-depth research into infrastructure usage data by utility, government and academic researchers. This research will help to inform future deployments of EV infrastructure, both at a broad public policy level, and at the level of individual station owners, helping to build an understanding around what kind of business models might exist for private investment in EV infrastructure. Some usage data is available to the public directly from the evCloud website, while summary reports are available to the public through BC Hydro and Natural Resources Canada. This section contains some highlights from this data set.

The evCloud is connected to over 460 charging stations across over 200 locations in BC. Of those stations, at least 250 are installed across 195 locations in the Metro Vancouver region:

Table 3: Usage statistics for charging stations in Metro Vancouver[15]

Metro Vancouver Level 2 Stations	
Number of stations monitored	250
Number of locations monitored	195
Average number of charge events per week:	969 (9.5 per location)
Busiest week:	2073
Average charge connect time:	4h36m
Average charge energy	7.4kWh

The following list shows the top ten busiest Level 2 charging locations in BC with publicly available data, ranked according to most number of charge events per week:

Table 4: Top-ten busiest Level 2 charging stations in BC (with publicly available data), data from Dec. 2015 to May 2016

Location	Venue Type	Overall ranking*	Number of Ports	Charge Events	Energy Dispensed (kWh)	Average Charge†	Charges /Week
Total for All locations			428	51,080	373,181	7.3 kWh, 3hr29min	1,986
Average L2 Location			2	278	2,028	7.3 kWh, 3hr29min	11
Richmond City Hall	Gov't	5	2	1,149	7,981	7.0 kWh, 1hr36min	47
Saanich Commonwealth Place	Leisure	9	2	1,003	6,324	6.3 kWh, 1hr48min	39
Edible Canada	Retail	10	2	994	6,114	6.2 kWh, 1hr39min	39
Lougheed Town Centre	Retail	11	2	974	4,988	5.1 kWh, 1hr14min	38
North Vancouver	Gov't	14	2	888	5,565	6.3 kWh,	35

[15] The region "Metro Vancouver" includes Burnaby, Langley, Maple Ridge, North Vancouver, Pitt Meadows, Tri-Cities, Richmond, Surrey, Delta, Vancouver, West Vancouver, and White Rock

Location	Venue Type	Overall ranking*	Number of Ports	Charge Events	Energy Dispensed (kWh)	Average Charge†	Charges /Week
City Hall						1hr50min	
Pearkes Recreation Centre	Leisure	16	2	857	4,925	5.8 kWh, 1hr34min	33
Metropolis at Metrotown	Retail	18	6	797	5,155	6.5 kWh, 1hr43min	31
Maple Ridge Business Centre**	Business	19	3	734	6,341	8.6 kWh, 9hr20min	29
ArtSpring Parking Lot (Salt Spring)	Leisure	20	2	711	4,380	6.2 kWh, 1hr35min	28
Guildford Towncentre	Retail	21	2	705	3,305	4.7 kWh, 1hr08min	27

* Overall ranking shows how these stations with publicly available data rank against all evCloud stations
** Being a Business Centre, employees may use EV spots for daily parking/charging.
† *Average Charge* refers to the average energy dispensed and the amount of time the vehicle is plugged in

Usage data from DC fast charge stations is of particular importance, as this is often considered "critical" EV infrastructure for enabling longer driving distances, and higher cost of installation and operation place a higher importance on establishing business models to support deployment. The following table provides a summary of the use of DCFC stations that were operational from June 1 to November 30, 2014:

Table 5: Usage of DCFC stations in BC – December 2015 to May 2016 (lifetime stats in parentheses)

Station	Online Since*	Charge Events	Energy Dispensed (kWh)	Fuel Displaced (L)*	Average Charge†	Charges/ Week
Total	n/a	4987 (11,158)	52,046 (109,318)	20,818 (43,727)	10.4 kWh, 26 min	194 (108)
Duncan	*6-Jun-14*	822 (1829)	9721 (19,451)	3889 (7780)	11.8 kWh, 32 min	31 (18)
North Vancouver	*19-Nov-14*	371 (1882)	3387 (16,536)	1355 (6615)	9.1 kWh, 25 min	28 (25)
Surrey	*2-Jun-14*	714 (1642)	9704 (18,992)	3882 (7597)	13.6 kWh, 27 min	27 (16)
Colwood**	*6-Jan-16*	618	4459	1784	7.2 kWh, 22 min	26
Saanich	*22-April-15*	619 (1315)	5356 (11,400)	2142 (4560)	8.7 kWh, 27 min	24 (20)
Abbotsford	*12-May-15*	422 (756)	4966 (8172)	1986 (3269)	11.8 kWh, 27 min	23 (14)
Squamish	*31-Aug-14*	470 (993)	5279 (10,845)	2112 (4338)	11.2 kWh, 31 min	18 (11)
Nanaimo	*4-Jun-14*	257 (655)	2838 (6645)	1135 (2658)	11.0 kWh, 28 min	10 (6)
Sechelt	*12-Feb-15*	240 (619)	1981 (4751)	793 (1900)	8.3 kWh, 22 min	9 (8)
Langley	*21-Jul-15*	175 (245)	1545 (2130)	618 (852)	8.8 kWh, 25 min	7 (5)

Station	Online Since*	Charge Events	Energy Dispensed (kWh)	Fuel Displaced (L)*	Average Charge†	Charges/ Week
Salmon Arm**	*8-Jan-16*	80	710	284	8.9 kWh, 37 min	4
Kamloops	*20-Jun-14*	81 (376)	718 (3431)	287 (1372)	8.9 kWh, 34 min	3 (4)
Hope	*18-Dec-15*	44	563	225	12.8 kWh, 37 min	2
Penticton**	*20-Feb-16*	24	205	82	8.5 kWh, 29 min	2
Merritt	*19-Aug-15*	16 (44)	256 (650)	103 (260)	16.0 kWh, 33 min	1 (1)
Keremeos**	*11-Dec-15*	24	292	117	12.2 kWh, 24 min	1
Whistler**	*25-Feb-16*	6	48	19	8.0 kWh, 26 min	n/a
Boston Bar**	*21-Jan-16*	1	8	3	n/a	n/a
West Kelowna**	*27-May-16*	3	8.8	4	n/a	n/a
Revelstoke	*24-Aug-15*	8	88	35	11.0 kWh, 30 min	n/a

*Fuel equivalency assumes 1kWh provides similar driving range as 0.4L of gasoline. "Online Since" date based on first communications with evCloud; some DCFC stations were operational before they came "online".
**Stations shown in grey were not in operation for the full duration of the reporting period.
† *Average Charge* refers to the average energy dispensed and the amount of time the vehicle is plugged in

The following figure is a snapshot of usage during the month of May 2015, showing how utilization varies considerably from one location to the next. One conclusion that can be drawn from this map is that DCFC stations located close to urban areas have so far been used much more regularly than stations along corridors that may facilitate longer trips. Utilization of stations may be impacted by the fact that the majority of stations are free-of-charge, although the station in Victoria is still the 3rd most heavily used station, despite requiring a usage fee to access the station.

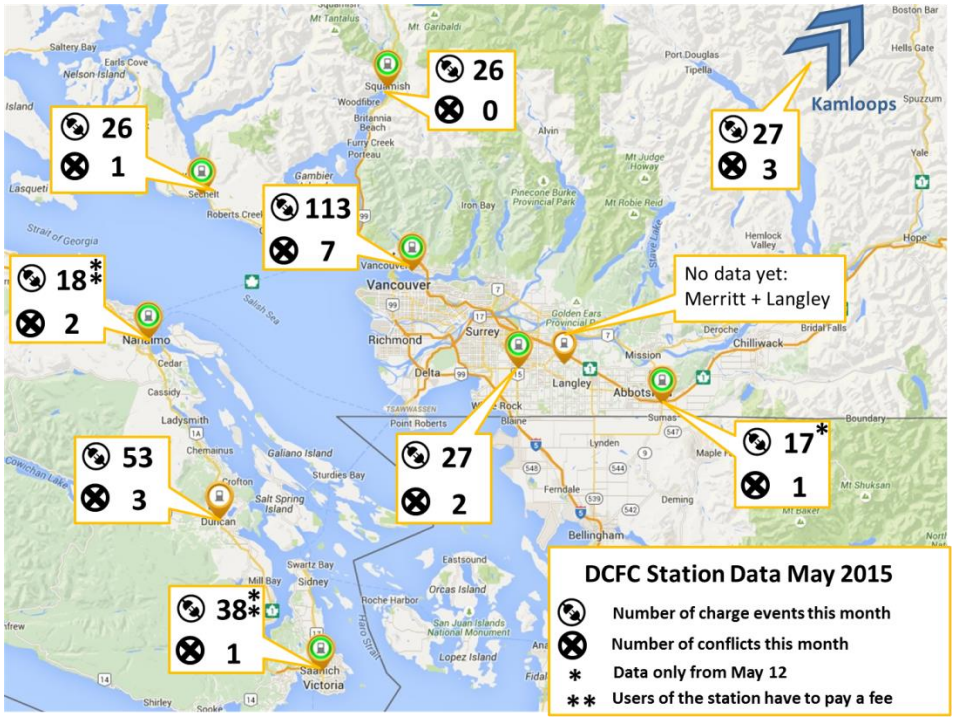


Figure 9: Usage of DCFC stations during May 2015, "conflicts" representing signs of queuing

In the previous figure, a "conflict" is defined as any two charge events at a given DCFC station that are separated by less than 5 minutes, indicating that an EV driver may have had to wait in line before accessing the station. This metric provides an additional means of identifying congestion at stations, beyond simply the overall number of usage sessions. This distinction is important for stations that may see concentrated usage on particular days, but lower utilization over all. Congestion at stations will be an important consideration for future expansions of the DCFC network, and will likely drive a requirement for DCFC stations to support multiple vehicles charging at once. The following graph highlights that the number of conflicts is accelerating considerably as overall utilization of the DCFC stations increases:

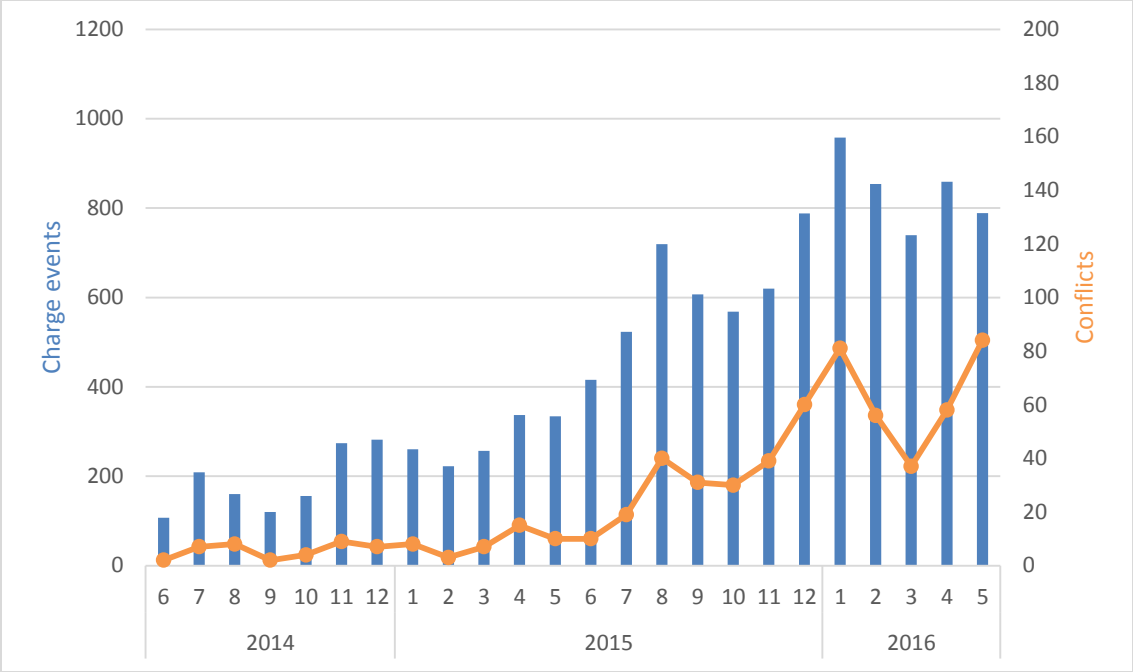


Figure 10: Usage data for DCFC sites in BC - congestion is increasing rapidly

Figure 11: Visual evidence of congestion at the Bakerview Ecodairy DCFC in Abbotsford

3 THE VEHICLES

3.1 Types of Vehicles

Since the late 1990's, a number of different types of "electrified" vehicles have come to market with varying levels of ability to move using electric power. The following are a few definitions to help clarify the distinction between these types of vehicles:

- **Hybrid Electric Vehicle (HEV):** A vehicle with both internal combustion and electric powertrains, but that cannot be charged from the grid and requires refueling using gasoline or other fuel.
    - **Examples:** Toyota Prius, Toyota Camry Hybrid, Ford C-Max

- **Battery Electric Vehicle (BEV):** A vehicle that is solely powered by an electric powertrain recharged from the electric grid. Also sometimes called "Pure EV" or "100% Electric".
    - **Examples:** Nissan Leaf, Tesla Model S, BMW i3

- **Plug-in Hybrid Electric Vehicle (PHEV):** A Hybrid Electric Vehicle that can be recharged from the electric grid, typically with the ability to travel significant distances without burning fuel, but with a combustion powertrain that can enable longer distances and faster acceleration.
    - **Examples**: Toyota Prius PHV, Ford C-Max Energi

- **Extended-Range Electric Vehicle (E-REV):** A type of PHEV that functions as a fully-performing BEV until the battery is depleted, at which point an internal combustion "range extender" (REx) or other auxiliary power unit (APU) is used to power the vehicle to enable longer distances. E-REVs typically have larger battery packs than PHEVs.
    - **Examples:** Chevrolet Volt, BMW i3 REx

- **Fuel Cell Electric Vehicle (FCEV):** A vehicle with an electric powertrain which may include a battery but primarily relies on a hydrogen fuel cell for power, and which can only be refueled with hydrogen[16].
    - **Examples:** Toyota Mirai, Hyundai Tucson FCEV

[16] The concept of a plug-in hybrid fuel cell electric vehicle, fueled by both hydrogen and electricity, has been shown by a number of automakers, and Mercedes is expected to launch such a vehicle with the GLC F-Cell in 2017: http://www.greencarreports.com/news/1104440_mercedes-benz-glc-to-offer-worlds-first-plug-in-fuel-cell-powertrain

This report will use the general term Electric Vehicle (EV) to include any vehicle that can be plugged in: Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Extended-Range EVs. In some technical contexts, the term Plug-in Electric Vehicle (PEV) is used instead, leaving "EV" to refer specifically to a BEV, but a more conversational language will use EV in the broader sense to denote any vehicle that can be charged up from the grid. The following diagram depicts the categorization of the above electrified vehicle types, with electric vehicles highlighted in red:

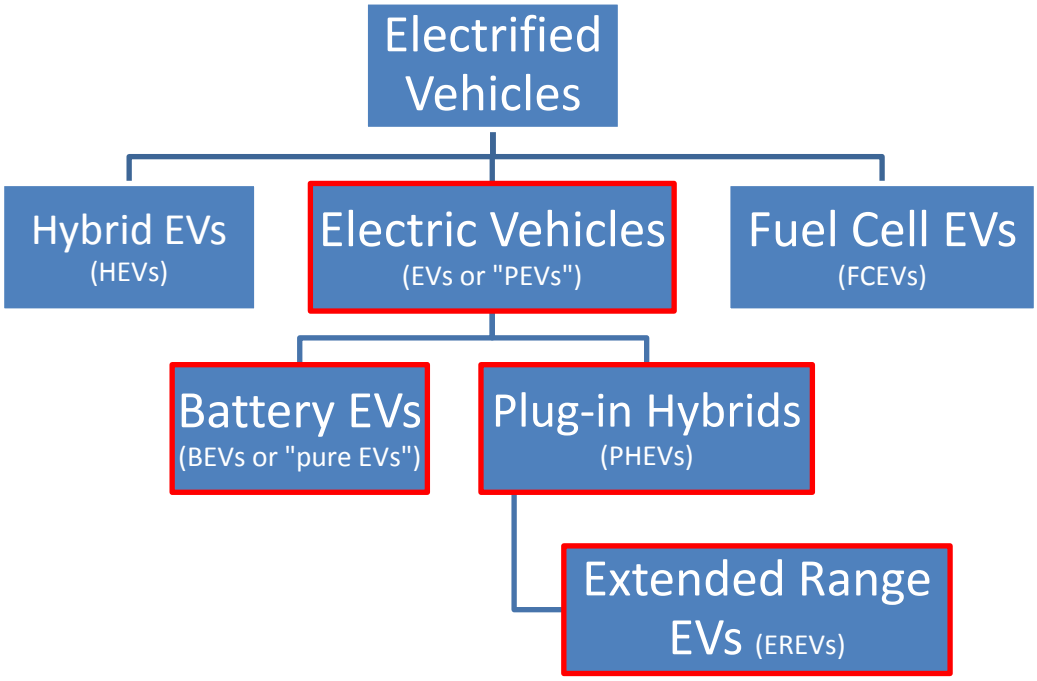


Figure 12 - Categorization of electrified vehicles; "plug-in" electric vehicles are highlighted in red.

While charging infrastructure may be less crucial to the operation of a PHEV (which has the ability to run on fuel once the battery is depleted), studies have shown that PHEV drivers may recharge more frequently, thereby achieving a comparable overall amount of electric driving as some BEV models.[17] In fact, public charging may have a greater impact on overall PHEV energy use, in that charging at a destination can often extend EV-mode range to cover an entire return trip, whereas BEVs can sometimes make a return trip without an actual need for charging at a destination. For this reason, it is recommended that charging infrastructure planning take into account all types of EVs in order to support greater overall EV adoption and maximize environmental benefits.

[17] http://avt.inel.gov/pdf/EVProj/eVMTMay2014.pdf

3.2 Currently Available EVs in North America

The following is a table of some of the most significant EV models available today, based on overall sales and availability. (See section 2.1 for overall sales numbers of these models in North America).

Table 6: Summary of significant EV models currently available in North America

Model	Vehicle Type	Electric Range (EPA certified)	Battery Capacity	Max AC Charging Rate	DC Charging Standard Supported	Max DC Charging Rate
Nissan Leaf	BEV	135-172km	24-30kWh	6.6kW	CHAdeMO	50kW
Chevrolet Volt (2016)	EREV (PHEV)	85km	18.4kWh	3.6kW	-	-
Tesla Model S	BEV	351-507km	60-100kWh	19.2kW	Tesla SuperCharger, CHAdeMO (via adaptor)	135kW (Supercharger) 50kW (CHAdeMO)
Tesla Model X	BEV	381-465km	75-100kWh	19.2kW	Tesla Supercharger, CHAdeMO (w/ adaptor)	120kW, 50kW CHAdeMO
Toyota Prius Plug-in	PHEV	18km (blended – gas assist)	4.4kWh	3.3kW	-	-
BMW i3	BEV or EREV	130km	18.8kWh	7.4kW	CCS	50kW
Smart ED	BEV	109km	17kWh	3.3kW	-	-
Ford C-Max/Fusion Energi	PHEV	32km	7.6kWh	3.3kW	-	-
Chevrolet Spark EV	BEV	132km	21.3kWh	3.3kW	CCS	50kW
Kia Soul EV	BEV	150km	27kWh	6.6kW	CHAdeMO	100kW
Mitsubishi iMIEV	BEV	100km	16kWh	3.3kW	CHAdeMO	44kW
Ford Focus Electric	BEV	122km	23kWh	6.6kW	-	-
Volkswagen eGolf*	BEV	134km	26.5kWh	6.6kW	CCS	50kW

*Products not currently available in Canada

3.3 Upcoming Products

Looking at upcoming models that have been announced by a number of automakers, four important trends stand out:

1. **Affordable long range BEVs**: While Tesla's Model S has shown that pure electric vehicles can be made with a driving range that is comparable to a conventionally fueled vehicle, its purchase price puts it out of reach of the majority of buyers. A number of automakers, however, are confirmed to be developing relatively affordable BEVs with a range of between 240km and 320km. The following are a few models with expected specifications, pricing and availability:

   a. **Chevrolet Bolt**
      - Compact hatchback
      - 383km Range
      - US$ 37,500
      - Available in late 2016

   b. **Tesla Model 3**
      - Midsize sedan
      - 345km range
      - US$35,000
      - Available in 2018

   c. **Nissan Leaf** (2nd generation)
      - Midsize hatchback
      - 240km range
      - US$30,000
      - Available in 2017

Figure 13: 2017 Chevrolet Bolt

   Increased range will make pure EVs more appealing for long trips, while also putting greater burden on charging infrastructure due to larger batteries. The "30 minutes to 80%" fast charge times often quoted for current products using typical 50kW DC Fast Charge stations will increase, unless charging stations increase in power to match these new products. Likewise, Level 2 AC charging will likely increase in power level, up to a possible maximum of 19.2kW, with 10kW being a more achievable target within reach of typical household electrical panels. Existing Level 2 infrastructure cannot typically deliver these higher power levels and would need to be replaced if higher power charging is desired.

2. **Even *more* affordable medium range BEVs:** While the above-mentioned "200-mile" EVs have attracted considerable media attention, 2016 saw the launch and/or announcement of a number of BEVs that serve to fill the gap between these "200-milers" and the first generation affordable BEVs that offered approximately 120-140km of range. In a number of cases, these are revised versions of existing BEVs that have been updated with a higher capacity battery, including the 2016 Nissan Leaf, the 2017 BMW i3, the 2017 Ford Focus Electric, and the 2017 or 2018 VW eGolf, all having batteries of between 30-36kWh and ranges of between 172-200km. If priced competitively relative to the longer range options, these models may find a market with two-car households, where the BEV is only required for daily commuting and not normally used for longer distance trips.

3. **Plug-in SUVs, Crossovers and Minivans:** While the Mitsubishi Outlander PHEV SUV has recently been one of the best-selling plug-in vehicles in Europe, the SUV-friendly North American market has been oddly starved of plug-in SUVs, crossovers and minivans so far. This began to change in late 2015, with the arrival of a number of PHEV models, largely at the more luxurious end of the market. The following are all plug-in hybrid mid-size SUVs, the majority of them with around 20-30km of EV range, although the Mitsubishi Outlander currently available in Europe offers an EV range of over 40km:

Figure 14: BMW X5 xDrive40e

   a. **Porsche Cayenne S E-Hydrid** (available now)
   b. **BMW X5 xDrive40e** (available now)
   c. **Mercedes GLE 550 e** (available now)
   d. **Audi Q7 e-Tron** (available late 2016)
   e. **Volvo XC90 T8** (available now)
   f. **Mitsubishi Outlander** (available early 2017)

   Pure electric SUVs are also starting to hit the road, with the **Tesla Model X** having launched in late 2015. The Model X has specifications similar to the Model S but with seating for 7, higher ground clearance, and standard all-wheel-drive. Audi and most recently BMW have since both announced tentative plans to develop similar all-electric SUVs or crossover vehicles in the 2018 to 2020 timeframe. Finally, the Chrysler Pacifica Hybrid will launch in late 2016 with 48km of electric range, becoming the first plug-in minivan, the first plug-in model from Chrysler, and also the first potentially large-volume plug-in vehicle assembled in Canada.

Figure 15: Chrysler Pacifica Hybrid

4. **Multiplication of PHEVs:** A number of automakers, particularly high-end German makes such as Mercedes, BMW and Audi, have announced that they will produce PHEV versions of the majority of their vehicle lineup. Most of these PHEVs have a modestly-sized battery, providing an electric range of around 20-30km, most will support Level 2 charging at 3.3kW, and most are not expected to support DC fast charging. Toyota will also be launching its next generation plug-in Prius in late 2016, the Prius Prime, now with a more competitive electric range of 40km, although seating has been reduced to four.

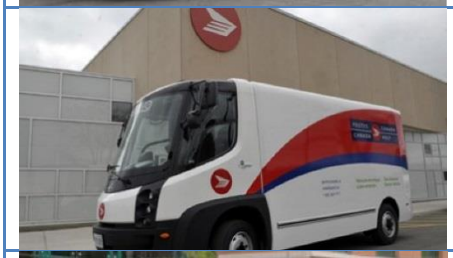
   a. **Hyundai Sonata PHEV**
   b. **Toyota Prius Prime**
   c. **Various BMW sedans (eg 3-series, 7-series, 5-series)**
   d. **Various Mercedes sedans (S-Class, C-Class)**
   e. **Various Audi hatchbacks and sedans (A3 e-Tron, A6 e-Tron)**

Table 7: Summary of upcoming EV models with expected specifications

Model (availability)	Vehicle Type	Electric Range	Battery Capacity	Max AC Charging Rate	DC Charging Standard Supported	Max DC Charging Rate
Chevrolet Bolt (2016)	BEV	383km	60kWh	10kW	CCS	75kW+
Tesla Model 3 (2018)	BEV	320km	60kWh	20kW	Tesla Supercharger, CHAdeMO w/ adaptor (expected)	120kW, 50kW CHAdeMO
Nissan Leaf (2017/2018)	BEV	240km	48kWh	10kW	CHAdeMO	75kW+
Ford Focus Electric (2016)	BEV	160km	30kWh (estimated)	6.6kW	CCS	50kW
BMW i3 (2016)	BEV,EREV optional	183km	33kWh	7.2kW	CCS	50kW
VW eGolf (2017)	BEV	200km	36kWh	7.2kW	CCS	50kW
Hyundai IONIQ (2016)	BEV	180km	28kWh	7.2kW	CCS	100kW
Mitsubishi Outlander (2017)	PHEV	40km	12kWh	3.3kW	CHAdeMO	50kW
Chrysler Pacifica Hybrid	PHEV	48km	16kWh	6.6kW	-	-
Hyundai Sonata (2016)	PHEV	30-40km	10kWh	3.3kW	-	-
Toyota Prius Prime (2016)	PHEV	40km	8.8kWh	3.3kW	-	-
Porsche Cayenne BMW X5 Mercedes GLE Audi Q7 Volvo XC90 (all 2016)	PHEV	20-30km	8-10kWh	3.3kW	-	-
Various Luxury sedans (2016-2017)	PHEV	20-30km	6-10kWh	3.3kW	-	-

3.4 Commercial Vehicles

While the vehicles discussed in the previous sections are primarily passenger vehicles, a large number and variety of commercial plug-in vehicles have entered the market in recent years, including delivery vans, utility trucks, and transit buses. The following table provides a quick summary of some of the commercial EVs that are currently available in North America (some with only limited availability of pre-production vehicles as of this writing):

Commercial EVs		Vehicle Type
	Smith Electric Delivery Truck (Previously in use by Novex) Range: [65 – 160 km] Payload Capacity: [725 – 7,400 kg]	BEV
	Nissan e-NV200 Van (available in Europe, limited availability in North America) Range: 170 km Payload Capacity: 703 kg	BEV
	Navistar eStar (in use by Canada Post) Range: 160 km Price: US$150,000 Battery swap available	BEV
	EVI Step-Van (in use by UPS in California) Range: 145 km Capacity: [662 – 970ft^3]	BEV
	VIA Motors V-Trux (in limited use by select utility fleets) Range: 64 km (electric) Payload Capacity: 1,000 lb	PHEV
	VIA Motors Shuttle Van (limited availability) Range: 55 km (electric) Payload Capacity: 2,000 lb	PHEV

Commercial EVs		Vehicle Type
	Odyne Bucket Truck (in use by City of Vancouver) Engine-off bucket operation Battery: [14 – 28 kWh]	PHEV
	Proterra Catalyst (In use by several US transit agencies) Battery: [79 – 660 kWh] Range: [79 – 563 km] Fast overhead charging	BEV
	NovaBus (limited trial by the Société de transport de Montréal) Fast overhead charging	BEV
	New Flyer (under test by Winnipeg Transit) Battery: [100 – 300 kWh] Fast overhead charging	BEV
	BYD K9 (In use by several US transit agencies) Range: [250 - 299 km] Price: [S$395,000 – S$592,600]	BEV
	BYD T7 (Class-6 Truck) Range: 200 km Battery: 175 kWh	BEV

Commercial EVs		Vehicle Type
	BYD Q1M (Class-8 Terminal Tractor) Range: 15 hours Battery: 209 kWh Max Torque: 1106 lbs-ft	BEV

3.5 Other Vehicles

3.5.1 E-bikes and Scooters

E-Bikes and E-scooters are road-legal, two-wheeled vehicles. To be classified as an E-Bike, a vehicle must have pedals for human propulsion, have a less-than 500W motor and be speed-limited to 32km/h; they do not require a licence or registration. The battery is usually small (less than 1 kWh), so it can often be removed and hand-carried to be charged on any outlet. Electric scooters are limited to 1.5kW and are subject to the same restrictions as scooters with a less-than 50cc gasoline motor. Their battery packs are between 1 and 2 kWh.

Typically, both E-bikes and scooters charge from a standard 120V/15A outlet, located in almost every building in the country. Charging using a standard J1772 EV charging station is typically not supported, unless the charging station is also equipped with a 120V/15A outlet, as in some earlier models from ChargePoint.

3.5.2 Motorcycles

The two major manufacturers of electric motorcycles are Lightning and Zero. Battery packs range from 5 kWh to 20 kWh providing range from 70 km to 300 km depending on driving style and conditions.

Figure 16: Lightning LS-218 electric motorcycle

Electric motorcycles typically charge using a J1772 connector, allowing them to use a standard Level 1 or Level 2 EV charging station. The onboard charger delivers around 1.3 kW which equates to 20 km of range per hour. Some models may not have a J1772 connector, requiring a 120V/15A outlet, as with most E-bikes and E-scooters.

Fast charging options are available on the Lightning motorcycle, and it is expected that future motorcycles will come standard with DC Fast charging technology,(CCS or CHAdeMO) reducing the charging time to 15 minutes.

3.5.3 Small Utility Vehicles

Small Utility Vehicles are available from companies such as Polaris and John Deere. They are classed as Low-Speed Vehicles and are limited to 40 km/h, but are allowed to drive on most roads posted at 60 km/h or less. Low-Speed Vehicles must have an electric drivetrain under Transport Canada regulations. Most of these vehicles use lead-acid batteries for their low cost and ease of replacement; however, as lithium-ion technology becomes cheaper and more commonplace, lead-acid will be phased out.

The Polaris GEM comes with a standard lead-acid battery or an optional lithium-ion battery to reduce weight and increase range. Chargers can be level 1 or level 2 and can deliver up to 6 kW of power using the J1772 standard. The GEM is available in a variety of configurations for passengers (from two to six seats) and cargo (eg covered boxes or open pickup bed) with pricing ranging between approximately $10,000 and $20,000 USD. Polaris also offers an all-terrain vehicle with the lead-acid batteries.

Figure 17: Polaris GEM eL XD

Figure 18: John Deere Gator TE

The John Deere Gator TE is powered by lead-acid batteries and does not offer a lithium-ion option yet. Charging is carried out at around 1.5kW and uses a standard outlet. Top speed is 25 km/h. The Gator TE currently retails for $15,703 CAD, representing about a $6000 premium over a comparable gas-powered model.

The Might-E Truck is made by Canadian Electric Vehicles Ltd (CanEV), located on Vancouver Island. It has a top speed of 40 km/hour and it is powered by a 16 kWh lead-acid battery. The load capacity is between 300 and 500 lbs on road with a 1000 lb configuration off road. It is charged by a 72V/12A charger, delivering 864 W. CanEV also has experience converting over 60 aircraft refueling trucks from fossil-fuel to electric power. Pricing for the Might-E Truck was not immediately available.

Figure 19: CanEV Might-E Truck

3.6 Battery degradation

One concern that is often raised about electrified powertrains is the durability of batteries. Based on experience with consumer electronics and possibly older technologies such as lead-acid batteries, one might expect that an electric vehicle would need frequent and expensive battery replacements. Older battery chemistries also required users to follow certain usage practices, such as avoiding partial charge and discharge cycles due to the so-called “memory effect”. Modern EVs, however, all use lithium-ion batteries that are relatively robust and flexible. Most EVs come with an eight- to ten-year battery warranty, and automakers do not impose any strict requirements on charging patterns. That said, some battery degradation over time is expected, and some automakers only guarantee that the battery will retain 75% to 80% of its original capacity by the end of the coverage period.

Factors affecting battery degradation include calendar age, number of charge/discharge cycle, state-of-charge during storage (degradation is worst when the battery is full), and temperature (high temperatures degrade batteries faster). Regular usage of fast charging stations is generally discouraged by automakers, although a study

conducted by Idaho National Laboratory found that fast charging had less of an impact on battery life than expected, and that high temperatures and overall distance travelled (and hence battery usage cycles) were stronger factors[18].

While the oldest samples of the current generation of EVs have only been on the road for about six years, early reports suggest that battery degradation varies from one automaker to the next, likely due to differences in battery and vehicle design. The Nissan Leaf does not employ an active cooling system for its battery. Some reports suggested that this left the Leaf vulnerable to excessive battery degradation in extreme climates, and Nissan has since responded by introducing a modified battery chemistry that is more resilient to hot temperatures.[19] The Chevrolet Volt, meanwhile, does include an active cooling system for its battery, and GM has suggested this has allowed them to avoid any warranty battery replacements due to capacity loss[20].

A survey conducted by Plug-in America collected the odometer and battery capacity of over 500 Tesla Model S vehicles to estimate battery degradation[21]. Generally, the battery packs were found to lose about 5% of their capacity in the first 80,000 km after which the degradation slows; owners of vehicles with over 160,000 km have reported less than 8% degradation.

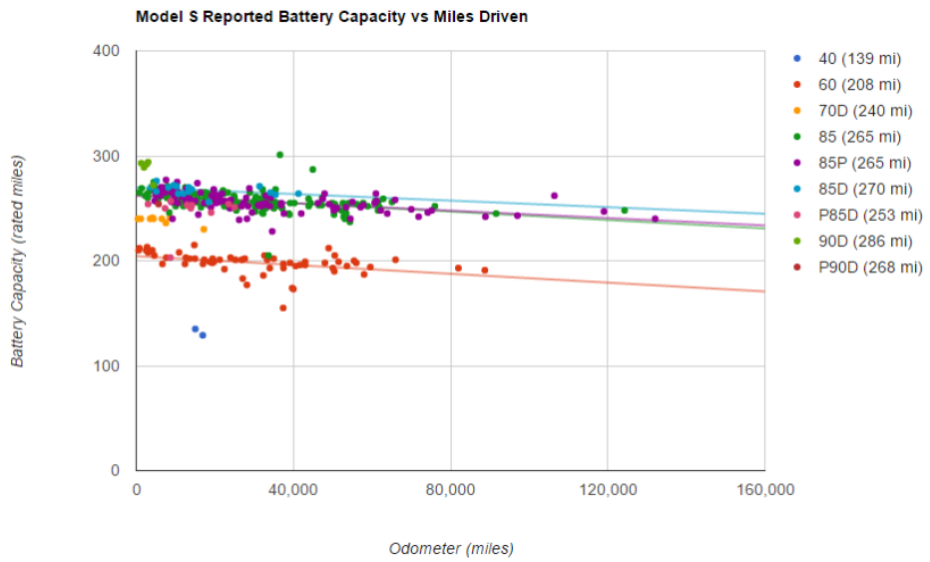


Figure 20: Model S battery capacity vs odometer readings – pluginamerica.org

[18] https://avt.inl.gov/sites/default/files/pdf/vehiclebatteries/FastChargeEffects.pdf

[19] http://www.greencarreports.com/news/1092983_nissan-leaf-battery-cost-5500-for-replacement-with-heat-resistant-chemistry

[20] http://insideevs.com/zero-first-generation-chevrolet-volt-battery-packs-replaced-due-general-capacity-degradation/

[21] http://survey.pluginamerica.org/model-s/charts.php

4 CHARGING INFRASTRUCTURE

An electric battery is a direct current (DC) device – there is a positive and a negative terminal, and they do not alternate! Charging an electric vehicle's battery therefore requires DC electrical power, whereas electricity is typically distributed in alternating current (eg 120V AC or 240V AC). This means that at some point, electricity must be converted from AC to DC. Whether this conversion happens onboard the vehicle or within a charging station is an important distinction for charging infrastructure.

The most common way to charge an EV is through AC charging. In this configuration, AC power from the grid is provided to the vehicle through the charge port, and an onboard component (the charger) converts this AC power to DC in order to charge the battery. This configuration allows the vehicle to charge in a broader range of places, as most of the specialized equipment is carried onboard the vehicle, and the stationary charging station can be quite simple. That said, the power of an onboard charger is more limited in order to avoid adding excessive cost and weight to the vehicle.

In the case of DC charging, the charging station itself performs the AC-to-DC conversion, and DC power is provided to the vehicle's charge port, bypassing the onboard charger and going directly into the vehicle's battery. With the DC charger off-board of the vehicle, it can be significantly larger and more powerful, and the higher cost of this equipment can effectively be shared across many users. On the other hand, this charging station is significantly more complicated and expensive than an AC charging station, adding to the cost of infrastructure deployment.

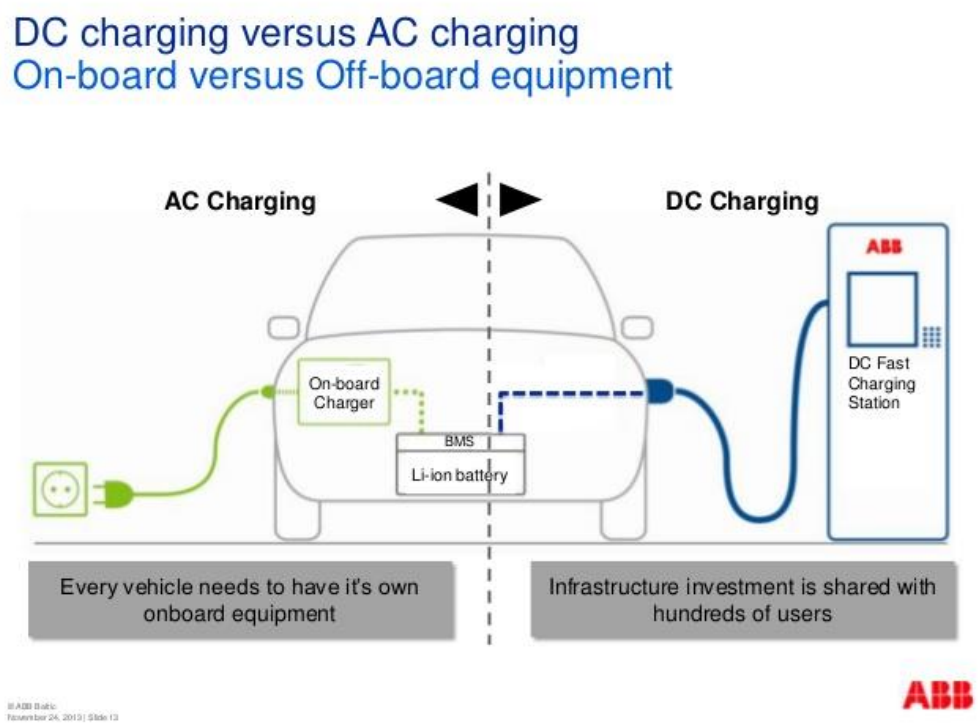


Figure 21: Diagram showing the difference between AC and DC charging - Source: www.abb.com

The following sections provide details on AC and DC charging, as well as two potential alternative means of replenishing an electric vehicle: wireless charging and battery swapping.

4.1 AC Charging

Since AC charging involves providing AC power to a vehicle's charge port, one might assume that all that is required is a simple extension cord plugged into a household outlet. This is close to true, but not quite. All passenger EVs sold in North America comply with the SAE J1772 standard which defines a standard connector and communications protocol for AC charging of electric vehicles. The J1772 standard ensures that a vehicle is aware of the limitations of the circuit it is connected to, ensures that power is only applied when the vehicle is actively requesting power (preventing bad connections, arcing and potential fire risks), and prevents the vehicle from being driven while a charging cable is still attached.

A J1772-compliant charging station or EV Supply Equipment (EVSE) essentially acts as an extension cord with these safety features built-in. An EVSE may either be a fixed piece of equipment, or a portable cordset that is kept with the vehicle in order to plug into existing outlets.

Charging Level	Specification	Charging Time	Application
AC Level 1	120V, 8-16A, 12A typical	PHEV: 8-12 hours BEV: 16+ hours	Suitable for PHEVs with smaller batteries. May be suitable for BEVs for overnight, workplace or long term parking.
AC Level 2	240V, 6-80A, 30A typical	PHEV: 2-4 hours BEV: 4-8 hours	Most common type of public charging.
AC Level 3 (in development)	3-phase AC	Large BEV: 2-8 hours	Standard in progress (SAE J3068) – intended to support large commercial vehicles.

4.1.1 AC Level 1

AC Level 1 charging is the slowest form of charging, although it is quite versatile due to the ubiquity of 120V outlets. Many PHEV owners and some BEV owners get by with only Level 1 charging at home. Four hours of charging at Level 1 can provide approximately 30km worth of range, depending on the vehicle and driving conditions. This may be sufficient to support daily driving with overnight charging or while charging at work. Supporting long distance travel on Level 1 becomes more problematic: at approximately 1.5kW, a full charge for a Nissan Leaf (24kWh battery) would take approximately 16 hours. A full charge for a Tesla Model S85 (85kWh battery) would take approximately 56 hours.

Charging Level	Panel Requirements	Charging time required to replenish 30km of range (~6kWh)	Charging time required to replenish 120km of range (~24kWh)
AC Level 1 (1.4kW)	120V, 15A	4h	16h

When discussing Level 1 charging infrastructure, it is important to consider the distinction between a simple 120V outlet, and a fixed Level 1 EVSE. While a 120V outlet is sufficient to provide power to an EV, the driver will be required to supply their own portable EVSE and leave this connected to the outlet. This can be less convenient to an EV driver – it can take a minute or two to unpack and connect a portable EVSE, and packing it up afterwards also takes time and can get messy depending on weather. This arrangement can also be less secure in that the EVSE may be easily stolen. This concern can be addressed either with a locking mechanism on the outlet, or by a charge port on the vehicle that may come equipped with a locking mechanism.

A level 1 EVSE addresses these concerns by fixing the equipment to the facility and allowing EV drivers to leave their portable EVSE in the trunk. This convenience may be appreciated in regular parking scenarios such as

workplace charging facilities where an EV driver might charge every day. EV drivers using long term parking facilities may be more willing to deal with these inconveniences as it is not likely to be as frequent a scenario.

AC Level 1: 120V outlet + driver-supplied EVSE

Advantage:

- Lowest cost

Disadvantages:

- Time it takes to unpack and pack up EVSE
- Mess of EVSE left on ground in bad weather
- Security – portable EVSE may be easily stolen if not otherwise locked

Applications:

- Long term parking facilities
- Locations where other infrastructure is unavailable

Figure 22: 120V Outlet + user supplied EVSE

AC Level 1: Fixed Level 1 EVSE

Advantages:

- Convenient for EV driver
- Security – EVSE is fixed in place
- Ability to implement access control and data collection

Disadvantage:

- Additional cost: $400-$1500 per port

Applications:

- Vehicles with light duty-cycle
- Long term parking facilities

Figure 23: Telefonix L1 PowerPost ($1500) and ClipperCreek ACS-20 ($400)

4.1.2 AC Level 2

Level 2 charging stations are the most common type of public charging infrastructure in North America, with over 35,000 Level 2 charging ports active as of August 2016[22]. The charging rate is typically more than doubled as compared to Level 1 charging, thanks to a higher voltage (240V vs 120V) as well as typically higher amperage circuits (40A being the most common, vs 15A circuits for Level 1). The J1772 standard supports Level 2 charging at rates between 1.4kW and 19.2kW. The actual charging rate will depend on the minimum of either the EVs maximum charging rate or the EVSE's available power. Most PHEVs and some BEVs are only capable of charging at 3.3-3.6kW due to the limitation of the onboard charger. Many BEVs now support Level 2 charging at 6.6-7.2kW (eg Nissan Leaf, Ford Focus EV, Volkswagen e-Golf). The Tesla Model S can draw up to the maximum 19.2kW allowed by the J1772 standard, provided the EVSE and electrical panel have sufficient capacity.

Charging Level	Panel Requirements	Vehicles Supported	Charging time required to replenish 30km of range (~6kWh)	Charging time required to replenish 120km of range (~24kWh)
AC Level 2 (3.3-3.6kW)	240V, 16A	All EVs	2h	8h
AC Level 2 (6.6-7.2kW)	240V, 40A	Most new BEVs	1h	4h
AC Level 2 (19.2kW)	240V, 100A	Tesla Model S	<0.5h	<1.5h

Figure 24: Some common Level 2 charging stations

4.1.3 AC Level 3 (in development)

AC Level 3 is a new category of charging that is in development as part of the SAE J3068 standard. It is intended to support larger plug-in vehicles such as electric buses and trucks; vehicles which would likely charge in commercial/industrial settings with access to high amperage 3-phase AC power. The standard is still under development but expected output power is 66 kW (480V/80A) with a connector similar to the Mennekes Type 2 plug, which is common in Europe instead of SAE J1772.

Figure 25: European "Mennekes" Type 2 connector

An advantage of this charging configuration is a symmetric three phase load, which helps preserve grid stability. Higher power levels could be possible as it uses a similar connector to the European Tesla Superchargers which deliver up to 140 kW DC.

[22] http://www.afdc.energy.gov/fuels/electricity_locations.html

4.2 DC Fast Charging

DC Fast Charging enables EVs to charge much more quickly, opening the door to longer distance trips and higher overall utilization of EVs. DC Fast Charging connects the charging station directly to the vehicle's battery terminals, therefore requiring a separate connection to the vehicle than that used for AC charging (unless wiring on the vehicle is automatically reconfigurable, such as with the Tesla Model S).

DC fast charging used to be referred to as "Level 3" charging, but this nomenclature was revised in 2011 in order to distinguish between the different charging configurations, and to leave the door open for definition of 3 charging levels for both AC and DC charging.

DCFC capabilities are most commonly available with BEVs, with the BMW i3 REx (equipped with range extending engine) standing out as the only PHEV currently available in North America with a DCFC port. Generally speaking, PHEVs have sufficient power from the gasoline portion of the powertrain to support long distance travel without the need for recharging. Studies have shown though that PHEV owners charge their vehicles more frequently than BEV owners[23], leading some to speculate that PHEV drivers may go out of their way to use a fast charge station in order to avoid burning gasoline on longer trips. While not yet available in North America, the Mitsubishi Outlander PHEV includes a CHAdeMO DCFC port in European and Japanese markets, and other automakers have suggested future PHEVs are likely to offer DCFC as an option.

4.2.1 DC Charging Rates

The most common DCFC stations in North America as of 2015 support charging at up to 50kW, and this aligns well with the maximum charging rate supported by the most common BEVs (eg those with ~24kWh of battery capacity, ~120km of range). These vehicles can actually only support this maximum charging rate during the earlier part of a charge event, and the charging rate must be tapered down as the battery approaches a full charge. The following graph shows a charge event that started at approximately 50% state-of-charge (SOC), with the charging rate beginning to reduce after only 5 minutes of charging:

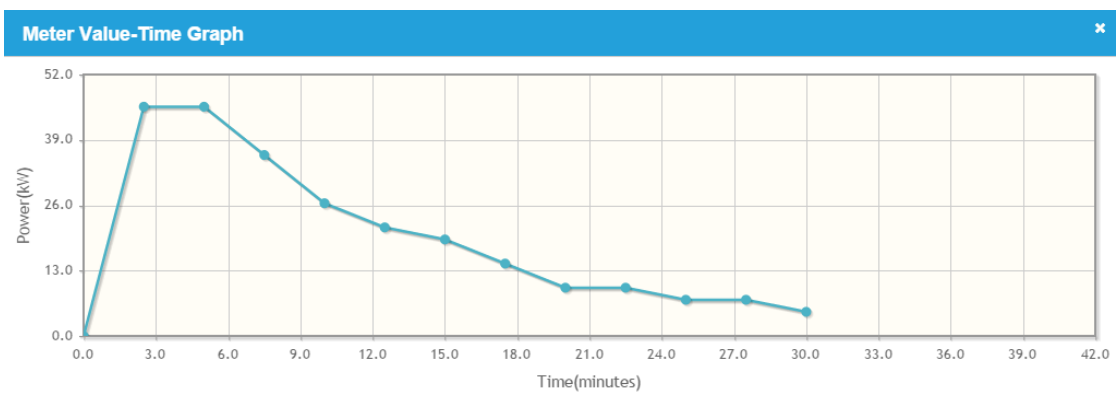


Figure 26: A charge event from a 50kW DCFC station

For this reason, some manufacturers (such as Bosch and Fuji) have launched DCFC products that are limited to 25kW, arguing that overall charging times for the current generation of EVs are not increased significantly, especially when vehicles are plugged in at 30% SOC or higher. Fuji claims that a typical EV charging from 30% SOC to 77% SOC would only require 7 additional minutes to charge using a 25kW station as compared to a 50kW station[24]:

[23] http://avt.inel.gov/pdf/EVProj/eVMTMay2014.pdf
[24] http://www.americas.fujielectric.com/systems/ev-charger/dc-quick-chargers-electric-vehicles-ev

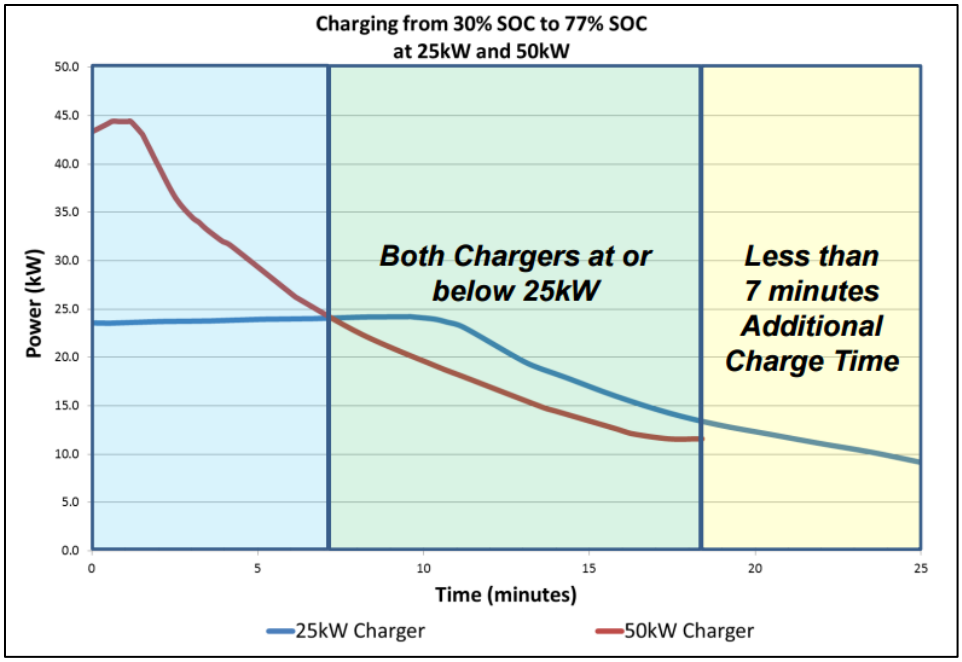


Figure 27: Comparison of 25kW and 50kW DCFC charge curves - www.americas.fujielectric.com

Fuji is also correct to highlight the reduced installation and operation costs of lower power DCFC stations. It is important to consider, however, that future BEV models with significantly longer range will require longer charge times, and will likely support a higher charging rate than the products currently on the market (much like the Tesla Model S can currently support charging at up to 135kW). A BEV with 320km of range would likely take over 2 hours to charge to 80% on a 25kW station, vs about 1 hour on a 50kW station. This next generation of longer-range BEVs has many considering the need to increase DCFC charging rates to 100kW and even higher. The following table shows various power levels considered for DCFC charging:

Table 8: DCFC charging rates

Charging Rate	Charging Time	Notes
25kW	40 mins to 80% (120km range EV)	Lower cost installations, slightly slower overall charge time for current generation of EV (~120km range)
50kW	30 mins to 80% (120km range EV)	Most common DCFC, maximizes charging rate on current generation of EV
100-150kW	30 mins to 80% (200km range EV)	Not yet common, will support future EVs with larger batteries, broader support expected by 2018
135kW (Tesla Supercharger)	40 mins to 80% (Model S)	Proprietary solution
300kW	15 mins to 80% (400km range EV)	In development, expected by 2020

4.2.2 DCFC Standards

While all EVs sold in North America support the J1772 standard for AC charging, there are currently two competing standards for DC charging, as well as a proprietary solution used only by Tesla.

Tokyo Electric Power Company (TEPCO): CHAdeMO

CHAdeMO was the first DC fast charging protocol to be deployed, debuting with the Nissan Leaf and Mitsubishi iMIEV in 2010. It supports charging at up to 60kW, while most EVs currently max-out at 50kW. As of September 2016, there were over 1900 CHAdeMO charging stations in North America and 3500 in Europe.[25]

Figure 28: Nissan Leaf charging ports, left to right: CHAdeMO DCFC, J1772 AC

Society of Automotive Engineers (SAE): Combined Charging System (CCS)

SAE's CCS charging protocol was adopted by all North American and European automakers in 2012. The vehicle charge port has a smaller footprint than the CHAdeMO protocol by reusing the same communications wires as those used by the J1772 AC charging port, thus the name "Combined Charging System". The first CCS DCFC stations appeared in 2013, and as of September 2016, there are now over 600 available in North America[26] and over 2400 in Europe.[27] Note that the European version of CCS is based on the European "Type 2" connector, as opposed to the J1772 connector used in North America. This is in order to support 3-phase AC charging which is more common in Europe, although the communications protocol is shared in either case.

Figure 29: SAE CCS charge couplers, European version on left, North American version (J1772) on right. The associated AC-only charge couplers are shown above each CCS variant for reference.

[25] http://www.chademo.com/
[26] www.plugshare.com
[27] http://insideevs.com/number-of-ccs-combo-chargers-in-europe-exceed-2400/

Tesla Supercharger
Tesla began deploying its own DCFC infrastructure in 2013. Using the same port as for AC charging, the vehicle is required to reroute electricity past the on-board charger in order to charge the battery directly with DC power. Since 2013, Tesla has installed over 400 Supercharger stations worldwide, including 15 in Canada, with an average of about 6 charging stalls per station. These stations support charging rates of up to 135kW.

The Tesla Model S is also able to use CHAdeMO DCFC stations through the use of a Tesla-designed adaptor.

Table 9: Summary of DCFC standards

Standard	Supported Vehicles	Supporting Automakers
CHAdeMO	Nissan Leaf Mitsubishi iMIEV Kia Soul EV Tesla Model S (via adaptor)	Mitsubishi Nissan Kia
CCS	BMW i3 Volkswagen eGolf Chevrolet Spark Hyundai Ioniq Ford Focus Chevrolet Bolt	BMW Volkswagen Audi Mercedes GM Ford Fiat-Chrysler Hyundai
Tesla Supercharger	Tesla Model S	Tesla

Major Japanese automakers Honda and Toyota have not announced details for any upcoming BEV products, and their support for either DCFC standard is unclear. Meanwhile, some automakers have shown signs of adopting standards based on sales region, with BMW offering a CHAdeMO-equipped i3 for the Japanese market, and Tesla adopting the standard “Type 2” connector for European sales of the Model S and European Supercharge stations.

Multi-Standard DCFC Stations

The complications introduced by the existence of multiple standards for DC charging have largely been eliminated by the introduction of multi-standard DCFC stations. Much like a gas-station pump with multiple nozzles for different types of fuel, a multi-standard DCFC station allows an EV driver to simply plug the appropriate connector into their vehicle and commence charging. The additional connector does add some cost to the equipment, although this is small relative to the overall cost of the charging station and installation.

North American multi-standard stations typically have two connectors: CHAdeMO and CCS. European multi-standard stations also include a high power AC charge port, which is more commonly supported on European vehicles. Some manufacturers of North American dual-standard DCFC stations include:

- Efacec
- Signet
- AddÉnergie
- ChargePoint
- ABB
- BTC Power
- Schneider

Figure 30: Multi-standard DCFC stations: AddÉnergie, ChargePoint, and ABB (European version shown)

4.3 Wireless Charging

Both the AC and DC charging approaches discussed above are considered "conductive" charging, in that metal conductors are used to supply electricity to a vehicle. There are, however, a number of ways of delivering power without wires. One such method is through induction, or "inductive" charging, where a receiver coil mounted on the vehicle may receive power wirelessly from a sender coil which composes part of a wireless EVSE, or WEVSE. Alternating current in the sender coil creates an alternating electromagnetic field which in turn induces alternating current in the receiver coil. Such systems have been designed to transfer power between a sender coil mounted flat on the ground to a receiver coil mounted on the underside of a vehicle. This can be used to recharge an electric vehicle while stationary, or even potentially while a vehicle is travelling.

At least one after-market wireless charging retrofit package is available for installation on select EVs. PluglessPower (www.pluglesspower.com) offers a 3.3kW charging system compatible with the Nissan Leaf and Chevrolet Volt for under US$ 2000, with some Nissan and Chevrolet dealers able to assist with installation of the Vehicle Adaptor that's required on the vehicle. Telecommunications giant Qualcomm is also actively developing wireless charging technology for EVs, and has demonstrated wireless charging BMW vehicles as part of the FIA Formula E racing series.

Automakers are working together to establish automotive standards for wireless charging, and it is generally expected that the functionality will be incorporated into future models. In early 2016, SAE published the J2954 "Technical Information Report", a specification guideline that will evolve into a formal standard once field data can be collected from early deployments[28]. A large number of automakers and component developers (including PluglessPower and Qualcomm) have contributed to the development of J2954.

The advantage of wireless charging is largely convenience – an EV driver would no longer be required to manually plug their vehicle in, but would rather be required to park in a precise location within range of a WEVSE. The driver may be provided with driver aids that help guide the vehicle to this precise location such that the vehicle is within the required range to establish a wireless connection with the WEVSE. This added convenience may become critically important for scenarios that involve frequent stop-start cycles and many opportunities for

[28] http://standards.sae.org/wip/j2954/

charging, where manually connecting a traditional charging station may be impractical. This could include taxis operating in a queue or buses that recharge while picking up passengers at a stop.[29]

The disadvantages of wireless charging are increase in cost and decrease in efficiency. The US Department of Energy's Idaho National Laboratory found the above-mentioned PluglessPower system to have an overall efficiency of between 86% and 90%, depending on alignment and the vertical gap between the coils.[30] This would cause an increase in the overall energy consumption of an EV for a given distance by about 10-15%.

The combination of increased vehicle cost, increased charge station cost, and decreased efficiency means that wireless charging is likely to remain an optional convenience feature, and it is not expected to replace conventional conductive charging as the standard means of charging EVs for the foreseeable future. While the technology may establish a foothold in luxury vehicle segments where cost and efficiency are often traded off for convenience features, or for specific applications with frequent opportunities for charging (such as with taxis or fleet vehicles), these vehicles are still likely to be equipped with a standard charge port as well, to ensure compatibility with existing charging infrastructure.

Wireless Charging	
Opportunity:	Convenience and ease of recharging, especially for frequent stop/start cycles.
Challenges:	Added cost and reduced energy efficiency.
Status	After-market retrofit packages readily available for existing EVs. Some future vehicle models likely to support wireless charging as early as 2017.
Ideal application:	Buses charging at passenger pick-up/drop-off areas, taxis charging while in queue.

[29] "London Buses to be Recharged Wirelessly During Stops" http://evworld.com/news.cfm?newsid=34021
[30] http://avt.inel.gov/pdf/evse/EvatranWirelessChargingFactsheetAug2013.pdf

4.4 Battery Swapping

Battery swapping has often been discussed as a potential means of speeding up the process of replenishing an electric vehicle's state of charge. By physically replacing a depleted battery with a fully charged one, an EV driver would potentially be able to carry on with their drive within minutes while their original battery is recharged at the battery swapping/charging facility. This was the vision of the now-defunct Project Better Place, an Israel-based company that operated between 2007 and 2013. Better Place envisioned an EV industry with standardized battery designs and subscription-based ownership models that mimicked the cellphone industry. The challenges of battery swapping for passenger vehicles are largely due to physical design:

1. Given that an EV battery can be a very large component, it can be difficult to design it in such a way to be easily swappable without overly compromising the mechanical and electrical design of the vehicle.
2. Given challenge #1, standardizing the battery design such that batteries can be shared across a broad range of vehicle makes and models with a variety of designs is an even greater challenge.

More recently, Tesla Motors has demonstrated battery swapping with the Tesla Model S, and has even established a single battery swapping facility in California. The Model S's design lends itself well to battery swapping, with the battery slung underneath the vehicle making it relatively easy to remove. Yet even with this swapping-friendly design, and with an automaker that's entirely focused on a single vehicle model, Tesla has found that battery swapping may not be worth the effort, given the advances in fast charging capabilities. Tesla's free network of 135kW "Supercharge" stations can provide a 300km charge in less than 30 minutes, whereas a battery swap requires a fee of approximately $50 (mimicking the cost of a full tank of gasoline). With a battery swapping facility located approximately midway between San Francisco and Los Angeles, Tesla has found that this service is not very popular, with most of their customers opting for the free but slower supercharging service.

Battery swapping is, however, widely practiced with commercial vehicles, especially material handling equipment such as forklifts. The high duty cycle of some commercial vehicles can benefit greatly from the quick turnaround of a battery swapping approach, and the dedicated design of the vehicles operating in a large fleet out of a single facility can simplify the logistics.

Battery Swapping	
Opportunity:	Very fast turnaround for a full charge.
Challenges:	Complicates vehicle design, difficult to standardize across vehicles
Status	Basic demonstrations, limited operation at one Tesla facility. No foreseen broad availability for passenger vehicles.
Ideal application:	Material handling equipment and other dedicated commercial fleets.

4.5 Costs, Usage Fees, and Best Practices

4.5.1 Typical Costs

The following cost estimates are based on actual project experience, with Powertech having installed numerous Level 1, Level 2 and DCFC stations, and played a supporting role in many more projects.

The costs of EV charging equipment vary greatly depending on charging level. The following table provides approximate ranges for the three most common currently available types of charging equipment:

Table 10: Approximate charge station equipment costs

	Equipment Cost (per port)	Factors affecting cost
AC Level 1	$50-1500	Outlet vs EVSE
AC Level 2	$1500-5000	Output power, power management and networking capabilities, station manufacturer
DC Fast Charge	$15,000-50,000	Output power (25kW vs 50kW), station manufacturer, support for multiple standards

The cost of installation of charging equipment can also vary greatly. The following installation costs are based on Powertech's experience across multiple projects, and include all aspects of a complete EV charging installation, including signage and associate hardware:

Table 11: Approximate charge station installation costs

	Installation Cost (per port)	Factors affecting cost
AC Level 1	$500-10000	Various site-specific considerations: distance from power source, ground surface type, future-proofing, available electrical supply.
AC Level 2	$3000-15000	
DC Fast Charge	$20,000-80,000	

The cost of operating an EV charging installation depends heavily on the utilization of the station. According to information available through Powertech's evCloud website (www.fleetcarma.com/evCloud), the average charge station in Metro Vancouver is used about 6 times per week, dispensing an average of 6kWh of electricity each time, adding up to about $150 of electricity per year. Some of the busier Level 2 stations in the region can see more than twice this amount utilization, while the busiest DCFC stations are used greater than 20 times per week. Depending on the peak power demand of a utility account, charging stations can incur additional fees due to demand charges[31], adding up to $6000 per year for a single DCFC station. Finally, many charging stations require payment of a yearly service fee in order to support network transactions for usage fee collection, data collection and power management. Here are the yearly fees for some of the most common EVSE network operators in BC:

Table 12: Charge station network service fees (as of 2015)

Network	Yearly service fee per port
Highest	$300
Lowest	$125
Typical	$260

[31] A demand charge is a fee based not on the total energy consumed (in kWh) over a billing period, but rather on the peak power level (in kW) delivered at any point during that period. See https://www.bchydro.com/news/conservation/2013/demand-charge.html for more information.

The following table summarizes typical charge station operational costs:

Table 13: Charge station operating costs (per port)

	Yearly Energy Cost	Yearly Demand Charges	Yearly Network Fee	Total Yearly Cost
AC Level 1	<$100	0	0	<$100
AC Level 2	$250-500	$0 - 400	$125-300	$375-1200
DC Fast Charge	$300-1000	$1800 - 6000	$260	$2100-7000

4.5.2 Usage Fees

Many charging stations support the collection of usage fees through the use of network member cards and smart phone applications. These networks typically require a user to sign up for an account with each individual network, although there have been some efforts to establish roaming systems that allow networks to share members and allow universal access to equipment across multiple networks.[32]

Usage fees for charging stations can be based on:

- Per usage session
- Energy (kWh)
- Time (minute or hour)

The most common type of fee structure is based on time. A time-based fee can be effective in incentivizing users to move their vehicle once charging is complete, and can help ensure the most effective utilization of charging equipment.

Usage fees based on a per-kWh energy value can be preferable in terms of ensuring all users pay the same amount for the same service. The speed of charging may depend on a number of variables (vehicle type, state-of-charge of battery, battery temperature, power reduction due to load management) and so a usage fee based on the actual energy delivered may be the most fair.

In selecting a usage fee, it may be desirable to select a fee that recovers the operating costs of the station, while still keeping the cost of charging an EV comfortably below that of fueling a conventional vehicle on a per-km basis. In BC, at $1.40/litre of gasoline, this equivalency works out to about $0.50 per kWh, or about $1.65 per hour if charging at a rate of 3.3kW. A rate of $1 per hour is common at many stations in the province of Quebec.

In BC, almost all Level 2 charging stations are free to use, although many are located in paid parking lots where EV drivers pay the same rate as other drivers. DCFC stations in BC are gradually adopting a price of $0.35/kWh, placing the price comfortably below parity with gasoline, while still applying a premium fee for the fast charging service.[33]

Resale of electricity in BC is regulated by the BC Utility Commission, and so the application of usage fees for EV charging is being carefully considered by the BCUC. While in other areas, time-based usage fees have avoided the scrutiny of regulatory bodies, it is not clear whether this would still be considered resale by the BCUC.

[32] http://news.hydroquebec.com/en/press-releases/750/electric-circuit-and-vernetwork-combine-forces/
[33] http://pluginbc.ca/wp/wp-content/uploads/2014/08/FAQ-EV-DCFC-pilot_August1_2014.pdf

Currently, only registered utilities are allowed to sell electricity in BC, with a few exceptions:

- Any municipality may resell
    - Currently reselling through DCFCs: Saanich, Nanaimo, Langley, Princeton, Keremeos, Merritt
- Landlords providing electricity to tenants may resell at cost (no profit)
- Employers providing electricity to employees may resell at cost (no profit)

In 2016, the BCUC approved a one-time exemption that allows the Bakerview Ecodairy, a private business located in Abbotsford, to apply a usage fee of $0.35 per kWh for usage of the DCFC station that it hosts and operates[34]. The Ecodairy is required to submit annual reports to the BCUC that will hopefully help to inform any future decisions by the BCUC regarding broader application of usage fees for EV charging.

BCIT applies a fee to use its DCFC stations by charging for the parking spot on a time basis.

4.5.3 Public vs residential charging

Data collected for the EV Project led by Idaho National Lab shows that 80% of EV charge events take place in the home (almost always at level 1 or level 2), while 20% take place in public locations. Of that 20%, 83% occurs at a level 2 charging stations where the car may require a few hours to fully recharge. The average charging time at public level 2 stations in BC is around 90 minutes.[35]

Some charge events occur on level 1 stations but they are often unmonitored and impractical due to their low power, delivering less than 10 km of range per hour. Campgrounds, hotels and businesses allowing overnight parking could have some interest in allowing EVs to charge using level 1. Data collected estimates their use at 6% of the total of public charging.

DC fast chargers provide a high-power option, as the vehicle gets hundreds of kilometers of range per hour: drivers stay on average for 25 minutes. Despite this advantage only 11% of public charging events per car use DCFCs. One explanation is the convenience of level 2: they are often close to venues and more common than expensive DCFC units.

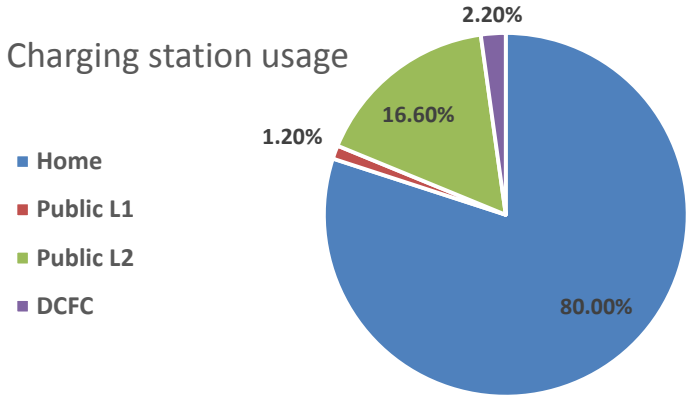


Figure 31: Charging at home represents 80% of all charging [The EV Project (Idaho National Laboratory, 2015)]

[34] http://www.ordersdecisions.bcuc.com/bcuc/orders/en/item/144369/index.do
[35] Powertech; evCloud report number four: BC Public EV Charging Station Usage

4.5.4 Other Considerations and Deployment Guidelines

For any parking lot that provides EV charging services, the number of parking stalls with access to charging equipment is an important consideration. Ideally, there should be adequate availability of charging stations to support the expected number of EVs visiting the parking lot at any given time. Section 0 recommended a guideline of 15-20% of parking stalls with access to charging infrastructure by the year 2030 based on expected uptake of EVs in the BC Lower Mainland. In order to manage growth of infrastructure leading up to that timeframe, and to prepare for increased adoption beyond 2030, it is recommended to deploy infrastructure in a way that enables scalability and easy expansion based on actual needs. While a deployment of charging infrastructure in 2016 may not be required to support 20% of parking stalls in a given lot, the long term costs of supporting that many stalls in the future can be reduced if the base infrastructure (such as transformers, electrical panels, conduit and wiring) are designed with future expansion in mind. With this base infrastructure in place, additional charging stations can be added at minimal cost as the need arises, based on analysis of utilization of existing stations.

In 2014, BC Hydro sponsored the development of the "Canadian Electric Vehicle Infrastructure Deployment Guidelines". These guidelines cover a broad range of topics that should be considered for any EV charging installation, including:

- Signage
- Accessibility requirements
- Lighting and shelter
- Vandalism
- Station layout design

These guidelines are publicly available as a PDF from the BC Hydro website – www.bchydro.com/ev.[36]

[36] https://www.bchydro.com/about/sustainability/climate_action/plugin_vehicles/charging___infrastructure.html

5 SMART GRID TECHNOLOGIES FOR EV CHARGING

"Smart Grid" is a term used to describe a number of technologies and concepts that can optimize the way we generate, deliver and consume electricity. There are a number of emerging Smart Grid technologies and concepts that have the potential to reduce the impact of EV charging on electrical infrastructure, and potentially even turn EVs into valuable assets that provide a net-positive benefit to the grid. The following sections provide a brief overview of some of the most relevant EV applications for smart grid technologies.

5.1 Smart Charging

"Smart Charging" is a term used to describe the optimization of EV charging according to electrical infrastructure conditions. One example of smart charging would be controlling EV charging loads according to the availability of renewable energy, such as wind or solar – flexible loads can be extremely beneficial for accommodating these typically variable sources of energy. In regions like BC that are rich in "firm" hydroelectric resources, smart charging may be most beneficial for addressing capacity constraints by deferring or reducing charging power at certain times. These constraints could be anywhere on the grid, from the generating stations all the way down to local distribution transformers, or even constraints within a site or building.

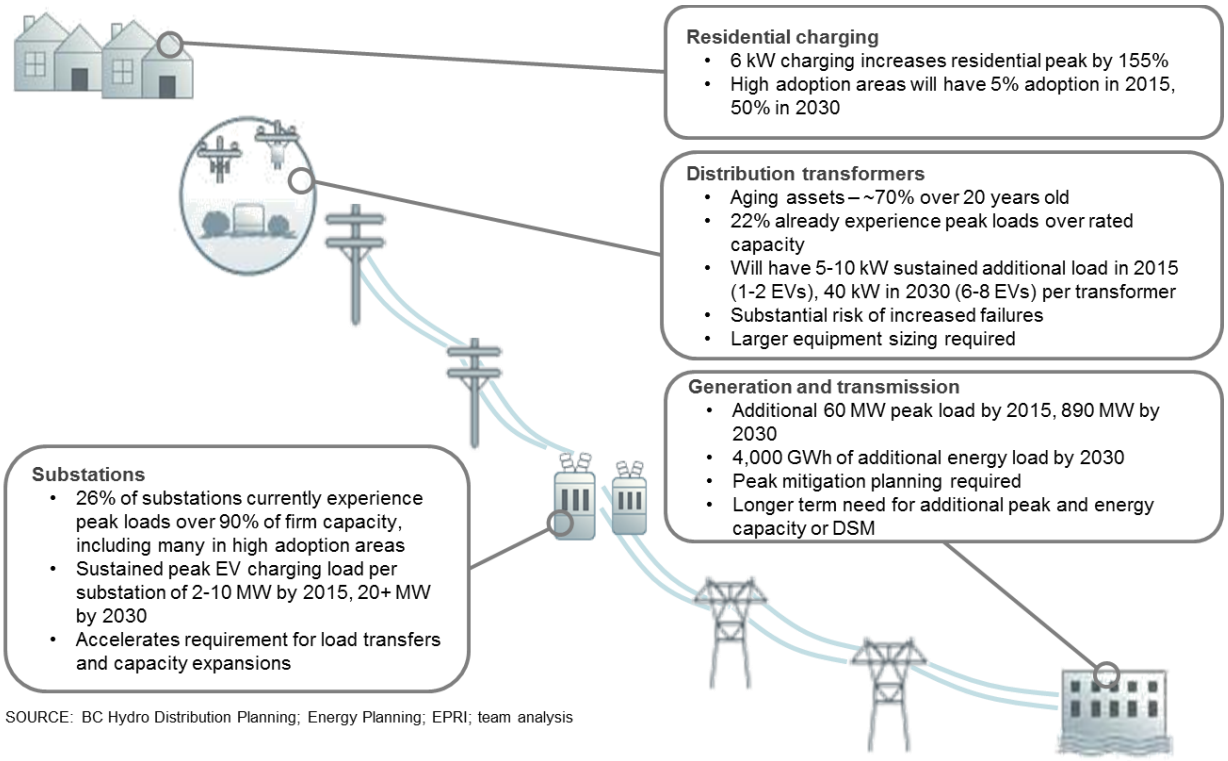


Figure 32: Diagram highlighting potential impact of EVs on various parts of the grid.

Depending on whether constraints exist on customer-owned assets (such as wiring within a building) or on utility-owned assets, there may be different types of systems and mechanisms to manage charging.

5.1.1 Utility-Interactive Smart Charging

For situations where smart charging is motivated by constraints on the utility's operations, a utility needs to establish a mechanism that incentivizes their customers to manage their charging loads accordingly.

Perhaps the simplest such mechanism that's already in practice today is variable electricity pricing. Either by employing a fixed Time-of-Use (TOU) pricing schedule (common practice), or through Real-Time-Pricing (RTP) that varies on a continual basis (less common), EV drivers can be incentivized to charge their vehicles at times of lowest demand. TOU pricing schedules are communicated to utility customers, and an EV driver can either:

a) Plug their EV in only during off-peak hours;
b) Use charge scheduling features built into their EV or EVSE to program charging accordingly;
c) Rely on an automated connection between their EV or EVSE and a utility pricing database to optimize charging schedule automatically.

BC Hydro does not employ Time-of-Use pricing, although this is now common practice in a number of other jurisdictions in North America. BC Hydro has announced that an EV-specific tariff is in development, with details expected in late 2016 or early 2017.

Some utilities are also exploring "Demand Response" (DR) systems where an EV can respond to signals from the utility and vary charging accordingly. These types of systems may rely on two-way communications between the utility and either the EVSE, the EV or both. The majority of these EV Demand Response programs are at the pilot stage, such as Pacific Gas and Electric and BMW's "i ChargeForward Program"[37] and FleetCarma and Toronto Hydro's "ChargeTO" program[38].

Smart Charging – Utility Interactive	
Opportunity:	Reduces impact of EV charging on utility assets
Challenges:	Need to establish value proposition for EV drivers
Status:	Large pilots in progress, broader roll-out dependent on standardized EV-utility interfaces
Ideal application:	Residential charging

5.1.2 Local Load Management Smart Charging

For scenarios where a customer may have local load constraints on their own electrical infrastructure, they may be motivated to implement Smart Charging using a local load management system, without the need for advanced, utility-interactive communications. These types of local load constraints become particularly relevant any time a large number of electric vehicles might be charging in the same location, such as in a workplace or fleet vehicle charging scenario. The 2015 Canadian Electrical Code added an allowance for sizing of circuits according to the maximum power allowed by a load management system, and this was adopted in BC in early 2016.

[37] http://www.bmwichargeforward.com/
[38] http://www.crosschasm.com/chargeto/

AddÉnergie Technologies - PowerSharing Systems

AddÉnergie Technologies, a Canadian manufacturer of EV charging equipment, has developed a charging solution specifically designed to address local load constraints. This solution consists of two main components:

1. **CoRe+ Level 2 charging stations** ($3250 each)
   - Mounted in pairs, up to 24 stations per installation
   - Up to 7.2kW each
2. **Site Controller** (one per installation, provided by AddÉnergie)
   - Communicates wirelessly with charging stations
   - Controls maximum power output of each charging station
   - Minimizes charging impact according to building demand schedule or through integration with building energy management system (eg BACnet)
   - Provides internet communications for EV driver user management and usage fee options

Figure 33: AddÉnergie CoRe+ Level 2 EVSE

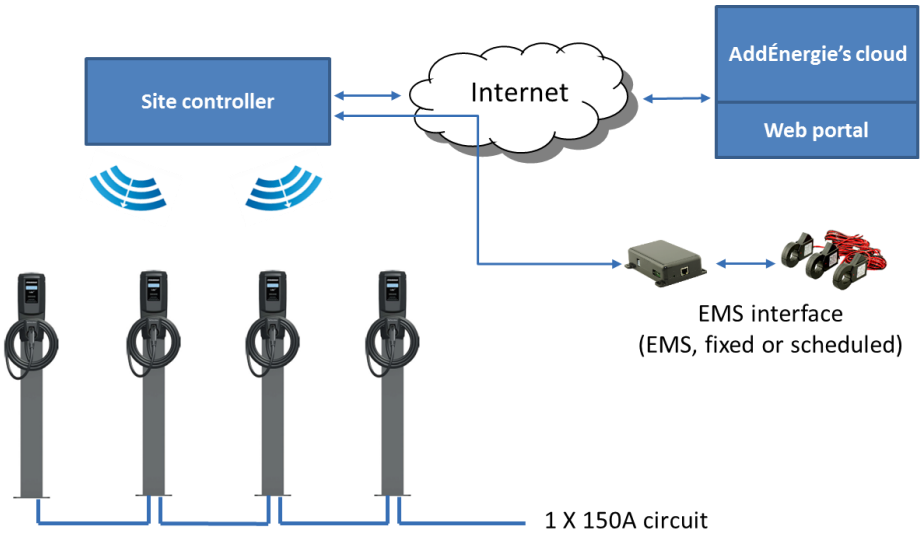


Figure 34: AddÉnergie's PowerSharing system with building EMS integration

While a single vehicle may charge at up to 7.2kW, the site controller may restrict charging to as low as 1.5kW if many vehicles are charging at the same time, or if it determines that the building is experiencing high overall demand. The approximate impact on charging time for a typical EV would be as follows:

Table 14: Impact on charging time for power sharing scenarios

Charging rate	Charging time required to replenish 30km of range (~6kWh)	Charging time required to replenish 120km of range (~24kWh)
1.5kW	4h	16h
7.2kW	1h	4h

Given typical commuting distances, most drivers would likely be able to receive a full charge by the end of a work day even with significant load management, although higher charging rates can be prioritized for certain drivers based on their specific driving needs.

Scalability

Another advantage of this solution is that it allows a charging installation to be expanded in the future as needed to support increasing EV adoption. By installing stations in a "daisy-chain" configuration along a single high-amperage circuit, additional charging stations can be added down the road without the need to add additional circuits, greatly simplifying and reducing the cost of future expansions.

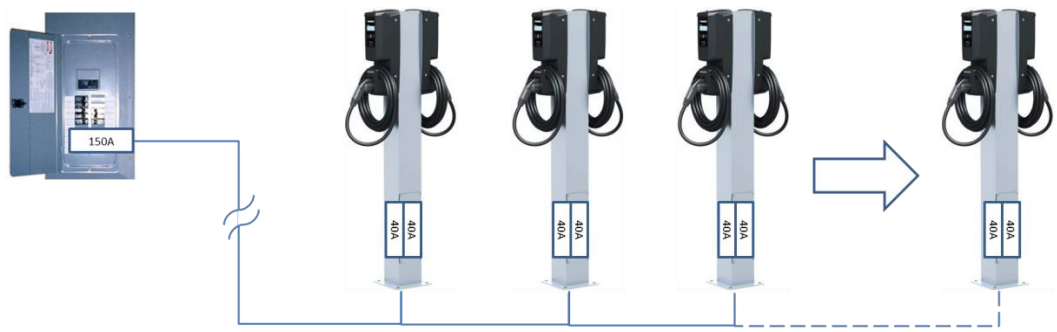


Figure 35: AddÉnergie's PowerSharing system enables expansion of EVSE installations using a daisy chain configuration

In the example above, a 150A circuit is shown expanding from six to eight 40A branch circuits through a daisy-chain configuration (each 40A branch circuit supporting one 7.2kW charging station). This 150A circuit could potentially support up to 24 charging stations, although in practice, AddÉnergie recommends reserving 10A per station (15 stations total in this case) in order to provide a minimum level of charging power for each station. This approach of sharing circuits across multiple charging stations is supported by the 2015 edition of the Canadian Electrical Code, and has been approved for multiple installations in Quebec.

ChargePoint – CT4000 Power Sharing

ChargePoint's CT4000 Level 2 charging station[39] also offers the ability to increase the total number of charging ports supported by a given size of electrical service by sharing a single 40A circuit across two charging ports. The charging station allows each port to charge at full power (7.2kW) if only one vehicle is connected, automatically reducing power by 50% (to 3.6kW) if both ports are in use. This allows a station host to effectively double the number of EVs that can be supported for a given size of electrical capacity, although it would not be as flexible in terms of optimizing a larger group of stations collectively and taking into account overall building demand. More recently, ChargePoint has announced availability of a panel-level load management solution similar to AddÉnergie's, relying on cloud-based control to manage groups of charging stations on shared infrastructure.

This Power Sharing capability is a standard feature of all dual-port CT4000 charging stations (CT402X), with pricing starting at approximately $6000 for a dual port station.

Figure 36: ChargePoint's CT4000 Level 2 EVSE with circuit-sharing capability

Smart Charging – Local Load Management	
Opportunity:	Reduces impact of EV charging on local electrical infrastructure
Challenges:	Need to establish value proposition for EV drivers
Status:	Availability from a limited number of charge station suppliers
Ideal application:	Workplace, fleet or public charging facilities supporting multiple EVs in a single location.

[39] http://www.chargepoint.com/files/73-001061-01-3_BR-CT4000-02.pdf

5.2 Vehicle-to-Grid

Vehicle-to-Grid (or "V2G") is the most common term used to describe the concept of an electric vehicle providing electric power back to the grid. Other terms include "bi-directional charging", "reverse power flow" and "EV as a distributed energy resource (DER)". EVs could effectively act as additional sources of generation on the grid, providing valuable services by alleviating peak demands on the grid, or by providing generation that is quicker to respond to changing grid conditions than some less agile types of power plants, thereby improving grid stability. V2G capable vehicles could also provide power during blackout scenarios, an application sometimes referred to as vehicle-to-home (V2H) or vehicle-to-building (V2B) – both typically considered special cases of V2G. Even in non-blackout scenarios, a V2G-capable vehicle could provide power back to a building in a way that offsets the rest of that building's energy consumption and minimizes its operating costs. Finally, the simplest form of V2G-like capability is for the vehicle to provide power to a stand-alone load, much like a generator that might be used to support power tools out in the field. This might be referred to as vehicle-to-load (V2L).

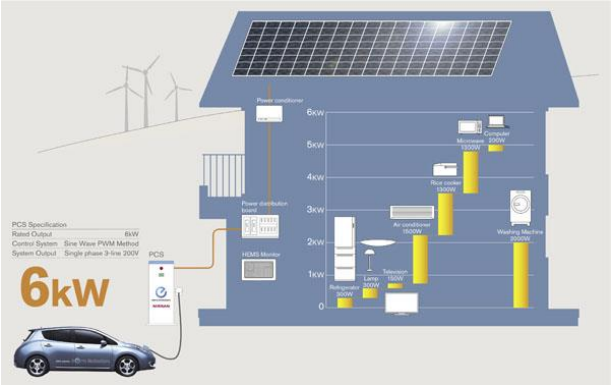


Figure 37: Nissan's Leaf-to-home system

While the above described services are all likely valuable to either the vehicle owner, building owner or electric utility, it becomes important to consider this value against the cost of providing such services. Unlike Smart Charging, V2G capabilities require significant additional equipment in the form of a DC-to-AC inverter, which may be either built into the vehicle or into a charging station (specifically one that connects to the vehicle through a DC charging port). This equipment is likely on the order of at least $1000-2000. Additionally, while Smart Charging should have little to no impact on battery life, V2G capabilities all involve adding additional usage cycles to the vehicle's battery. While these additional usage cycles may be small compared to normal use of the vehicle in driving mode depending on the specific V2G application, the impact on battery life must still be considered against the value of V2G services, and automakers must determine how to account for V2G in defining battery warranty parameters, which are currently based solely on calendar life and vehicle odometer readings.

For these reasons, V2G has thus far largely remained the subject of small trials and pilot demonstrations. These demonstrations generally require the support of the automaker, as accessing the battery onboard a vehicle for V2G purposes either requires an inverter that is built into the vehicle, or at least vehicle software that permits reverse power flow while connected to a DC station. The only products that have an apparent path to market availability are those that either support backup power functionality (such as Nissan's "Leaf to Home" system currently being tested in Japan, using a stationary inverter connected to the Leaf's DC charge port[40]) or systems that can be used to power equipment in remote locations (such as Via Motors' export power system[41]). Both of these applications treat the vehicle as a replacement for a gas-powered generator, and as such may find broader market appeal.

[40] http://www.nissan-global.com/EN/TECHNOLOGY/OVERVIEW/leaf_to_home.html
[41] http://www.viamotors.com/vehicles/electric-truck/

Figure 38: Export power panel on a VIA Motors V-Trux with 2x120V and 1x240V outlets

Vehicle to Grid	
Opportunity:	EVs can support electrical infrastructure and provide backup power for power outages
Challenges:	Significant additional cost, requires a clear value proposition for EV drivers
Status:	Largely limited to research projects and small scale pilot demonstrations.
Ideal application:	Fleet vehicles with low utilization, zero-emissions backup power.

5.3 Stationary Energy Storage

While not specifically an Electric Vehicle-specific smart grid technology, stationary energy storage can be particularly useful in accommodating the high electrical loads associated with charging of electric vehicles. Stationary Energy Storage Systems (ESS) often use lithium-ion batteries similar to those that are used to power electric vehicles, although potentially in much larger quantities. The size of an ESS depends entirely on its intended application, and can range anywhere from household units that are the size of a small refrigerator, intended to support rooftop solar power and provide occasional backup power, to utility-scale systems of multiple megawatt-hours that are intended to support grid operations, often built using one or several full-size shipping containers. A few of the most common applications for ESS include:

1. Supporting intermittent renewable energy sources;
2. Providing temporary backup power (duration depends on specifications and use, but durations of 2 to 20 hours are common);
3. Buffering out intermittent peak loads.

Figure 39: Tesla Powerwall Residential Battery

Any of these applications can be accommodated at a wide range of scales simply by scaling the design of the ESS accordingly. For example, peak loads can be accommodated at a grid-scale, with a large, multi-megawatt ESS fulfilling the role of traditional “peaker” power plants that only operate during periods of peak demand. At a much smaller scale, a single DC fast charge station can be supported by a relatively small ESS, minimizing the brief peak load typically seen during the first few minutes of a fast charge session.

Similarly, the recently announced Tesla Powerwall 10kWh residential lithium-ion battery can provide a typical home with 6 hours or more of backup power during an outage, while BC Hydro’s 1MW battery system in the Canadian Rockies can power the entire town of Field, BC for 6 hours or more during outages.

Energy storage systems of a wide range of sizes are now being deployed in large numbers in certain parts of the world. California in particular has recently seen a considerable surge in energy storage projects, thanks to a state

law which requires Californian utilities to procure 1.3 Gigawatts of energy storage capacity (equivalent to about 750,000 Tesla Powerwalls) by 2024, ranging from residential scale home-based batteries up to multi-megawatt transmission-interconnected systems.[42] This law puts an emphasis on cost-effective solutions, and the first rounds of procurement have already shown signs of an emerging competitive field of technology providers.[43]

Figure 40: A 500kWh lithium-ion battery system designed and built by Powertech Labs for BCIT's Energy OASIS Project, supporting a 250kW solar canopy over the parking lot, and supplying 2 DCFC and 2 Level 2 EV charging stations.

Stationary Energy Storage	
Opportunity:	Can reduce impact of EV charging on local electrical infrastructure, support renewable generation, and provide zero-emission backup power.
Challenges:	Cost – while volumes are driving costs down, systems typically have an installed cost of around $500-1000 per kWh.
Status:	Transitioning from largely research and pilot demonstrations to a more mature commercial market with quickly decreasing costs. Tesla's recently announced products have a cost as low as $250/kWh, although this does not include installation and supporting infrastructure.
Ideal application:	Facilities with constrained electrical infrastructure, high demand from EV charging, large amounts of variable renewable energy, and/or a desire for zero-emissions backup power

[42] http://www.greentechmedia.com/articles/read/sce-pge-issue-first-energy-storage-requests-to-meet-ab-2514
[43] http://www.greentechmedia.com/articles/read/california-dreaming-5000mw-of-applications-for-74mw-of-energy-storage-at-pg

6 EV PROGRAMS AND POLICIES IN BC

British Columbians can benefit from a number of programs and policies that aim to make EVs more affordable, increase access to charging infrastructure, and increase awareness of EVs. These programs are supported by a variety of organizations collaborating under the Plug in BC initiative, including the BC Ministry of Energy and Mines and BC Hydro. The PlugInBC.ca website acts as a hub of information for these programs, as well as a source for anyone looking to learn about EVs in general.

This final section of the report provides a brief overview of these programs, as well as a few potential future programs and priorities.

6.1 Vehicle Incentives

The Clean Energy Vehicle for BC Point of Sale Incentive Program provides up to $5000 off the purchase price of qualifying plug-in vehicles for B.C. residents, businesses, non-profit organizations, and local government organizations. The program is managed by the BC Ministry of Energy and Mines, with support from the New Car Dealers Association of BC. The stated goal of the program is to "stimulate the market such that by 2020, 5% of new light duty vehicle purchases in British Columbia are clean energy vehicles". More information is available here: https://www.cevforbc.ca/

As of March 2016, vehicles with an MSRP of over $77,000 are no longer eligible for the incentive. The actual incentive amounts depend on the vehicle's battery capacity:

- Between 4kWh and 15kWh: $2,500
- Above 15kWh: $5,000

This is actually the second phase of the CEVforBC purchase incentive, with the first phase having ended in March 2014, and the second phase not launching until a year later. The current phase is slated to run until March 31, 2018 or until funds run out, whichever comes first.

The CEVforBC purchase incentive can be combined with the BC SCRAP-IT program, under which an additional $3,250 can be put towards the purchase of a new EV in return for retiring an older vehicle. More information on the BC SCRAP-IT program can be found here: https://scrapit.ca/evprogram/

6.2 Charging infrastructure

6.2.1 Previous Level 2 Infrastructure Programs

Phase 1 of the BC Clean Energy Vehicle Program supported the deployment of a large number of Level 2 charging stations. In particular, 550 public Level 2 charging stations were installed across BC, primarily under the Community Charging Infrastructure fund. These public Level 2 charging stations represent the bulk of usage data monitored by the evCloud and presented in Section 2.3 of this report. A further 142 Level 2 stations were installed in multi-unit residential and commercial buildings, and incentives were provided for 306 Level 2 stations in single family homes.

6.2.2 Multi-Unit Residential Building Charging Program

In 2016, the BC government and Fraser Basin Council launched the MURB Charging Program, offering support for installation of Level 2 charging infrastructure in existing buildings. Retrofits were specifically targeted, as these can be particularly challenging from both a technical perspective, and in terms of meeting the expectations of a large number of stakeholders in any given building. The program provided 75% of cost up to $4,500 per charge port, and applicants were required to install additional conduit to allow for future expansions. The program was very popular and quickly filled up. More information is available here: http://pluginbc.ca/charging-program/murb/

6.2.3 Fleet Infrastructure Incentive

Also in 2016, the BC government and Fraser Basin Council launched the Fleet Infrastructure Incentive, in conjunction with the Fleet Champion Program, providing support for the installation of charging infrastructure for fleet vehicles. The program provides 33% of costs up to $2000 for the purchase and installation of a Level 2 charging station. More information is available here: http://pluginbc.ca/charging-program/incentives-for-fleets/

6.2.4 DCFC Phase 1

As part of the federally and provincially funded BC EV Smart Infrastructure Project, 30 50kW DC Fast Charge stations were installed across BC between 2013 and 2016 by BC Hydro with support from Powertech Labs. These DCFC stations are monitored by the evCloud data collection platform, and a summary of usage data was provided in Section 2.3 of this report. With the exception of the Bakerview Ecodairy in Abbotsford and the station installed at Powertech Labs, all stations were hosted by municipal or regional governments.

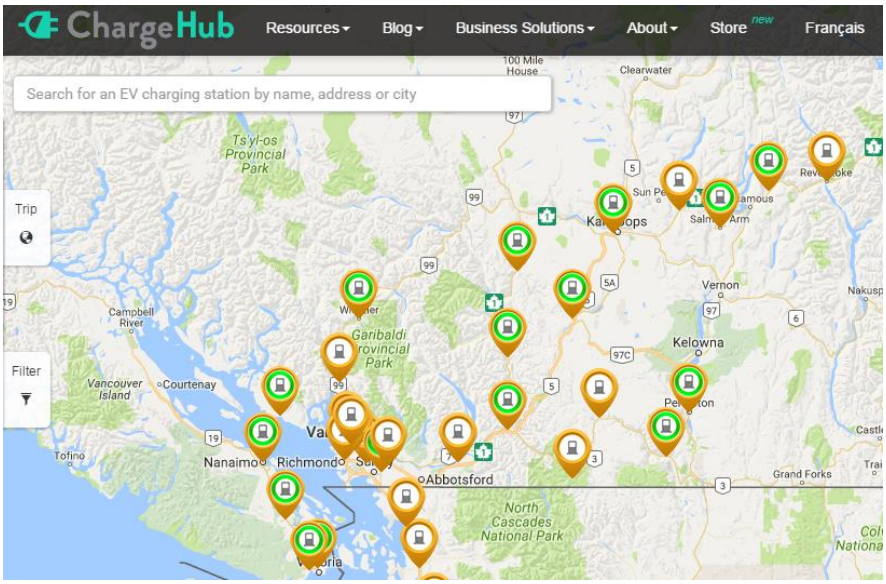


Figure 41: BC DCFC Phase 1 stations - www.chargehub.com

While the earliest DCFC stations installed under this program supported only the Chademo connector, additional funding provided by the BC government and BMW allowed BC Hydro and Powertech Labs to retrofit most of these early sites with dual-standard DCFC stations. See Section 4.2.2 of this report for a discussion of the DCFC standards landscape.

6.2.5 DCFC Phase 2

During the spring of 2015, the BC government announced funding to support up to 20 additional DCFC stations. Shortly afterwards, Fraser Basin Council conducted a gap analysis to help prioritize locations for future DCFC stations in BC, recommending an EV tourism approach, focusing on heavily populated urban areas with high EV adoption rates while connecting them to neighbouring destinations. In 2016, the federal government, through Natural Resources Canada, provided a funding opportunity to support up to 70 DCFC stations across Canada. In parallel, the BC government conducted a Request for Expressions of Interest from potential Phase 2 DCFC station hosts. Details and timing of the DCFC Phase 2 expansion are expected in late 2016.

6.3 Building Codes

Building codes can be an extremely effective tool for ensuring access to charging where it's most valuable and convenient, especially at home. EV infrastructure is much more costly to install as a retrofit as compared to during initial construction, so ensuring that new buildings are built with EVs in mind is an excellent way for governments to reduce barriers for EV adoption.

6.3.1 Vancouver Building Bylaw

Vancouver is the only municipal government in Canada to enforce its own building codes. Vancouver leveraged this mechanism back in 2008 to require that 20% of parking stalls in multi-unit residential buildings and all stalls in houses be "EV ready", requiring electrical infrastructure necessary to support the future installation of a charging station. This was expanded with a 10% requirement for commercial buildings in 2013. Vancouver is currently developing an electric vehicle infrastructure strategy that will aim to ensure that access to charging is available throughout the city, and this may include further revisions to the Building Bylaw. More information is available here: http://vancouver.ca/streets-transportation/electric-vehicles.aspx

6.3.2 Update to the BC Building Act

While the City of Vancouver is in a special position thanks to its Building Bylaw, the BC government sought to enable other municipalities to enact similar support for EV infrastructure in new buildings with an update to the BC Building Act in 2016[44]. Under this update, requirements for EV charging infrastructure in buildings are now considered "out-of-scope" of the BC Building Act, and this should provide local governments with greater flexibility to enact their own requirements related to EV charging infrastructure.

[44] http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/baguide_sectionb1appendix-june2016.pdf

REVISION HISTORY

Rev	Description	Revised by	Date
D01	Initial draft	JT	Sept 9 2016
D04	Revisions according to feedback and questions	ML,LW	October 7 2016
R01	Final revision	JT	October 19 2016

Appendix G

CITY OF VANCOUVER ADMINISTRATIVE REPORT ON ELECTRIC VEHICLE CHARGING USER FEES

RR-1(d)

CITY OF VANCOUVER

ADMINISTRATIVE REPORT

Report Date:	June 20, 2017
Contact:	Doug Smith
Contact No.:	604.829.4308
RTS No.:	12009
VanRIMS No.:	08-2000-20
Meeting Date:	June 27, 2017

TO: Vancouver City Council

FROM: General Manager of Planning, Urban Design and Sustainability

SUBJECT: User Fees for City Owned and Operated Public Electric Vehicle Charging Stations

RECOMMENDATION

A. THAT Council approve the charging of user fees at City owned and operated public Electric Vehicle (EV) charging stations as described herein.

B. THAT Council approve, in principle, changes to the Parking Meter By-law No. 2952, as generally outlined in this report and Appendix A, to effect the charging of user fees at City owned and operated public EV charging stations.

C. THAT Council authorize the Director of Legal Services to prepare and bring forward for enactment amendments to the Parking Meter By-law No. 2952 as generally outlined in Appendix B.

REPORT SUMMARY

The City committed to introducing user fees for public electric vehicle ("EV") charging stations as part of the 2016 EV Ecosystem Strategy. The intent of this report is to seek Council approval to charge user fees at City owned and operated public EV charging stations and to amend the Parking Meter By-law to allow implementation and enforcement of these fees.

User fees will be introduced with the intention of increasing turnover at EV charging stations, and encouraging EV drivers with access to home or workplace charging to use those preferentially.

The City consulted with stakeholders and thought leaders on EV infrastructure in early 2017 as part of the development of this program.

COUNCIL AUTHORITY/PREVIOUS DECISIONS

The City has the legal authority to own and operate EV charging stations in the City of Vancouver pursuant to section 145 of the *Vancouver Charter*. As part of the City's authority to operate EV charging stations, the City may charge user fees.

In November 2016, Council unanimously adopted the EV Ecosystem Strategy, providing a five-year strategy on the City's approach to home, workplace and public charging infrastructure; and, defined the City's role as a provider of and a market enabler for electric vehicle charging access as a community amenity to 2021. The introduction of user fees was the Fair Access Quick-Start committed to under the EV Ecosystem Strategy.

In November 2015, Council adopted the *Renewable City Strategy*, committing to derive 100 per cent of all energy used in Vancouver from renewable sources before 2050; and, to reduce greenhouse gas emissions by 80 per cent from 2005 levels before 2050.

In August 2013, Council adopted new minimum requirements for all parking stalls in new one- and two-family homes, 20 per cent of parking stalls in multi-unit residential buildings, and ten per cent of parking stalls in new commercial buildings, such that they be equipped with a "Level 2" charging circuit under the *Vancouver Building By-law*.

In October 2012, Council adopted *Transportation 2040*, which includes actions to support electric vehicle deployment and the provision of charging infrastructure.

In July 2011, Council adopted the *Greenest City Action Plan (GCAP)*. Goal 9 (Clean Air) of GCAP includes encouraging electric vehicle transport. Goal 2 of GCAP includes carbon reduction goals to reduce greenhouse gas emissions by 33 per cent by 2020 over 2007 levels. In 2009, Council adopted requirements in the *Vancouver Building By-law* for electric vehicle charging circuits in new homes and multi-unit residential buildings. These were the first such requirements in North America.

For many years preceding this, Council has directed staff to develop policy and plans that have been built upon in the current Greenest City work including *Clouds of Change*, the *Community Climate Change Action Plan*, EcoDensity and others.

CITY MANAGER'S/GENERAL MANAGER'S COMMENTS

The City Manager recommends approval of the foregoing.

REPORT

Background/Context

The 2016 EV Ecosystem Strategy describes how different approaches to deploying electric vehicle charging infrastructure in the home, workplace, and public settings can create an interdependent network that will support the electrification of light-duty vehicles in Vancouver. The different approaches build on an existing public network of charging stations (currently numbering approximately 250, of which approximately 75 are City owned)), and on a growing number of homes and commercial buildings that have been constructed with EV charging circuits since 2011.

A public survey of over 2,000 Vancouver residents in 2016 indicated that 85% of people planning to buy new cars in the next five years would or would consider buying an electric vehicle, a number greater than total EVs registered in Vancouver at the time.

Challenges

Presently, the City does not require payment for the use of City owned and operated public charging stations, although the standard parking rates for each block or parking lot apply. Use of City owned and operated EV charging stations has more than doubled in the past two years, with over 17,000 charging sessions averaging nearly five hours per day per station, but with some locations having up to approximately 13 hours of use per port, per day. Increasing congestion at many of the City owned and operated public access EV charging stations is reducing their utility to members of the public who rely on them. The significant growth in EV uptake (a 63% increase between 2015 and 2016) is likely to exacerbate this issue under current conditions.

In 2016, City owned and operated public access EV charging stations logged over 17,000 charging sessions. Data shows that approximately half of all time spent at City owned and operated EV charging stations occurs after the battery is full, suggesting a need for greater turnover.

Solutions

If approved, user fees will be introduced and phased in at City owned and operated EV charging stations with the intention of increasing turnover at such stations, and encouraging EV drivers with access to home or workplace charging to use those preferentially.

The City consulted with stakeholders and thought leaders, including BC Hydro, SFU Sustainable Transportation Action Research Team, Metro Vancouver, and the BC Institute of Technology, among others, on EV infrastructure in early 2017 as part of program development.

The user fee program for City owned and operated EV charging stations will be guided by the following principles, in order of importance:

1. Increasing turnover
2. Ease of understanding
3. Encourage home use where possible and use of lowest power infrastructure
4. Eventual return on investment on infrastructure
5. Fairness
6. Rates that encourage the transition to electric vehicles

Roll-out of User Fees to initial City owned and operated EV Chargers

Initially, user fees will be introduced at City owned and operated EV charging stations located at 16 different locations – all of which are City or Park Board jurisdiction sites. For context, EV charging stations presently exist under four different operating models in Vancouver, as described in the table below. User fees proposed in this report will be applied to Groups ‘A’ and ‘D’ initially. The EV charging station in Group D is the only one that is not City owned and operated. That charger is owned by BC Hydro and operated by

the City. EV charging stations that fall within Groups B and C are not under consideration for user fees at this time.

Group	Owner	Operator	City to Apply User Fees	Example(s)
A	City	City	Yes	City Hall Main Library Branch Hillcrest Community Centre Curbside locations
B	City	Third Party Site Host	No	Oakridge Mall Bentall Centre
C	Third Party	Third Party	No	Fairmont Pacific Rim Vancity Credit Union
D	Third Party	City	Yes	Empire Fields (BC Hydro owns station, City operates).

A separate approval process for charging stations at Park Board jurisdiction sites is required by the Park Board and this may be scheduled in the fall of 2017.

Proposed Fees

Fees will be charged hourly instead of per unit of energy, to encourage turnover once batteries are fully charged. Charging hourly is also a more familiar and easily understood method of payment. For more details on the fee models considered please see Appendix A.

User fees are initially proposed as follows:

- Level 2[1]: $2.00/hour plus regular meter rate (as applicable)
- DC Fast Charge[2]: $16/hour plus regular meter rate (as applicable)

[1] Typically provides up to 30km of range per hour plugged in
[2] Typically provides up 200km of range per hour plugged in

The above pricing equates to about $0.46/L and $0.50/L of gasoline equivalent respectively[3]. The City's existing EV infrastructure on those City owned and operated EV chargers that are part of the initial rollout is capable of collecting user fees based on rates set by the City. With the exception of three charging stations at Hillcrest Community Centre, which are being upgraded, no additional changes or upgrades to City EV infrastructure is anticipated to implement the user fee system. The City will also ensure that, before applying a user fee at any particular City owned and operated EV charger, the party that has been hired by the City to electronically process payment at that EV charger complies with the standards established by the Payment Card Industry's PCI Security Standards Council.

For more detail on rates, please refer to Appendix A and page 41 in the EV Ecosystem Strategy.

Strategic Analysis

Pricing will be designed so that residential charging will cost less than public charging, and Level 2 to cost less than Fast Charging. The primary goal of this graded pricing model is to encourage drivers with home or workplace charging options to use them when possible. Because of the large price differential between electricity and liquid fuels in the region, it will be possible to implement charge station pricing that is effective in minimizing abuse while at the same time being far less expensive than gasoline or diesel. Also these rates will help ensure that other modes like walking, biking and transit will remain more attractive financially than driving an EV.

The pricing structure will be developed as an "add-on" to existing parking fees to optimize station utilization. In other words, the Level 2 and DCFC rates that are developed under the above criteria will be in addition to a given parking lot price or fee zone prices.

It should be noted that those City owned and operated EV charging stations that are part of the initial rollout and that are located in parking lots should not require a change in pricing policy by the parking management company. The City will set rates through the EV charging stations that will include the usual parking fee at a given lot and remit the parking fee to the lot operator. The City will agree upon the terms and conditions of such an arrangement with the parking lot operator before applying a user fee to such EV chargers.

Implications/Related Issues/Risk (if applicable)

Financial

Details of financial implications of introducing user fees are provided in Appendix A of this Council Report. The existing thirty (30) Level 2 stations and one (1) DC Fast Charging station will not incur any additional capital costs. Future installations, as approved under the 2016 EV Ecosystem Strategy, will have capital costs that will be funded within the approved 2015-2018 capital plan and expenditures will be managed with existing budget.

[3] Equivalency with gasoline is strictly an estimate, and can vary based on the energy efficiency of vehicles being compared. Typically, an EV can travel approximately nine to ten times further on a unit of energy than a similar internal combustion engine vehicle. Home charging would be closer to $0.20/litre equivalent.

It is estimated that annual revenues from all stations will be $23,500 with annual operating (excluding the investment for capital costs and installation) of approximately $14,500. It is anticipated that the currently proposed user fees will achieve a positive return-on-investment ("ROI") for Level 2 charging stations in approximately 1.25 years. It is anticipated that the currently proposed user fees for DC Fast Charge stations will not achieve a short-term ROI, however, revenues will increase significantly as electric vehicles become more common.
\
It is not presently known how sensitive EV drivers will be to user fees. As more market data is obtained and as the number of EVs on the road increases, it is expected that user fees will be adjusted and that positive ROIs will be achievable during the useful lifetime of the infrastructure.

The framework for rate-setting is described in detail in Appendix A.

Human Resources/Labour Relations

The introduction of user fees for City owned and operated public EV charging stations, and the concurrent inclusion of EV infrastructure within the Parking Meter By-law will generate the need for, and the ability of the City to, enforce the appropriate use of such public charging stations. This in turn will generate training needs for City Parking Enforcement staff and external partners, including parking management companies such as Easypark. Sustainability will support such training prior to the launch of user fees.

The collection of user fees will be via electronic means through existing data network providers that support the City owned and operated public EV charging stations. Human resources implications for this are therefore expected to be minimal and no new resources will be required.

Legal

The City may sell electricity through City owned and operated EV charging stations for a user fee without attracting public utility regulation under the British Columbia *Utilities Commission Act*. The definition of "public utility" under the *Utilities Commission Act* excludes municipalities.

Notwithstanding the above, the sale of electricity by the City through a City owned and operated EV charging station would trigger certain filing requirements under "energy supply contract" section (s. 71) of the *Utilities Commission Act*. This includes the need to file a generic sales contract as well as quarterly and annual sales information.

Public Notifications

City staff will provide public notifications for at least one month prior to implementing new user fees. Notifications will be provided through four modes simultaneously:

1. Messages displayed on EV charging station displays at affected sites.
2. Messages posted online at Vancouver.ca and to EV infrastructure mapping sites like Chargehub.com and plugshare.com outlining new pricing and implementation
3. Signage posted adjacent to EV charging stations at affected locations.

4. Regular social media reminders leading up to implementation.

The City will continue to gather input via 311 and social media to monitor implementation and may convene future user workshops to get input on evolving the program to best suit user's needs.

CONCLUSION

As directed by Council via the EV Ecosystem Strategy, the introduction of user fees at City owned and operated public access EV charging stations will increase turnover and ensure that the infrastructure is used more optimally and make owning an EV easier and more attractive. To implement a user fee system, Sustainability staff will work with Easypark, EV charging station data network providers, and City staff in affected departments and the Park Board. Public notifications will be provided approximately one month before the initiation of user fees, expected during summer 2017.

* * * * *

Financial Plan for COV Owned and Operated Public Electric Vehicle Charging Station Rates

1. Summary

The City committed to introducing user fees for public electric vehicle ("EV") charging stations as part of the 2016 EV Ecosystem Strategy. Sustainability will present an update to City Council on June 27, 2017 that will include proposed rates and changes to the *Parking Meter Bylaw*.

Presently, the City does not charge any fees at any of its public charging stations. Increasing congestion at many of the City's public access EV charging stations is reducing their utility to members of the public who rely on them. The significant growth in EV uptake (a 63% increase between 2015 and 2016) is likely to exacerbate this issue under current policy.

In 2016, City public access EV charging stations logged over 17,000 charging sessions. Data shows that approximately half of all time spent at City-owned EV charging stations occurs after the battery is full, suggesting a need for greater turnover.

The City consulted with stakeholders and thought leaders on EV infrastructure in early 2017 as part of program development.

2. Guiding Principles

User fees will be introduced with the intention of increasing turnover at City owned and operated EV charging stations, and encouraging EV drivers with access to home or workplace charging to use those preferentially.

The user fee program for City owned and operated EV charging stations will be guided by the following principles, in order of importance:

1. Turnover
2. Ease of Understanding
3. Encourage home use, lowest power use infrastructure
4. Return on investment on infrastructure
5. Public perception of fairness
6. Inexpensive compared to fossil fuels (maintain attractiveness of EVs over ICEs)

3. Consultation & Fee Models

Three potential models for fees were considered as part of the program design and consultation. The City plans to implement a time-based ($/hour) model as described below due to its alignment with the program principles as described above. A brief description of the three fee options is below.

Time-based ($ / hour)

Charging fees based on the length of time a station is occupied, and will encourage turnover so that charging stations are used by those who need them for EV charging and not simply as parking spaces, and optimize access through improved availability. Hourly fees are simple to understand, and would mirror existing rate structures for parking meters.

Energy-based ($/ kWh)

An alternate argument suggests that a fee based on energy (per kWh) would be more equitable between different models of vehicles with different on-board charging speeds, since users would only pay for energy received regardless of the length of time to charge. This, however, may hamper the ability for users who may be queuing to use station to determine wait times, and the ability for enforcement staff to manage these systems becomes increasingly complex.

Hybrid rate ($/kWh until battery full, then $/hour)

The third, hybrid option, would ensure equity in terms of pricing of energy delivered, while at the same time ensuring that users continue to pay a rate for staying at a charging station. Some jurisdictions have examined using relatively high hourly rates once a battery is fully charged to more strongly disincentivize “squatting”. However, a hybrid rate is also more difficult for users to understand, and may possibly lead to a less positive user experience. Some jurisdictions have introduced a ‘punitive’ hybrid rate such that the price is dramatically higher after a given time. However, more conventional parking enforcement measures can be employed by the City to prevent drivers staying beyond time limits at a given location.

It should be noted that upper limits on parking / charging times will be imposed, in line with the lot or city block that the charger is located on.

4. Station Usage

The City will only be bringing in user fees at locations where the City owns and operates the EV charging stations. The only exception is the DC Fast Charge Station located at Empire Fields, where BC Hydro owns the charge station and the City operates it. At these locations, the City owns the electrical supply, which is limited to City/Park Board buildings, City parking lots and stations on City ROW.

Such stations are present at 16 locations, as follows:

<u>Level 2 Stations (7kW)</u>

1. Arbutus St. adjacent to Kits Beach tennis courts
2. Britannia Community Centre
3. City Hall
4. Pacific National Exhibition

5. Mainland St. at Nelson
6. 180 Keefer St.
7. Mt. Pleasant Community Centre
8. Laneways at Oak & 49th Ave.
9. Coal Harbour Community Centre
10. Vancouver Aquarium
11. Vancouver Public Library Main Branch
12. Hillcrest Community Centre
13. Beach Ave. at Cardero St.
14. Beach Ave. at Bute St.
15. Beach Ave. at Bidwell St.

<u>DC Fast Charge Station (50kW)</u>

16. Empire Fields

Analysis of usage at 15 Level 2 locations was conducted for the period from January 10, 2016 to January 9, 2017 to determine the variations in usage at each location, and the typical session length and power obtained by users. It should be noted that usage at all locations has been increasing since 2013 when analysis began.

Usage of the Empire Fields location is not presently monitored, but is anecdotally reported to be high.

Analysis determined that the public Level 2 stations are used quite frequently, but not necessarily in a way that provides maximum public benefit. In the period mentioned above, a total of 17,016 charging sessions were recorded across the network.

The Level 2 stations were used on average for approximately three hours per session, consuming an average of approximately 8.2kWh. This suggests that the users of these stations are remaining longer than is necessary: a Level 2 charging station dispenses between 6.7kWh and 7.7kWh, indicating that on average, stations stop dispensing power less than halfway through a session.

The table below provides the breakdown, for illustration purposes, of the usage at Level 2 charging stations on City property.

Table 1 - EV Infrastructure Usage at City Properties

Station Name	Average Session Length	Avg. Energy (kWh/ session)	Total Sessions	Avg. Sessions / Month	Avg Session / per port	Avg Sessions (port/mo)	Average Usage per Day (hh:mm/port/d)
Kits Beach	2:40:18	8.76	1668	139.0	834	70	6:06
Britannia Community Centre	2:31:43	7.58	1910	159.2	955	80	6:36
City Hall	4:01:17	5.65	3035	252.9	759	63	8:21
Hastings Park	3:23:05	10.8	619	51.6	310	26	2:52
Mainland St.	2:53:41	10.8	3253	271.1	1627	136	12:53
Mt. Pleasant Community Centre	2:10:09	7.25	418	34.8	139	12	0:49
Oak St. / W.49th Ave.	1:30:10	5.03	177	14.8	177	15	0:43
Coal Harbour Community Centre	7:50:24	15.3	746	62.2	373	31	8:00
Vancouver Aquarium	1:38:31	5.33	965	80.4	483	40	2:10
VPL Main Branch	5:22:46	9.78	746	62.2	249	21	3:39
Hillcrest Community Centre	1:47:47	6.54	2475	206.3	825	69	4:03
Beach Ave (all)	1:25:19	5.47	1004	83.7	167	14	0:39
180 Keefer St.	1:40:10	5.143	471	39.3	236	20	1:04
Overall Average	**3:06:16**	**8.19**	**1418**	**118.17**	**575**	**48**	**4:44**
Overall Total			**17,016**				

5. Framework for Rate-Setting

The introduction of user fees will follow the City's model set out in the December 2016 *Parking Meter Bylaw* update. This framework is data-driven, and allows for adjustments to pricing based on a pre-determined objective for occupancy / availability. With respect to charging infrastructure, little is known on consumers' sensitivity to pricing, as few jurisdictions have introduced user fees to-date. Vancouver has significantly higher rates of use (and therefore of congestion) compared to many jurisdictions.

Generally, public understanding of energy consumption is quite low. Based on consultation with other local governments and thought leaders in this field, it was determined that a time-based system of user fees was simpler to integrate into existing parking regimes; and, was more likely to be understood by users. Further, pricing by time ensures an incentive for turnover, as public charging stations will continue to accumulate costs to a user's account; an energy-based system would cease to charge fees once a battery became completely charged.

Due to variations between vehicles, some EVs will obtain less energy over a given charging time than others, giving rise to concerns about equity between users. However, this disparity is not dissimilar from conventional fossil-fueled vehicles, whereby vehicles with poorer fuel economy derive less range per dollar spent compared with more fuel efficient models. Access to the infrastructure is arguably the value proposition behind introducing user fees. Therefore, that access, measured over time, appears the simplest method to ensure fairness.

Rates will be set as follows:

- Price per hour continuously while vehicles are connected
    - In some locations, this will likely be accompanied by an enforced upper limit on parking time.
    - For DC Fast Charge stations, this will be presented as a price-per-minute
- Structured as an 'add-on' to parking fees in a given lot or zone
- Correlated roughly to the power provided
- Tiered such that the charging stations providing the most range per hour will be the most expensive, and all public charging locations will be more expensive than residential electricity rates
- Fees for charging (not including the local parking rate) will be significantly lower than the equivalent fossil fuel costs.

6. Introductory Rates

The City will introduce the following rates, with adjustments expected as user sensitivity to pricing is better understood. The following introductory rates are additional to the parking rate at a given location, although the two fees will likely be collected at the charging station.

- AC Level 2: $2.00/hr
- DC Fast Charging (50kW): $16/hr.

7. Profit-Loss Expectations / Cost-Revenue

All public charging stations have both fixed and variable operating costs, as follows:

Fixed costs:

- Equipment lease or interest on capital investment
- Network services

- Utility basic charges
- Rate rider

Variable costs:

- Utility charges (electricity usage)
- Demand charges
- Transaction fees (network charge)

In order to be remotely monitored and collect payments, a fixed network fee is charged by a third-party operator that provides a cellular data connection to the charger. In addition, BC Hydro rates include a fixed daily charge. Operating costs include the cost of electricity, transaction charges from network providers, and demand charges[1]. It is expected that the introduction of user fees will cover the operating costs of EV charging infrastructure. It is also expected that a 5 year return-on-investment is possible even with a modest decrease in utilization. Because few jurisdictions in North America have implemented pricing for the purposes of easing congestion, projections will be challenging prior to implementing the program.

[1] As of April 1, 2017, BC Hydro now includes a demand charge for all medium and large site accounts (previously, only peak consumption over a specific threshold triggered demand charges).

Typical Cost-Revenue for a Level 2 (~7kW) charging station is provided in the table below.

Table 2 - Proposed Initial Profit-Loss Calculations for a Level 2 EVSE

Item	Unit Qty.	Per Session	Monthly
Typical Session Energy (kWh)		**8**	
Installed Capacity (kW)	**6.65**		
# Sessions	**-**	**1**	**125**
Usage Length (regardless of energy consumption) (hours)	**3**	**3**	**375**
Fixed			
Capital cost	**$4,500**		
Labour & Installation	**$2,500**		
Annual Network Fee	**$225**		**$18.75**
Basic Daily Utility Charge	**$0.2429**		**$7.39**
Annual Maintenance	**$200.00**		**$16.67**
Variable			
Electricity Cost ($/kWh)	**0.0880**	**$0.70**	**$88.00**
Demand Charge ($/kW)	**4.92**		**$32.72**
Rate Rider	**5%**		**$6.41**
Swipe Transaction Fee ($/txn)	**0.91**	**0.91**	**$113.75**
Total Variable Costs		**$1.61**	**$240.87**
Total Operating Costs			**$283.68**
User Fees Revenue	**$2.00**	**$6.00**	**$750.00**
Net Revenue over operating			**$466.32**
Annual Revenue over operating			**$5,595.86**
Simple Payback (yrs)			1.251

Overall, revenues for a Level 2 station could be as high as $750 per month, based on current usage rates. However, it is expected that this will be lower in practice. From a consumer perspective, $2.00/hour translates into about $0.30 per kWh, or the approximate equivalent energy as $0.46 per L of gasoline[2].

[2] Estimates of electricity vs. gasoline fuels' price equivalency are highly imprecise due to broad differences in vehicle efficiency between EVs and fossil-fueled vehicles. An EV can go approximately nine times further per unit of energy compared with a similar fossil fueled vehicle. As the two fuels themselves cannot be easily compared (electricity does not have a physical volume to be priced by), comparisons rely on estimated range per dollar of fuel purchased.

Table 3 - Proposed Initial Profit-Loss Calculations for a DC Fast Charging Station

Item	Unit Qty.	Per Session	Monthly
Typical Session Energy (kWh)		**25**	
Installed Capacity (kW)	**50**		
# Sessions	**-**	**1**	**125**
Usage Length (regardless of energy consumption) (hours)	**0.5**	**0.5**	**62.5**
Fixed Costs			
Capital cost	**$40,000**		
Labour & Installation	**$50,000**		
Annual Network Fee	**$225**		**$18.75**
Basic Daily Utility Charge	**$0.2429**		**$7.39**
Annual Maintenance	**$200.00**		**$16.67**
Variable			
Electricity Cost ($/kWh)	**0.0880**	**$2.20**	**$275.00**
Demand Charge ($/kW)	**4.92**		**$246.00**
Rate Rider	**5%**		**$26.42**
Swipe Transaction Fee ($/txn)	**0.91**	**0.91**	**$113.75**
Total Variable Costs		**$3.11**	**$661.17**
Total Operating Costs			**$703.97**
User Fees Revenue	**$16.00**	**$8.00**	**$1,000.00**
Net Revenue over operating			**$296.03**
Annual Revenue over operating			**$3,552.31**
Simple Payback (yrs)			25.336

The above table provides a sample calculation of the costs and revenues from a DC Fast Charging Station. Note that the simple payback period is significant. However, this assumes an initial usage of approximately 125 sessions per month. As EV adoption grows, it is likely that more than 300 sessions per month would occur, significantly reducing the payback period.

As the primary goal of the User Fees program is to create turnover, but also to ensure that electricity remains a significantly less expensive option, an hourly rate of $16.00 is proposed. From a consumer perspective, this translates into an approximately $0.50/L gasoline price.

8. Adjustments

Rate adjustments will be controlled through a similar methodology to the supply and demand based system applied to parking meters under the *Parking Meter Bylaw*. This is a data-driven system that sets rates to maintain a target occupancy/vacancy in a given area. When the number of vacant parking stalls is too low, parking rates are increased to create turnover and availability; when the number of vacant parking stalls is higher than targeted, parking rates are

reduced to increase demand for those stalls. A similar approach can easily be taken with EV charging, since networked stations are able to track their own availability and use.

Parking meter rates are adjusted based on the Peak Daytime Curbside Occupancy Rate over a calendar year, with adjustments occurring in the following calendar year. The Peak Daytime Curbside Occupancy Rate is defined as "the ratio of the number of occupied spaces on a block during the hours of 9:00 am to 6:00 pm to the total number of spaces on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year."

In the case of EV charging infrastructure, different target occupancies and availabilities are proposed initially because the sensitivity of consumers to price changes is unknown, and the relative availability of public infrastructure is quite low compared to that of metered parking stalls. Additionally, rate adjustments are recommended on a semi-annual basis for the first two years following the introduction of user fees.

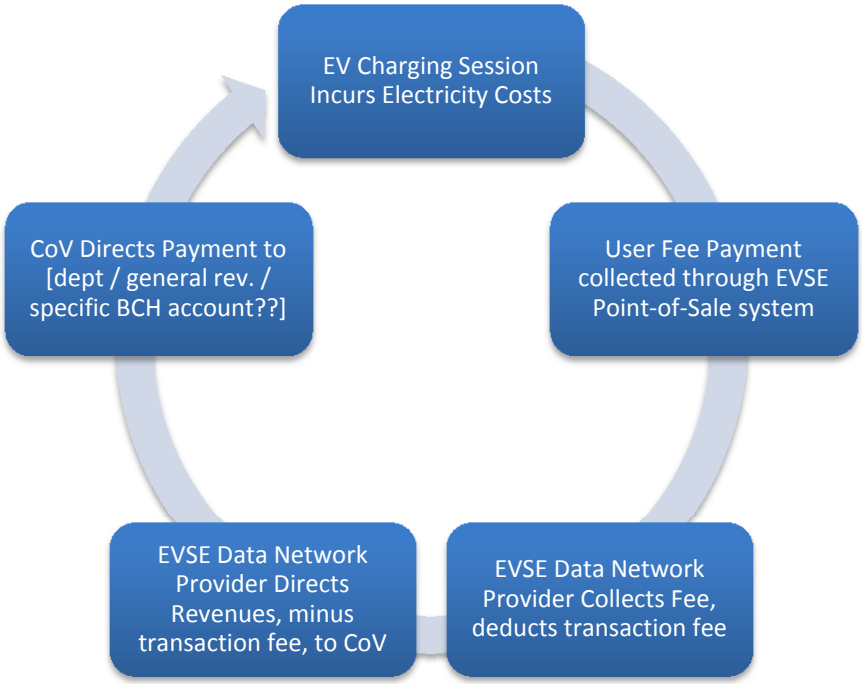
9. Use of Revenues

Two separate arrangements currently exist for electricity costs associated with EV charging stations on City properties.

1. EV infrastructure connected to an electrical panel that supports other loads and is not metered separately from other loads.
2. EV infrastructure is on a separate electrical panel that has a dedicated BC Hydro meter that bills only for EV charging loads.

A project to retrofit all locations captured under 1., above, is presently underway. However, it is anticipated that at some locations, installation of a separate BC Hydro meter may not be possible. In such scenarios, a revenue-grade submeter, as specified by Real Estate and Facilities Management, will be installed to determine the EV infrastructure-specific loads.

Under any of the above scenarios, the intended use of EV infrastructure revenues will be first to ensure cost recovery to the sites or departments responsible for them.



In the case of pay parking lots (i.e. – off-street parking), parking fees will be rolled into fees charged at the charging station, to avoid users needing to pay at multiple locations (i.e. – once at the charger, again at a payment kiosk). In such situations, the portion of revenues from EV charging stations equivalent to the parking rate will be directed back to the parking management company by the City.

10. User Fee Program Responsibilities

Department	Role
Sustainability	• Develop policy for User Fees and Oversee Implementation
Engineering	• Integrate EV Infrastructure User Fees Into Parking Management Policies, Consult with Sustainability on fee adjustments for two years following implementation • Quarterly and annual reporting to BCUC under S.71 of the Utilities Commission Act, supported by SUS • Direct payments to Easypark for portion of revenues equivalent to parking rates.
REFM Energy Management	• Manage Utility bills associated with EV charging
Finance	• Ensure flow of revenues to appropriate departments / accounts
EVSE Network Provider	• Provide monitoring data and remit revenues to CoV
Parking Enforcement (Internal to CoV or Easypark)	• Ensure that time limits at all EV infrastructure are enforced, and the any parking stalls associated with EV infrastructure are used only for that purpose.

A By-Law to amend

Parking Meter By-law No. 2952

regarding electric vehicle charging stations

THE COUNCIL OF THE CITY OF VANCOUVER, in public meeting, enacts as follows:

1. This by-law amends the indicated provisions of the Parking Meter By-law No.2952
2. In Section 2, Council inserts the following definitions in correct alphabetical order:

"Direct Current Fast Charging Station" or "DCFC" is a battery charging station equipment that transfers electric energy (by conductive or inductive means) to a battery or other energy storage device in an electric vehicle, is publicly available and that has a nominal power output of at least 24kW.

"Electric Vehicle" means any vehicle that operates, either partially or exclusively, on electrical energy from an off-board source, that is stored on-board for motive purpose; but, for the purposes of this by-law, does not include vehicles that cannot be licensed by the Insurance Corporation of British Columbia.

"Electric Vehicle Charging Station" means a Direct Current Fast Charging Station or a Level 2 Charging Station.

"Electric Vehicle Parking Space" means any marked parking space that identifies the use to be exclusively for the parking of an electric vehicle. Electric vehicle parking spaces may or may not be situated adjacent to an Electric Vehicle Charging Station.

"Interim Maximum Daytime Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations during the hours of 9:00am and 6:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City over a 30 day period.

"Interim Maximum Evening Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations during the hours of 6:00pm and 10:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City over a 30 day period.

"Interim Maximum Overnight Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations during the hours of 10:00pm and 9:00am to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City over a 30 day period.

"Level 2 Charging Station" is a battery charging station equipment that has as its primary purpose the transfer of electric energy (by conductive or inductive means) to a battery or other energy storage device in an electric vehicle, is publicly owned and publicly available or privately owned and publicly available and that has a nominal power output between 4kW and 15kW.

"Maximum Daytime Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations on a block during the hours of 9:00am and 6:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year.

"Maximum Evening Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations on a block during the hours of 6:00pm and 10:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year.

"Maximum Overnight Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations on a block during the hours of 10:00pm and 9:00am to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year.

"RFID EV network card" is a card provided by a data network operator of Electric Vehicle Charging Stations on a block that activates an Electric Vehicle Charging station through radio frequency identification technology for the purposes of providing electricity to an electric vehicle and collecting payments.

3. In Section 2, Council strikes the definition of "Parking Meter" and replaces it with:

   "Parking Meter" means a parking meter stand and the single or double parking meter head that it supports or an Electric Vehicle Charging Station.

4. In Section 2, Council adds a new subsection (8) to the definition of a "Metered Space" as follows:

   (8) in the case of an Electric Vehicle Charging Station any lawful parking space on a street between the curb adjacent to the roadway and an imaginary line on the roadway parallel to and 2.5 meters from the curb in an area marked as an Electric Vehicle Parking Space.

5. In Section 5 (1), Council adds the following new subsections:

   (g) in the case of an Electric Vehicle Charging Station designed to accept payments via a network subscription, tap the appropriate RFID EV network card on the appropriate part of the Electric Vehicle Charging Station and connect the electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session;

   (h) in the case of an Electric Vehicle Charging Station designed to accept payments via a smartphone application, use the smartphone application appropriate to the Electric Vehicle Charging Station and connect the electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session;

   (i) in the case of an Electric Vehicle Charging Station designed to accept payments via an RFID-enabled credit card, tap the credit card on the appropriate part of the Electric Vehicle Charging Station and connect the

electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session; or

(j) in the case of an Electric Vehicle Charging Station designed to accept credit card payments by phone, call the phone number printed on the Electric Vehicle Charging Station and provide the appropriate details to initiate a session, and connect the electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session.

6. In Section 5(2), Council adds the following new subsection:

(d) the time recorded on the Electric Vehicle Charging Station

7. In Section 5A, Council adds the following new subsections

(13) The initial metered rates for all Level 2 Charging Stations in an existing meter zone shall, prior to adjustment in accordance with this section 5A, be the metered rate for that block plus an additional $2.00 per hour.

(14) The initial metered rates for all Level 2 Charging Stations not in an existing meter zone shall, prior to adjustment in accordance with this section 5A, be $2.00 per hour.

(15) The initial metered rates for all Direct Current Fast Charging Stations in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be the metered rate for that block plus an additional $16.00 per hour.

(16) The initial metered rates for all Direct Current Fast Charging Stations not in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be $16.00 per hour.

(17) The initial metered rates for Direct Current Fast Charging Stations with nominal power outputs greater or less than 50kW in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be the metered rate for that block plus an amount calculated proportionally to the hourly rate of the nearest existing Direct Current Fast Charging Station as follows:

$$(R_{Near}) \times \left(\frac{P_{New}}{P_{Near}}\right) = R_{New}$$

Where

R_{Near} = Hourly Meter Rate of Nearest DCFC ($)

P_{New}= Power Output of New DCFC (kW)

P_{Near} = Power Output of Nearest DCFC (kW)

R_{New} = Hourly Meter Rate of New DCFC ($)

(18) The initial metered rates for Direct Current Fast Charging Stations with nominal power outputs greater or less than 50kW not in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be an amount calculated in accordance with the formula set out in subsection 5A(17) above without the metered rate.

(19) If the Maximum Daytime Charging Station Occupancy on a block exceeds 75% in a calendar year, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm for the subsequent calendar year shall be increased by $1.00 per hour no later than March 1 of that year.

(20) If the Maximum Daytime Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm for the subsequent calendar year shall be decreased by $1.00 per hour by no later than March 1 of that year provided that the rate shall not be less than the metered rate for that block.

(21) If the Maximum Daytime Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm for the subsequent calendar year shall be decreased by $1.00 per hour by no later than March 1 of that year provided that the rate shall not be less than $1.00 per hour.

(22) If the Maximum Evening Charging Station Occupancy on a block exceeds 75% in a calendar year, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm for the subsequent calendar year shall be increased by $1.00 per hour no later than March 1 of that year.

(23) If the Maximum Evening Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than the metered rate for that block.

(24) If the Maximum Evening Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than $1.00 per hour.

(25) If the Maximum Overnight Charging Station Occupancy on a block exceeds 75% in a calendar year, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am for the subsequent calendar year shall be increased by $1.00 per hour no later than March 1 of that year.

(26) If the Maximum Overnight Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than the metered rate for that block.

(27) If the Maximum Overnight Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than $1.00 per hour.

(28) If the Interim Maximum Daytime Charging Station Occupancy is more than 75%, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm shall be increased by $1.00 per hour.

(29) If the Interim Maximum Daytime Charging Station Occupancy is less than 40%, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm shall be decreased by $1.00 per hour provided that the rate shall not be less than the metered rate for that block.

(30) If the Interim Maximum Daytime Charging Station Occupancy is less than 40%, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm shall be decreased by $1.00 per hour provided that the rate shall not be less than $1.00 per hour.

(31) If the Interim Maximum Evening Charging Station Occupancy is greater than 75% then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm shall be increased by $1.00 per hour.

(32) If the Interim Maximum Evening Charging Station Occupancy is less than 40%, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm shall be decreased by $1.00 per hour provided that the rate shall not be less than the metered rate for that block.

(33) If the Interim Maximum Evening Charging Station Occupancy is less than 40%, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm shall be decreased by $1.00 per hour provided that the rate shall not be less than $1.00 per hour.

(34) If the Interim Maximum Overnight Charging Station Occupancy is greater than 75% then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am shall be increased by $1.00 per hour.

(35) If the Interim Maximum Overnight Charging Station Occupancy is less than 40%, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am shall be decreased by $1.00 per hour provided that the rate shall not be less than the metered rate for that block.

(36) If the Interim Maximum Overnight Charging Station Occupancy is less than 40%, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am shall be decreased by $1.00 per hour provided that the rate shall not be less than $1.00 per hour.

Appendix H

PLUGIN BC FAQ ON DC FAST CHARGING

The BC Electric Vehicle Infrastructure Project: DC Fast Charging

The British Columbia Electric Vehicle Infrastructure Project was launched in 2012 to support the mass adoption of electric vehicles in the province by addressing one of main barriers to adoption, the lack of public refuelling infrastructure. The project is led by BC Hydro and supported by the province of British Columbia, the federal government, municipalities and the private sector.

The BC EV Infrastructure Project, also known as the EV Experiment, supports the installation and operation of approximately 500+ level 2 charging stations for public use in urban areas across the province and 30 DC fast-charging stations along major transportation corridors.

WHAT'S IN A CHARGE?

Most electric car charging in Canada has zero out-of-pocket cost to the consumer. However, there is of course a cost to buy the charging station, install it, get permits to install it, develop signage for it, etc.

DIFFERENT TYPES OF CHARGING

Level 1 (120v, 1kW)	Level 2 (240v, 3-6kW)	DC Fast Charging (50kW)
• Cost = $200-$2,000	• Cost = $1,000-$2,500	• Cost = $50,000-$100,000
• 1 hr charge = 5-7km range	• 1 hr charge = 15-30km range	• 20 min charge = -80% (~90+km range)
• Use = home or Emergency trickle charge	• Use = home, work or on the go parking	• Use = long distance trips

DC FAST CHARGING HOSTS

In BC, you have to register as a utility in order to re-sell electricity, which is quite onerous

given the uncertain business prospects of operating a single DC fast charger. There are some exceptions such as landlords can resell to tenants and municipalities can resell within their jurisdiction. The latter was identified as the most suitable model for implementation at this time. For this project, the municipalities are considered the DC fast charging "hosts".

If hosts who install charging stations decide to recoup their investment and operating costs, there needs to be a viable business model for operating charging stations so that charging station networks exist far into the future.

Hosts can also assume the cost into their municipal budget as a service to the community and as an investment for economic development– it is up to each host. For example, a DC fast charger in a community has the potential to attract "EV tourism".

DC FAST CHARGER OPERATING COSTS

In addition to the upfront costs presented in the table above, **DC fast chargers** have operating costs:

- Variable costs include electricity @ $2 per a typical fill (about 20kWh) and a $0.91 transaction fee. These can be passed directly onto the customer.
- Fixed costs amount to $1,500 annually. The three main components include: $1,000 in utility charges, the bulk of which are *demand charges*[1]; $260 for the charging station network management system, which provides remote data collection, monitoring, payment processing and call centre; and general maintenance. These costs need to be repaid over the number of customers over a year.

For the purpose of this pilot DC fast charging project, all hosts have agreed to implement a **$0.35/kWh** charge with a minimum $2.00 sales per charge session. The minimum sales amount ensures the recovery of the $0.91 payment transaction fee and any electricity (kWh) dispensed before reaching the $2.00 mark.

[1] A charge for your highest rate of energy usage in a billing period.

FAQ

Q: WHERE DO I CHARGE MY EV?

Most people charge at home or at work while their cars are parked. There are over 650 free public charging stations in BC (the most in Canada). Public DC fast chargers serve as “EV gas stations” for longer trips.

Q: HOW MANY DC FAST CHARGING STATIONS ARE THERE IN BC?

The DC Fast Charging Pilot Program is part of the Clean Energy Vehicle Program (launched in May 2012) designed to provide British Columbians with more affordable clean transportation options. By March 31, 2016, there will be a total of 30 DC fast charging stations added to BC’s charging network. As of July 2014, there are seven DC fast charging stations available for use with another six being installed by December 2014.

Q: WHO IS FUNDING THE DC FAST CHARGING STATIONS?

The funding comes primarily from the Province of B.C. and the federal government.

In January 2013, the Province of B.C., along with BC Hydro, announced the Clean Energy Vehicle program that will help electric vehicle owners across British Columbia.

(Link to news release: http://www2.news.gov.bc.ca/news_releases_2009-2013/2013ENV0002-000067.htm)

On July 14, 2014, the federal government announced it was investing over $4.1 million to support the British Columbia Electric Vehicle Infrastructure Project Through the ecoENERGY Innovation Initiative (ecoEII).

(Link to news release:
http://news.gc.ca/web/article-en.do?nid=867749)

Q: WHERE ARE THE CURRENT DC FAST CHARGING STATIONS IN BC?

There are eight sites in BC to fast charge your EV:

Duncan – Island Saving Plaza

- Nanaimo – VI Conference Centre
- Langley – Events Centre
- Surrey – Museum
- Surrey – Powertech (9am-4pm , Mon-Fri only)
- Merritt – Visitor Information Centre

- Squamish – District of Squamish
- Kamloops – Hillside Stadium

***** pilot pricing began – July 21, 2014

Each host will be rolling out pricing at their station at different times. Visit Plug-In BC for updates.
Visit http://www.plugshare.com/ for a map of these stations.

There are another six DC fast charging stations being planned in Vancouver, North Vancouver, Hope, Saanich, Sidney and Sechelt.

The remaining 17 will be determined based on a range of factors including distance between stations and completing a full corridor loop in the Southern Interior.

Q: WHAT DATA WILL BE COLLECTED at THESE DC FAST CHARGING STATIONS?

No personal information is being collected. Information about each charging session such as time of charge and the amount of energy used will be gathered for analysis.

Q: WHAT ARE THE CONSIDERATIONS IN CHOOSING A DC FAST CHARGING SITE?

Drivers want to be able to charge at home, but to overcome range anxiety they will want access to quick and convenient charging on the road as well.

Sites are determined based on a range of factors including distance between stations, main transportation corridors (i.e. Sea to Sky highway), and community interest.

Q: WHY IS THERE A CHARGE FOR DC FAST CHARGING NOW AND WHERE DOES THE MONEY GO?

Although most charging will be done at home, DC fast charging ensures drivers can conveniently top up when they need to away from home and on longer trips.

While government funding supports the purchase and installation of charging infrastructure, the $0.35/kWh fee will help to recover some of the operating costs that hosts will incur.

This fee will ensure there is a sustainable infrastructure that survives beyond government support. Specifically the fee will help recover operating costs such as the demand charges and network service fees. However, at this time, due to the small but growing number of EV drivers using DC fast chargers, these fees are not expected to cover these operating costs yet

Q: WHAT IS THE PLAN FOR SAE (CCS) CONNECTORS FOR THE PROJECT?

The DC Fast Charger (DCFC) standards battle is reminiscent of the classic Beta/VHS battle and it is difficult to pick winners.

Nissan was first to market in 2011 with an all battery electric vehicle as well as a DC fast charging standard, CHAdeMO.

The American auto manufacturers introduced a North American standard for fast charging under the umbrella of the Society of Automotive Engineers (SAE). The standard is referred to as Combination Charging System (CCS). However, DC fast chargers for the CCS standard did not become available until the summer of 2014, along with CCS electric vehicles.

At the time of the initial procurement of DCFCs for this project, March 2013, only CHAdeMO stations were available. Therefore, the initial wave of DCFC installationS will only offer CHAdeMO fast charging. The remaining procurement of DCFC units will be dual standard (CHAdeMO & SAE CCS) stations, depending on availability and cost.

Q: WHY AM I GETTING A MESSAGE ABOUT DC FAST CHARGING FROM GREENLOTS? HOW DOES GREENLOTS FIT INTO THE BC EV INFRASTRUCTURE PROJECT?

The British Columbia Electric Vehicle Infrastructure Project is led by BC Hydro and supported by the province of British Columbia, the federal government, municipalities and the private sector. As a private partner, Greenlots provides the EV network solution that manages EV charging stations and associated services, including payment service and driver support.

Appendix I

REFERENCED DOCUMENTS

(Provided in electronic format only due to
document size and in order to conserve paper)

Charging Stations

More Places to Charge Up

There are a growing number of electric vehicle charging stations in homes, at workplaces, and in public places throughout British Columbia, with over 1000 public charging stations available. Additionally, charging stations extend beyond British Columbia, and EV owners can utilize the West Coast Electric Highway for trips to just about anywhere along the West Coast.

There are three levels of charging offering different amounts of power. The more power a charging station provides, the faster the vehicle is charged.

1. *Level 1 (120volt): Regular outlet, also known as "trickle charge", best used when parked overnight or long-term;*
2. *Level 2 (240volt): Typical for at home, at work, or short- to medium-term parking, e.g. while shopping; and*
3. *DC Fast Charging: Best for longer trips, allowing travel between cities.*

Learn more about charging basics in the EV101 Guide.

See maps of public charging stations.

Networked vs. Non-Networked

Networked charging stations are those that are connected to other stations and/or to a server. Some of the benefits of networked charging stations include data tracking, remote monitoring and updating, charge station reports, user access controls, mobile app integration, payment collection, and online reservation systems.

Non-networked, or basic stations are not able to communicate with other stations or servers. As such, these stations have little additional benefits beyond charging capability. However, since many networked stations often require station hosts to subscribe to a network, non-networked stations can be less expensive alternatives.

See also:

1. Home and Work Charging
2. Public Charging
3. Finding stations
4. Planning and Hosting a Charging Station

These Maps Show The State Of Electric Vehicle Charging In 2016

By *Eric Schaal* Posted *September 27, 2016* In *EV Charging*, *EV Industry*

There are many arguments about how public charging stations affect the adoption of electric vehicles in North America. Some say people charge at home most of the time so it doesn't matter; others say people need to know they can charge outside the home to avoid range anxiety and get more use out of their cars.

While each side has a point, it's difficult to imagine EVs taking off in an area without public charging infrastructure in place, especially with charging speeds getting faster. There is no range anxiety if:

1. You finish a 30-minute shopping trip to find your car gained 170 miles of charge
2. You finish a beautiful day at the beach with 100 miles added to your battery at no cost
3. During a trip from Boston to Philadelphia, you only needed to stop 15 minutes to charge your car

These scenarios are not hypothetical. The above can be done in 2016 with a) a Tesla Model S and a Supercharger, b) a Nissan Leaf at the main Santa Monica parking garage and c) any Tesla using a fast-charging station on the Northeast corridor.

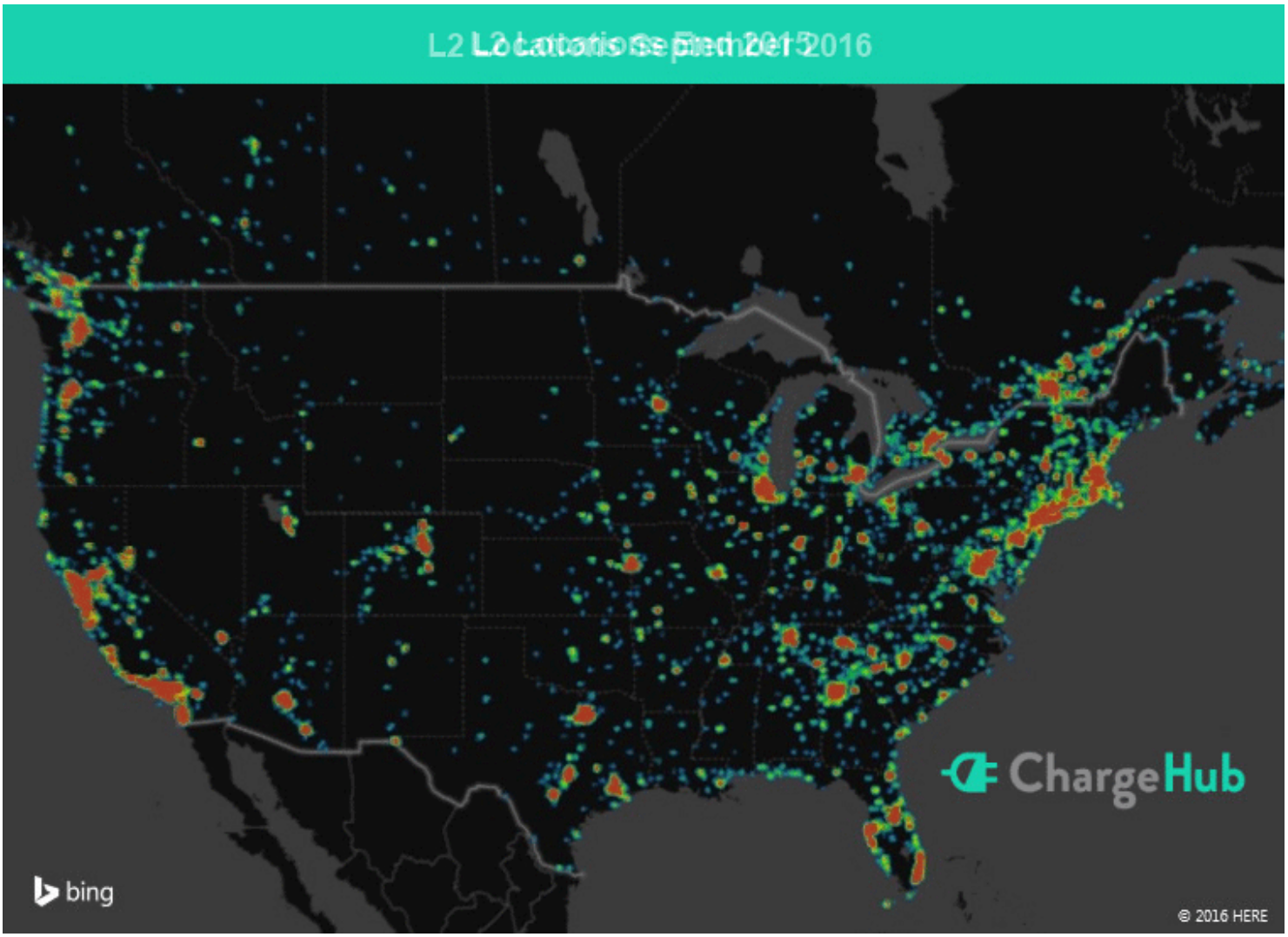
In fact, there have been major increases in the number of Level 2 charging and DC fast charging stations over the past year alone. Here is the state of electric vehicle charging in 2016 as told in maps (from our friends over at ChargeHub).

These Maps Show the State of Electric Vehicle Charging in 2016

CLICK TO TWEET

Appendix 3

Level 2 Charging in North America



Looking at the map of Level 2 charging ports at the end of 2015, we can see significant infrastructure in place, with the highest concentration of plugs in California and the North Atlantic region stretching from Maryland to lower New England. Chicago, Detroit, Montreal, South Florida and the largest Pacific Northwest cities also feature plenty of options for EV drivers in need of a charge.

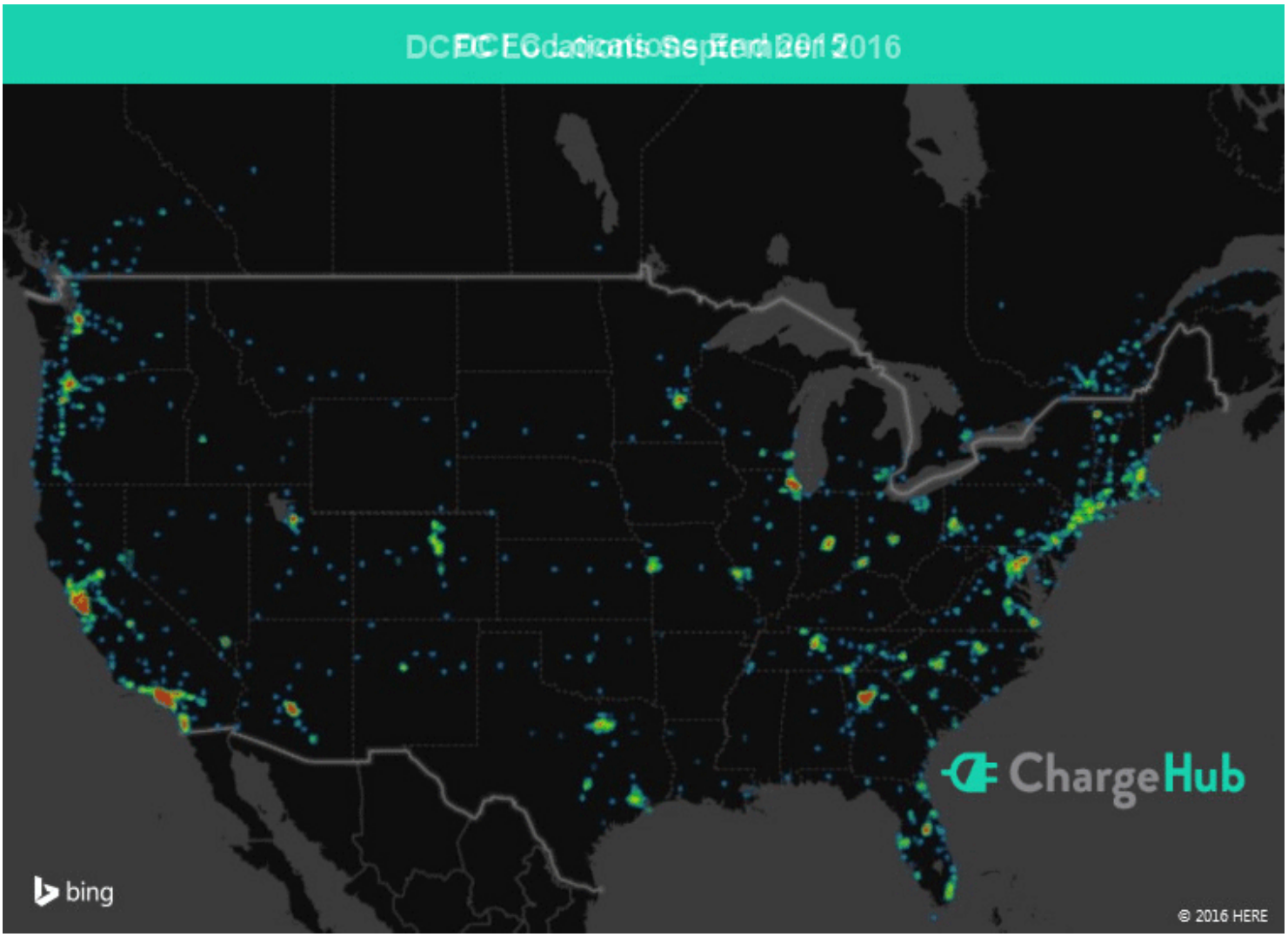
Want more content like this? **Subscribe to our newsletter** and we'll send it right to your inbox.

According to ChargeHub, there were 27,950 plugs available at the close of 2015. Just nine months later (September 2016), the number had jumped to 33,688 plugs – a difference of over 20%.

You can see the dots connecting along the Northeast Corridor where I-95 connects the cities of Boston, New York, Philadelphia, and Washington, D.C. Other changes are subtler, but the numbers show the U.S. gained over 5,000 Level 2 charging ports to hit 30,416 plugs by August 30. Canada gained over 500 plugs over the same nine-month span to hit 3,272. Growth was also close to 20% with Quebec showing improvements year-over-year.

DC Fast Charging in North America

Appendix 3



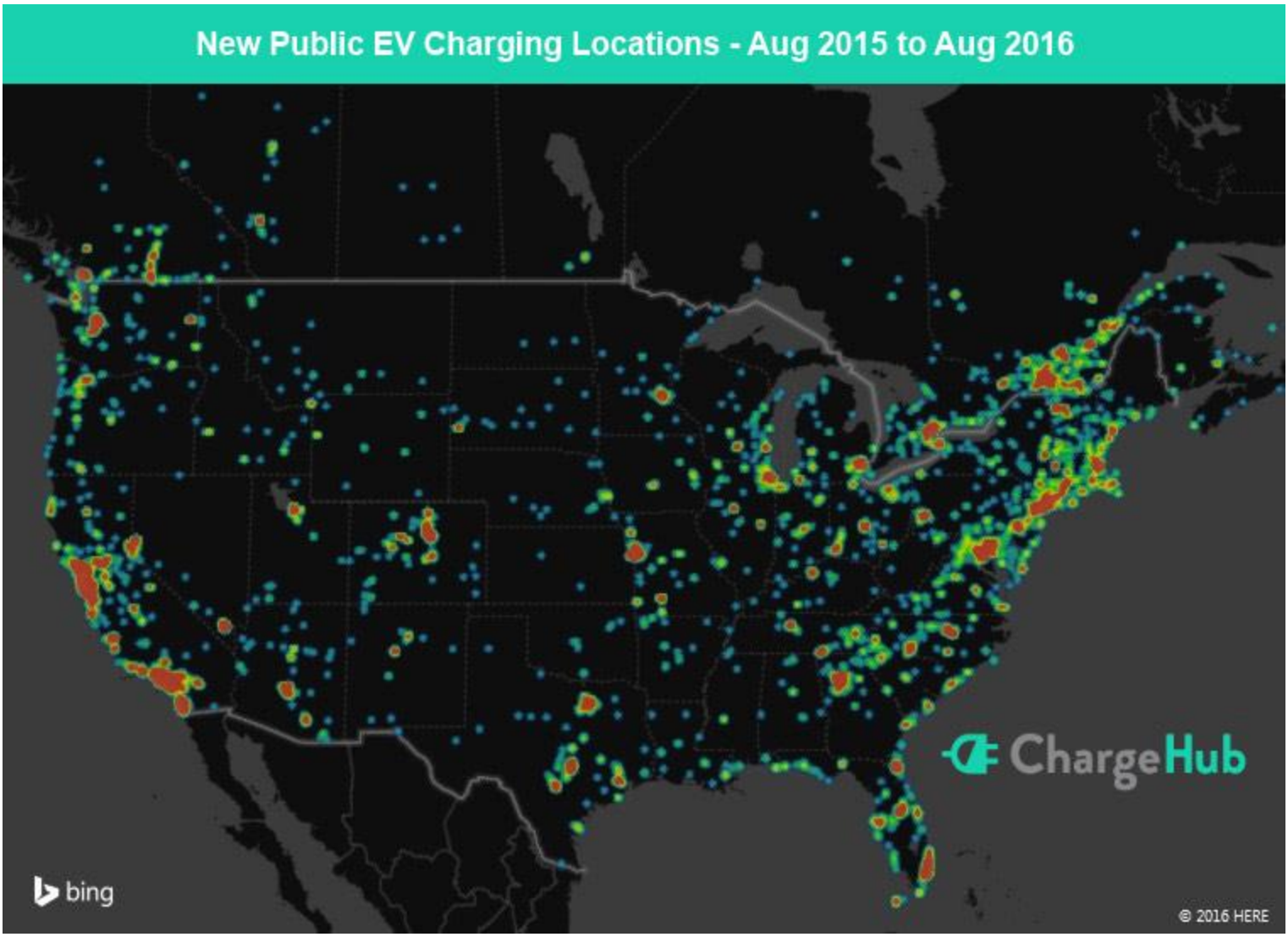
Electric car drivers on the hunt for DC fast chargers (also referred to as Level 3 chargers) have much fewer options. Of course, this is to be expected given the purchase and installation costs for a system that can power an automobile to 80% charge in as little as 30 minutes. At the close of 2015, there were 2,805 DC fast charging plugs in North America, with the lion's share (2,650) located in the U.S.

Nine months later, drivers could find 4,269 fast charging points in the same stretch of the Western Hemisphere, which represented a 33% increase in just nine months. This expansion of the network was the same on both sides of the border between Canada and the U.S.

Again, the Washington, D.C.-Baltimore area has the most visible growth when looking at the maps, while the Los Angeles area's concentration of fast chargers became even more pronounced over that time period. The recent completion of the Express Charging Corridors — a joint effort by ChargePoint, BMW, and Volkswagen – was the most notable upgrade along the East and West Coasts.

Clearly, the plan is to eliminate the need for EV drivers to get a rental car when traveling between cities. Trips between Boston and New York (215 miles), New York and Philadelphia (96 miles) or Philadelphia and D.C. (138 miles) should not be intimidating to EV drivers now. When the Chevy Bolt EV and Tesla Model 3 join the club with 238 miles and at least 215 miles, respectively, you will see EVs state their case even more clearly.

Overall Growth in Infrastructure



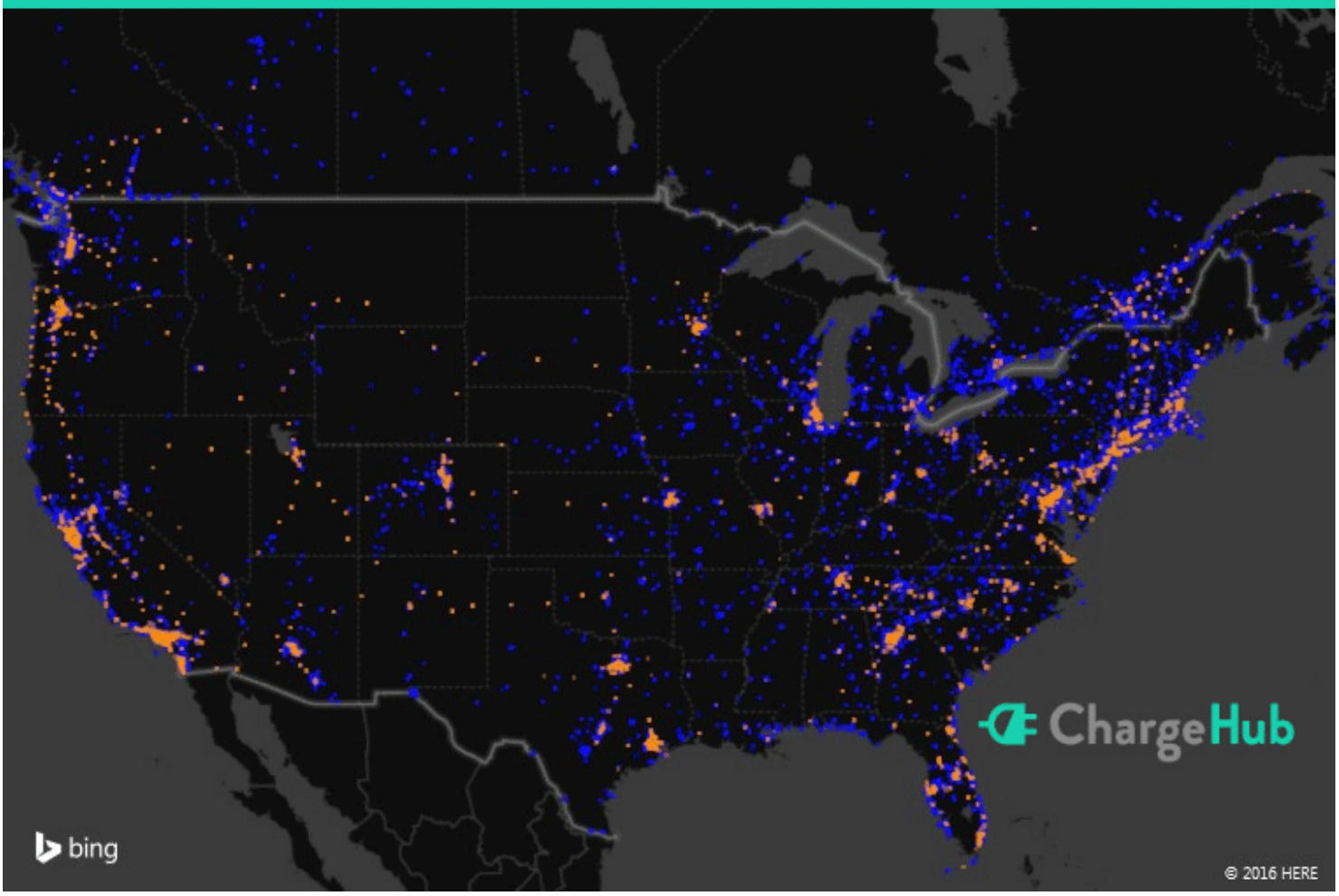
EV charging station growth heatmap (no fade effect on this map)

Of the 39,000+ charging ports now available in North America, over 7,000 came online between August 2015 and August 2016. The heat map above shows the biggest gains coming in California, where residents have registered about half the electric vehicles on the road in the U.S.

As the country's biggest auto market with a rapidly expanding population, California has an obvious need to reduce emissions. The lack of public transportation infrastructure in places like Los Angeles plays an important part in this issue. In most cases, L.A. residents need a car to get around the city, even if it means braving traffic. In the Northeast U.S., city commuting is largely possible on public transport.

When electric cars gain more range capabilities and become viable as the only vehicle in a family garage, it becomes more important to make road trips up and down the coast without losing time charging – much the way you do not when operating a car on gasoline. Continued improvements in charging infrastructure will make the electric way of life possible for more families. (According to an MIT study, 87% of U.S. drivers could use a short-range EV and get the job done in 2016.)

The Final Hurdles in EV Charging



With the public charging map looking more and more complete in areas of high EV adoption, automakers like Tesla, BMW, and Volkswagen deserve credit for their efforts along with charging station providers. ChargePoint, North America's largest provider of plugs, points out that drivers can charge for free at over half of its stations. (Parking fees apply at many free stations.) Changing habits is another part of the equation.

"It's important to remember that EVs change the way people refuel, shifting from a fill-up model to a 'top-off' model where drivers continually sip electricity at the places they spend time throughout the day," a ChargePoint spokesperson said. "That means that charging needs to be everywhere that EV drivers go." As a result, the company aims to offer solutions for everywhere a driver might be in the course of a day in town or weekend out of town.

If this trend continues, the angst about driving an electric car without a place to charge – known to many as range anxiety – should die a peaceful death in North America.

Note: want to embed these maps on your site? Shoot us an email :) sunny@fleetcarma.com.

Climate Leadership Plan

AUGUST 2016

BRITISH COLUMBIA

Climate Leadership Plan

AUGUST 2016

For more information visit the website:
gov.bc.ca/ClimateLeadership

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Table of Contents

B.C.'s Vision for Climate Leadership

British Columbians are proud to be recognized worldwide as leaders in the fight against climate change. We have proven that you can cut emissions while creating jobs.

In 2008, the Province released our Climate Action Plan and the world took notice. Since then it has provided us with the foundation we needed to reach our first target to reduce greenhouse gas (GHG) emissions to 6 per cent below 2007 levels by 2012.

We knew then that carbon pricing had to be central to any plan to fight climate change. That is why British Columbia was the first jurisdiction in North America to introduce a broad-based, revenue-neutral carbon tax. We knew we had to get our own public sector emissions in order before asking industry and the general public to do the same, so we implemented our Carbon Neutral Government legislation. Along with California, we were also the first to implement a low carbon fuel standard.

Our plan recognized that there were fundamental policies that everyone had to get going on — like addressing the emissions that come from our built environment, helping buyers afford low-emission, electric and hydrogen fuel cell vehicles, and preparing our province for climate change with an adaptation strategy.

Since 2011, I have had the honour to serve as British Columbia's Premier, and I am proud to say we have continued this passionate commitment to fighting climate change through actions such as: renewing the Clean Energy Vehicle program; expanding the Carbon Neutral Capital Program to health authorities and public post-secondary institutions; providing funding for energy efficiency improvements in our local governments and First Nations; and working with partners here in Canada and the U.S. on initiatives to fight climate change.

Through these actions and others, British Columbia has demonstrated that we can reduce emissions while continuing to grow the economy and create jobs. We are already seeing proof — our province now has over 60,000 clean economy jobs.

Today, we continue to build on the work we started in 2008 by launching our new Climate Leadership Plan. While our 2008 strategy laid the foundation for large scale change, we are now developing a strategy to add targeted, coordinated, sector-specific actions. We started by consulting with experts and listening to British Columbians. Now we are taking action with an approach that recognizes that real sustainability means balancing environmental concerns with social and economic issues, such as affordability and job creation.

B.C. has the highest and most comprehensive carbon tax in North America. As climate leaders, we know we can achieve more working together with Canada's provinces, territories and the federal government, while respecting each other's jurisdictions. We support the adoption of B.C.'s price on carbon as a national benchmark, and increasing that price together in an effective and affordable way, once others catch up.

Revenue neutrality remains the core principle of British Columbia's carbon tax. The carbon tax can only increase if every dollar is returned to citizens in the form of tax relief. In that way, we tax the pollution we don't want and use the money for what we do want — money in people's pockets, jobs and opportunity.

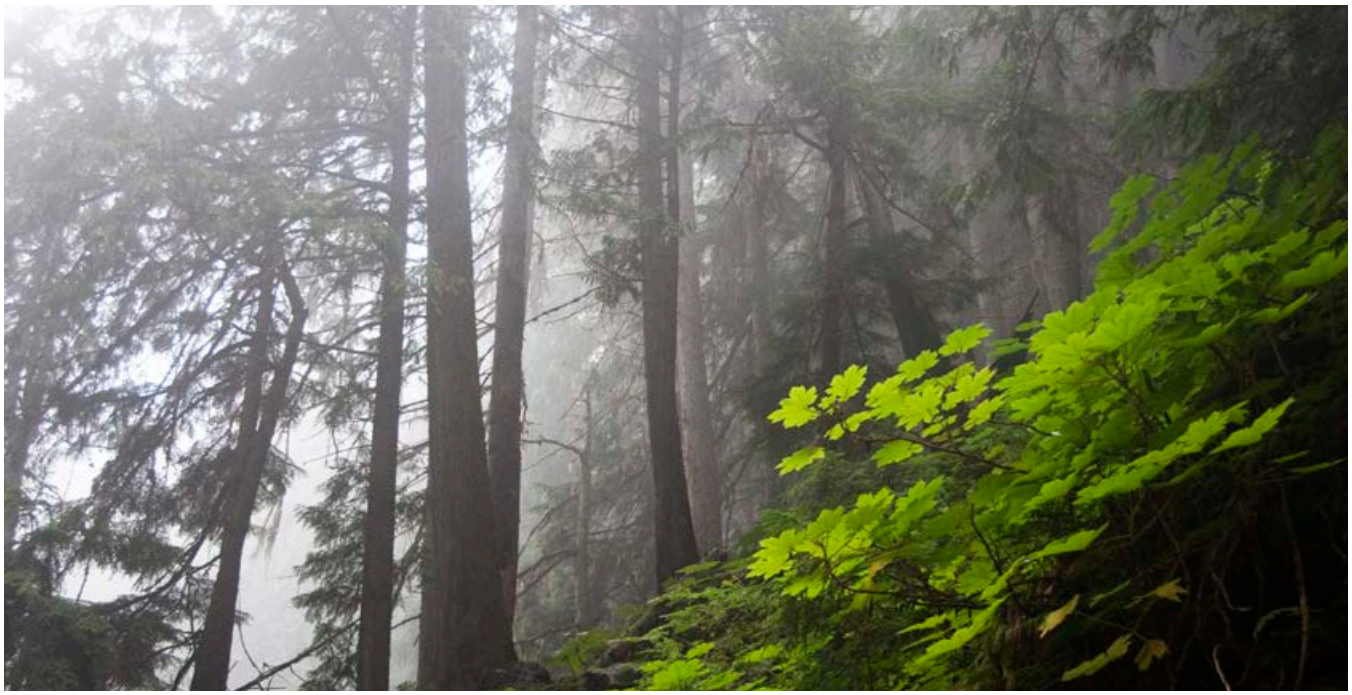
The Province will also protect jobs by ensuring B.C.'s global competitiveness. As our Climate Leadership Team recommended, we will design a mechanism to protect the competitiveness of our industries that depend on energy and trade.

> *British Columbia has the highest and most comprehensive carbon tax in North America.*

Carbon pricing is one of several key tools to tackle climate change. Technological breakthroughs and innovations are also required, as well as targeted actions to reduce greenhouse gas emissions, like the ones we are announcing today.

We are taking action across key areas where emissions are created, including upstream methane emissions mitigation, new transit options and energy-efficient building improvements. We are ensuring that we develop industries like liquefied natural gas in ways that are cleaner than competing jurisdictions, allowing us to ship it to other nations where it can reduce their reliance on higher carbon energy sources like coal and oil. By seizing the opportunity of a low carbon economy and securing global trade partnerships, we can create thousands of green jobs in areas like clean technology and clean energy, contributing to reductions in emissions not just here at home, but around the world.

Photo Credit: Adam Ryder/World Bank (https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode)



B.C.'s Climate Leadership Plan must be a living, breathing strategy. It has to grow as we work with our partners across Canada to align policies to produce the most effective results. It must also engage our industry, communities and First Nations to find ways to achieve our goals together. This first set of actions cannot solve all of the issues we face — many will require complex strategies that account for a wide range of related factors. So we need to take the time to get them right.

B.C. is committed to reaching our 2050 target to reduce GHG emissions to 80 per cent below 2007 levels. That means continuing to update our plan, which we will do over the course of the following year and every five years after that.

This document will help you learn about the first new steps we are taking, as well as the ways that industry, First Nations, communities and individuals can participate in our mission to fight climate change.

The world is moving towards a lower carbon future and B.C. is well positioned to continue to lead this movement. With over 200 clean tech companies, abundant clean energy and natural resources, and a strategy to support innovation across all sectors, B.C.'s green economy is creating jobs today and the foundation for a secure tomorrow.

We applaud the federal government's renewed commitment to the fight against climate change, and look forward to working with them on the Pan-Canadian Framework. This is a critical issue that requires every level of government working together, alongside industry and communities, to create an integrated strategy to achieve our climate action goals. Our province is committed to being at the forefront of this fight and continuing to demonstrate climate action leadership.

We hope that you will join us in this important mission.

Sincerely,

HONOURABLE CHRISTY CLARK
PREMIER OF BRITISH COLUMBIA

Climate Leadership Plan at a Glance

The Climate Leadership Plan is British Columbia's next step to fight climate change. This plan highlights the first set of actions we are taking to help meet our 2050 emissions reduction target of 80 per cent below 2007 levels, while building a clean economy.

These actions are expected to reduce annual greenhouse gas emissions by up to 25 million tonnes below current forecasts by 2050 and create up to 66,000 jobs over the next ten years.

Natural Gas

Natural gas offers an opportunity to grow British Columbia's economy, while helping other jurisdictions reduce their carbon footprint by transitioning to this cleaner burning fuel.

We are taking action in three key areas:

- ☑ Launching a strategy to reduce upstream methane emissions by 45 per cent;
- ☑ Developing regulations to enable carbon capture and storage; and
- ☑ Investing in infrastructure to power natural gas projects with British Columbia's clean electricity.

This action area is expected to reduce annual emissions by up to 5 million tonnes by 2050.

Transportation

Transportation is essential to keep British Columbia moving, but a significant source of our emissions.

The Province is launching new actions to reduce the impact of transportation, including:

- ☑ Increasing the requirements for our Low Carbon Fuel Standard;
- ☑ Amending regulations that encourage switching commercial fleets to renewable natural gas;
- ☑ Expanding support for zero emission vehicle charging stations in buildings; and
- ☑ Expanding the Clean Energy Vehicle program to support new vehicle incentives and infrastructure.

This is in addition to our 10-year transportation plan that will:

- ☑ Invest in infrastructure to reduce congestion;
- ☑ Create new rapid transit lines; and
- ☑ Shift more public transit to low carbon fuels.

In total, this action area is expected to reduce annual emissions by up to 3 million tonnes by 2050.

Forestry & Agriculture

Forestry and agriculture are foundational industries in British Columbia's economy. Our forests also offer incredible potential for storing carbon, so we are taking further action to:

- ☑ Rehabilitate under-productive forests;
- ☑ Recover more wood fibre; and
- ☑ Avoid emissions from burning slash.

Additionally, we are expanding a nutrient management program that will help improve the environmental performance of B.C.'s farms. This action area is expected to reduce annual emissions by up to 12 million tonnes by 2050.

Industry & Utilities

B.C.'s industrial sectors create good jobs for British Columbians, but they also require significant amounts of energy to power production. That is why we are taking action to reduce these emissions, including:

- ☑ Developing new energy efficiency standards for gas fired boilers;
- ☑ Enabling further incentives to promote adoption of efficient gas equipment; and
- ☑ Facilitating projects that will help fuel marine vessels and commercial vehicles with cleaner burning natural gas.

We are working with utilities on their demand-side management programs to make electrification projects and natural gas equipment more efficient. We are also committing to making B.C.'s electricity 100 per cent clean or renewable, with allowances to address reliability. These actions are expected to reduce annual emissions by up to 2 million tonnes by 2050.

Communities & Built Environment

Communities across B.C. play a critical role in the fight against climate change, particularly in the areas of buildings, waste, and planning. To build on progress already made in our communities, we are:

- ☑ Working with local governments to refresh the Climate Action Charter;
- ☑ Identifying tools to focus growth near transit corridors; and
- ☑ Supporting more resilient infrastructure.

We are also amending regulations to promote more energy efficient buildings, developing requirements to encourage net zero ready buildings, and creating a strategy to reduce waste and turn it into valuable resources. This action area is expected to reduce annual emissions by up to 2 million tonnes by 2050.

Public Sector Leadership

B.C.'s public sector is already leading the way in demonstrating how climate action can help reduce emissions. To continue this leadership, we are taking action with new strategies, including:

- ☑ Promoting use of low carbon and renewable materials in public sector buildings; and
- ☑ Mandating the creation of 10-year emissions reduction and adaptation plans for provincial public sector operations.

This action area is expected to reduce annual emissions by up to 1 million tonnes by 2050.

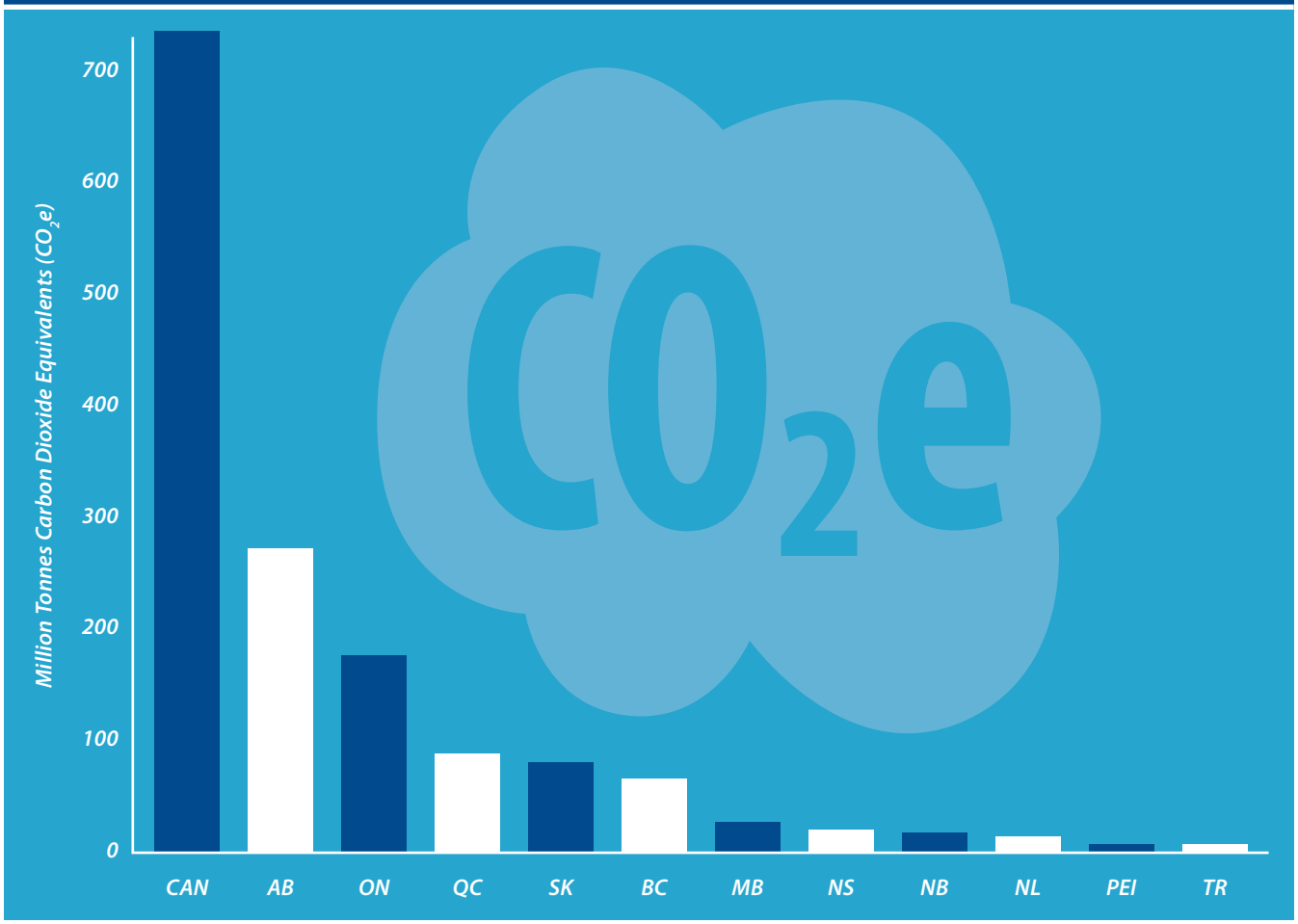
This set of 21 actions targets key areas we can act on now. The Climate Leadership Plan will be updated over the course of the following year as work on the Pan-Canadian Framework on climate action progresses.

Pathway to the Plan

The strategic actions included in this document represent the first steps the B.C. government is taking to update our climate action plan to work towards our 2050 goal. This plan is informed by the recommendations of our Climate Leadership Team, as well as our public engagement with British Columbians, industry, First Nations, communities and key stakeholders.

As we work with the federal government and our provincial and territorial partners to establish and implement a coordinated climate action plan, more actions will be announced. In this section you will learn what has driven the development of the actions being taken today, as well as a report on our progress to the 2050 target to date.

CANADIAN 2014 GREENHOUSE GAS EMISSIONS



Climate Change is Happening

Climate change is one of the most critical issues humanity faces. It is an important battle that all governments need to demonstrate leadership on.

This year in Canada, we saw its impacts happening in real time, as out-of-control wildfires in British Columbia and Alberta displaced thousands of workers, families and residents. The evidence is in front of us — we have already seen considerable climate change in British Columbia over the past century.

ENVIRONMENTAL CHANGE IN B.C. LOOKING BACK

TEMPERATURE: Average temperature has increased over all of B.C. since 1900 (1.4°C per century).*

PRECIPITATION: Average precipitation has increased over most of southern B.C. (1900 – 2013).

GLACIERS: All glaciers in British Columbia have retreated from 1985 to 2005.

SEA LEVEL RISE: Average sea level has risen along most of the B.C. coast over the past 95 years.

* *Winter is warmer on average than it was 100 years ago. Higher temperatures drive other climate systems and affect our environment and ecosystems.*

The impacts of climate change will become more pronounced as we head towards 2050. That is why it is critical we continue to work to achieve our climate action goals. We must take action to mitigate these impacts today.

LOOKING TO 2050

TEMPERATURE

- By 2050, B.C. is projected to be at least 1.3°C warmer and may be as much as 2.7°C warmer than in recent history.
- Growing seasons will be longer; species ranges will shift; the winter tourism season will be shorter.

PRECIPITATION

- By 2050, average annual rainfall may increase from 2 per cent to 12 per cent, with the potential for increased frequency of drier summers and increases in extreme rain events.
- Dry conditions contribute to forest fire season severity; heavy rain impacts buildings and infrastructure.

GLACIERS

- By 2100, B.C. is projected to lose up to 70 per cent of its glaciers.
- This will impact the timing and volume of river flow, drinking water quality and quantity, agriculture and winter alpine tourism.

SEA LEVEL RISE

- Sea level will continue to rise at most locations on the B.C. coast.
- Coastal flooding frequency and magnitude is expected to increase.

Sources: Plan2Adapt, Pacific Climate Impacts Consortium; http://www.plan2adapt.ca; Relative Sea-level Projections in Canada and the Adjacent Mainland United States; Geological Survey of Canada. James, TS, et al, 2014; and Projected Deglaciation of Western Canada in the 21st Century; Nature, Clarke et al, 2015.

British Columbia is Taking Action

Increasing knowledge of the impacts of climate change is what drove the launch of our world-leading Climate Action Plan in 2008. This plan included a wide range of large-scale policies designed to reduce British Columbia's impact on the environment, and was foundational in driving us to reach our first target to reduce GHG emissions to 6 per cent below 2007 levels by 2012.

To read the original plan in detail, go to: http://www2.gov.bc.ca/gov/content/environment/climate-change/policy-legislation-programs.

By the end of 2012, all of the actions outlined in the first plan were underway or complete, including more than $1 billion in climate action programs and tax incentives to encourage cleaner choices.

Since 2012, British Columbia has continued to invest in the innovation and infrastructure that will help us reach our 2050 target.

To date, an additional $1.9 billion has been dedicated to keeping British Columbia on the path to a lower carbon economy, including investments such as:

- » $50 million in clean energy and technology;
- » $831 million for clean transportation;
- » $300 million for transportation infrastructure;
- » $24 million to improve the energy efficiency of homes and businesses; and
- » $704 million for clean electricity infrastructure.

In 2016, British Columbia has continued engagement on climate action by participating in initiatives that align our climate action goals with our neighbours within Canada and internationally, including:

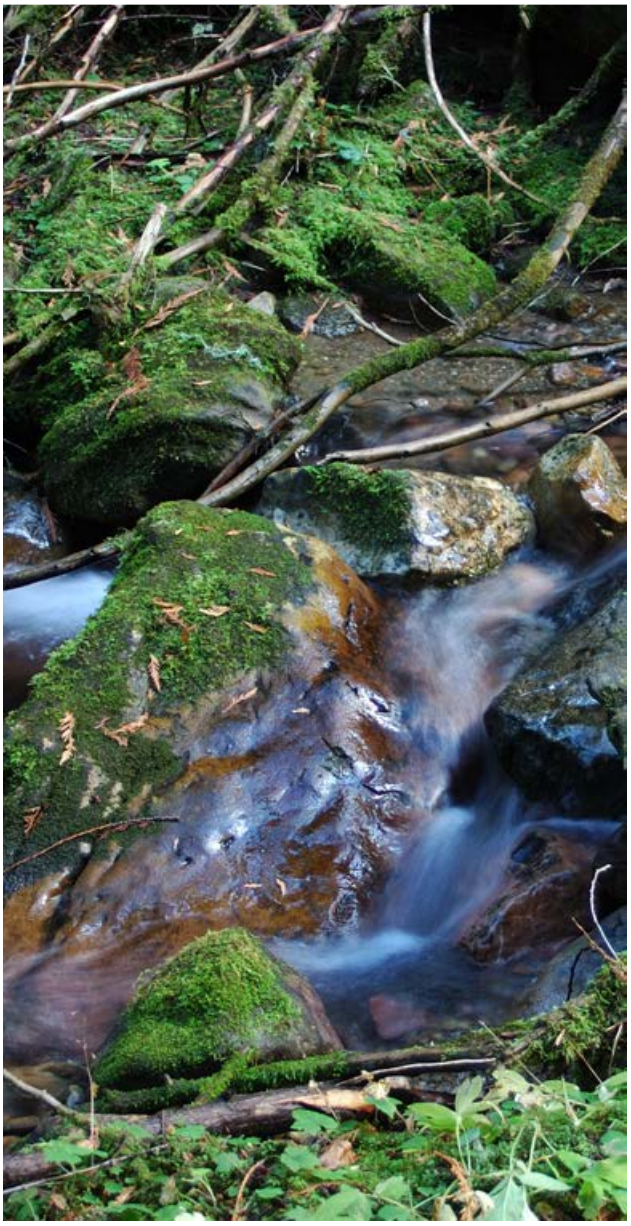
- The ***Vancouver Declaration on Clean Growth and Climate Change***;
- The ***Carbon Pricing Leadership Coalition***;
- ***Under 2 MOU*** (Subnational Global Climate Leadership Memorandum of Understanding);
- ***Pacific Coast Collaborative*** Climate Leadership Action Plan;
- ***RegionsAdapt*** Initiative; and
- ***International Zero-Emissions Vehicle Alliance***.

Now, the actions presented in this document outline the first steps we are taking under our new Climate Leadership Plan. This plan, which we will continue to update over the course of the following year and every five years after that, is creating strategies, programs, infrastructure, initiatives and incentives that will help us reach our 2050 target.

The Climate Leadership Team

In 2015, Premier Christy Clark challenged the world to meet or exceed the standard B.C. has set for climate action. She also announced that work was beginning to build on B.C.'s world-leading plan, including the formation of a Climate Leadership Team (CLT), made up of diverse leaders from British Columbia businesses, First Nations, local governments, communities, academia, and the environmental sector.

Through a series of collaborative working sessions, this team was asked to develop recommendations for actions that would maintain B.C.'s climate leadership. The CLT recommendations largely address carbon pricing and taking action to reduce emissions across the industry, transportation and built environmental sectors, while maintaining a strong economy.



The actions presented in this plan are driven by the hard work of the CLT. Throughout the action area descriptions, we have identified where they align with the CLT's recommendations. While they do not represent a full-scale implementation of all the CLT recommendations, we will continue to work on ways to take further action on their recommendations, particularly as our work with the federal government progresses and more funding opportunities for climate action become available.

To review the CLT's recommendations in detail, please visit: http://engage.gov.bc.ca/climateleadership/.

Public and Stakeholder Engagement

To inform the Province and the CLT's work, B.C. launched a public engagement campaign to invite input on the values and priorities British Columbians wanted to see in B.C.'s new climate action plan. We also conducted sector-specific engagements with stakeholders in B.C.'s various industries. Across two engagement periods we received considerable feedback, and affirmed the passionate commitment of British Columbians to fighting climate change.

Our engagement results to date include:

- 27,000+ website visits;
- 7,600+ feedback forms completed;
- 300+ detailed submissions;
- 7,400+ discussion guide downloads;
- 8,200+ emails received; and
- Input from over 300 organizations, local governments, and businesses via webinars, meetings, teleconferences, and email.

The initial survey presented four visionary goals for climate action, and asked British Columbians to prioritize which areas were most important to take action on, as well as priorities within each of those areas.

VISIONARY GOALS FOR CLIMATE ACTION

THE WAY WE LIVE:

- Focus: buildings, communities, and waste.
- Goal: communities are thriving and resilient in the face of climate change.

THE WAY WE TRAVEL:

- Focus: movement of people and goods.
- Goal: people and goods move efficiently and reliably, using clean transportation.

THE WAY WE WORK:

- Focus: business, industry, products and services.
- Goal: B.C.'s economy remains strong, and jobs continue to be created, while greenhouse gas emissions fall.

WHAT WE VALUE:

- Focus: how we consider the cost of climate change to society when making decisions.
- Goal: the cost of climate change to society is considered whenever British Columbians make important decisions.

Overall, the importance of a number of themes were repeated across the two engagement periods, particularly on issues such as transportation, clean technology and clean energy, the carbon tax, communities, climate adaptation and employment.

To see a summary of results from our consultations, go to: http://engage.gov.bc.ca/climateleadership/.

To achieve our goals, we need a shared vision that unites British Columbians in this important battle. That is why we listened to the priorities identified by British Columbians when developing this plan — fighting climate change must be a collaborative effort across government, industry, First Nations and communities.

The Province of British Columbia would like to thank all of the stakeholders that contributed to the development of this plan, from the Climate Leadership Team, to the individuals, communities, First Nations, businesses and organizations that participated in our public engagement campaigns.

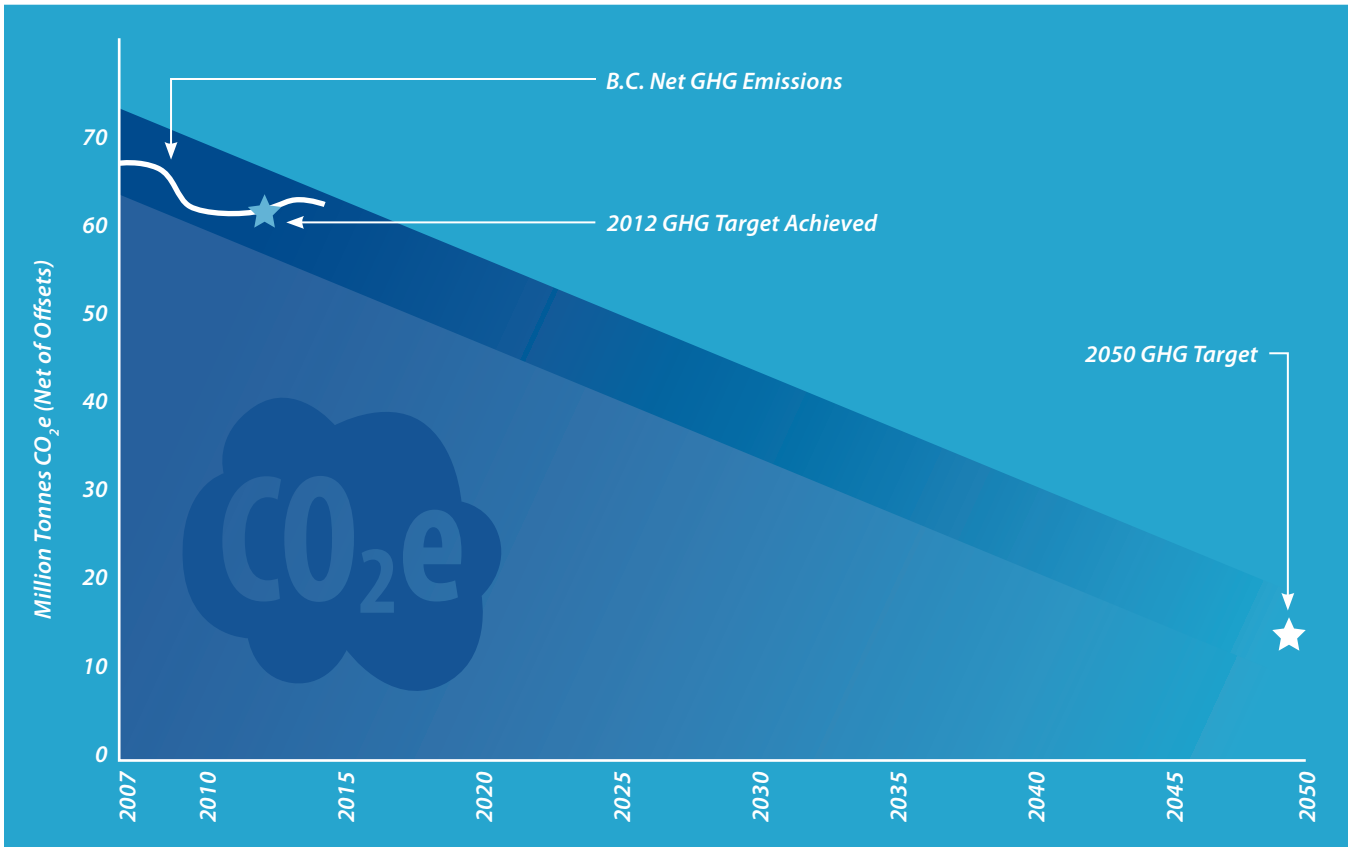
Fighting climate change is one of the most critical issues our world faces today, and any plan to combat it requires we listen to the voices of all those affected.

Progress to 2050 Target

Across all of this hard work and valuable contributions, one thing has clearly emerged — B.C. is committed to reaching our 2050 target of reducing GHG emissions to 80 per cent below 2007 levels. We have already made considerable strides towards that goal. In 2012, we reached our first interim target to reduce emissions to 6 per cent below 2007 levels.

Since that time, B.C.'s emissions levels have remained relatively unchanged. B.C.'s greenhouse gas emissions in 2014 were 62.7 million carbon dioxide equivalent tonnes (tCO_2e), including 1.8 million tonnes CO_2e in offsets from forest management projects, for a net reduction of 5.5 per cent since 2007. The 2014 greenhouse gas inventory for British Columbia can be viewed online at: http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/provincial-ghg-inventory.

B.C. NET GHG EMISSIONS AND TARGETS



Without renewed action, emissions may begin to rise again. So we are taking action starting with the release of this plan.

Beyond overall GHG emissions reductions, further proof that our plan is working is evidenced in the way that carbon pollution is decoupling from Gross Domestic Product (GDP) growth. In their recommendations, the CLT noted that:

> *"This past year, global carbon pollution from fossil fuels levelled off, even as GDP continued to grow. It was the first time in nearly half a century that carbon pollution decoupled from GDP globally. The International Energy Agency, which reported the finding, cited policy action on energy efficiency and renewable energy as the main factor driving the change.*
>
> *It was a remarkable signal and — as the impacts of climate change become increasingly visible and acute — it telegraphed a clear message to governments: Your efforts are essential, and you are making a difference. Keep going."*

In B.C., both GDP and population have been growing at rates comparable to the national average. Between 2007 and 2014, population growth in B.C. has been 8.1 per cent. Real GDP growth has been 12.4 per cent. With relatively stable emissions, this demonstrates a reduction in GHG intensities, both per capita and per dollar of economic output.

This decoupling shows that British Columbia has the ability to continue growing our economy and creating jobs, without a proportional increase in GHG emissions. However, we must be cautious in our approach, and each policy we implement must be tested before it is put into place to ensure that it is both environmentally and economically sustainable.

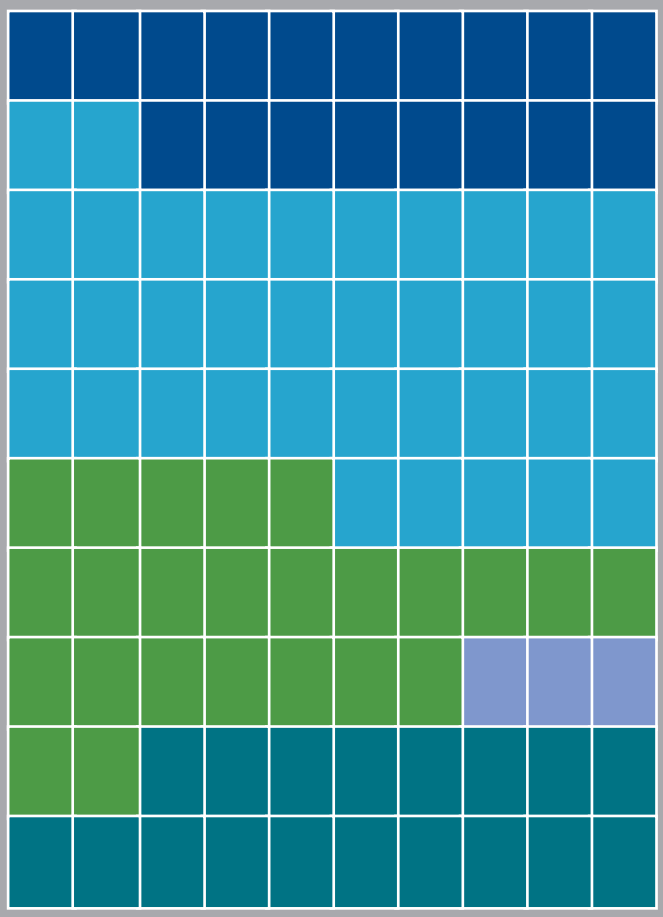
B.C.'s emissions per capita and per unit of GDP are well below the national average. Going forward, the rate of this decoupling needs to accelerate to hit our target. However, this information sends a clear message — our plan is working.

Action Areas

In the following sections of British Columbia's Climate Leadership Plan, we have identified the key areas where we can take action today: natural gas; transportation; forestry and agriculture; industry and utilities; communities and built environment; and public sector leadership.

While further actions will be announced over the course of the following year, these areas represent critical priorities where B.C. can take action to reduce GHG emissions that are not dependent on the work we are undertaking with the federal government on a Pan-Canadian Framework to fight climate change.

2014 GHG EMISSIONS BY SECTOR



INDUSTRY & UTILITIES 18%

- Electricity 1%
- Cement 3%
- Mining and smelting 3%
- Forest products 3%
- Manufacturing 8%

TRANSPORTATION 37%

- Commercial transport 23%
- Personal transport 14%

BUILT ENVIRONMENT 24%

- Residential buildings 6%
- Commercial buildings 4%
- Waste 9%
- Deforestation 5%

AGRICULTURE 3%

OIL & GAS 18%

Note: In 2014, British Columbia's emissions were 62.7 million tonnes CO_2e, including 1.8 million tonnes CO_2e in offsets from forest management projects.

Action Area: Natural Gas

WHY NATURAL GAS MATTERS

Natural gas is a growing industry in B.C. that can secure our economy for generations to come, while creating good jobs for our citizens. Natural gas is also the cleanest burning fossil fuel, representing an opportunity to shift global economies off GHG-intensive fuels like coal and oil to reduce worldwide emissions. The sector is reducing emissions intensity as it grows and currently contributes about 18 per cent of B.C.'s total emissions.

B.C.'s climate action strategy and implementation of new technology by the natural gas industry has already contributed to a 37 per cent decrease in emission intensity per unit of production since 2000. We have also eliminated all routine flaring at oil and gas wells and production facilities. Our carbon tax, together with offset payments, has encouraged improved efficiency in the sector, including waste heat recovery, methane leak reduction and electrification of facilities.

Yet we must still do more. B.C.'s natural gas sector needs to meet the challenge of becoming one of the world's cleanest producers and distributors of this fuel, so that the benefits of this cleaner burning fuel can contribute to global GHG reductions when we ship it to markets seeking to transition away from more emissions intensive fuels.

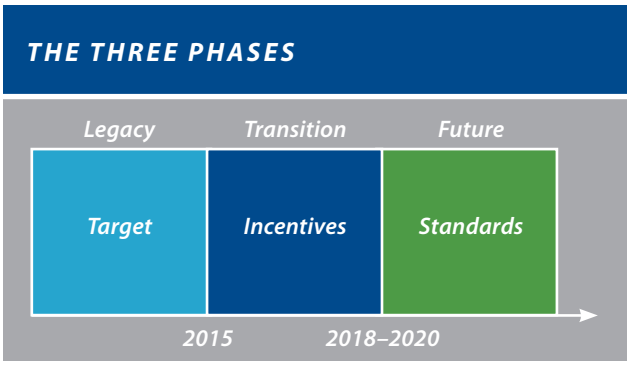
Almost 40 per cent of the natural gas sector's emissions come from non-combustion sources such as venting and leaks. Establishing standards for these processes that will lead in North America will help the sector to curb emissions as operations continue.

TAKING ACTION: LAUNCHING A STRATEGY TO REDUCE METHANE EMISSIONS

Oil and gas production accounts for approximately 11 million tonnes of annual GHG emissions in our province. Approximately 2.2 million tonnes of that total come from fugitive and vented methane emissions released during the production process.

As such, the CLT recommended that B.C. should set a goal to reduce fugitive and vented methane emissions by 40 per cent within five years, through regulating best practice leak detection and repair activities, as well as developing methane reduction and reporting best practices. They also recommended that after five years we determine if a more ambitious action is necessary.

Our first action for the natural gas sector is a methane emissions reduction strategy. This strategy is targeted at producing real, tangible reductions in emissions, while ensuring the industry remains competitive and has room to grow. B.C. will tackle methane emissions in three phases, using a combination of tools.



» The legacy phase will include targets for reducing fugitive and vented emissions from extraction and processing infrastructure built before January 1st, 2015. This will include:

- A 45 per cent reduction of these emissions by 2025, estimated at an annual reduction of 1 million tonnes for 2025; and
- A midpoint check in fall 2020 to determine progress towards this target, establish what happens if the target is not attained by 2025, and make adjustments if the target is not technically feasible.

» The transition phase will offer incentives to drive methane emissions reductions for all applications built between 2015 and 2018, and to help tackle legacy infrastructure retrofitting. Incentives will include:

- A Clean Infrastructure Royalty Credit Program, which will help stimulate investments in new technology to convert current infrastructure to less carbon intensive machinery. The pilot program will provide royalty deductions of up to 50 per cent of the cost of developing infrastructure that reduces fugitive or vented methane emissions from oil and gas; and
- A new offset protocol to further encourage innovative projects that reduce methane emissions.

» The future phase will establish standards that will guide the development of projects after the transition phase. This will include:

- Developing and enforcing standards to reduce methane emissions for all applications; and
- Making leak detection and repair mandatory, with protocols to be developed and enforced in alignment with other jurisdictions.

» Coordination with western Canadian provinces and the federal government will also be a key part of our methane emissions reduction strategy, to ensure regulatory alignment, while allowing for flexible provincial approaches accounting for resource base and individual provincial needs.

GET INVOLVED: SWITCH YOUR TRUCK FLEET TO NATURAL GAS

Cleaner burning natural gas can help you reduce the environmental impact of your industrial truck fleet.

FortisBC will cover up to 90 per cent of the cost to convert your medium/heavy duty fleet to compressed natural gas or liquefied natural gas.

Check out the full range of transportation fuel incentives available: https://www.fortisbc.com/NaturalGas/Business/NaturalGasVehicles/Howwecanhelp/Incentives/Pages/default.aspx.

MORE EFFICIENT ENGINES MEAN FEWER EMISSIONS

REM Technology Inc. is helping the natural gas industry lower its emissions through the use of two innovative new technologies called REMVue® AFR and SlipStream®. The REMVue® AFR is an engine management system used to control natural gas engines that compress natural gas from well-sites to processing plants. The system enables these engines to run more efficiently and reliably, while lowering the emissions created in the process. SlipStream® is designed to capture vented hydrocarbons like methane, and utilize them as fuel, either for a natural gas engine or process burner. Not only does this technology significantly reduce greenhouse gases, it reduces fuel costs for the engine or burner by up to 50 per cent. B.C.'s provincial offset standards and carbon pricing are helping drive these innovative offset projects.

TAKING ACTION: REGULATING CARBON CAPTURE AND STORAGE PROJECTS

Another important area where we have taken action to reduce the impact of natural gas development on climate change is Carbon Capture and Storage (CCS). CCS involves using innovative technology to capture waste carbon dioxide from industrial facilities and then transport it to a storage site, such as an underground geological formation, so it will not enter the atmosphere.

The Ministry of Natural Gas Development has developed a CCS regulatory policy framework to guide CCS development, ensure it is done safely, and provide transparency. In fall 2015, the first piece of legislation needed to enable CCS was passed. The Province is now collaborating with the BC Oil and Gas Commission to complete the regulatory policy framework and develop the additional legislative changes needed to allow CCS projects to proceed.

TAKING ACTION: USING ELECTRICITY TO POWER NATURAL GAS PRODUCTION AND PROCESSING

B.C.'s planned liquefied natural gas projects will create thousands of jobs and require additional volumes of natural gas production. The Province is committed to capitalizing on this opportunity while minimizing its carbon footprint. Production and processing (referred to as the "upstream" natural gas sector) typically requires the use of natural gas and diesel as fuel for industrial processes. Replacing those fuels with B.C.'s clean electricity could contribute to significant GHG reductions.

Capital funding will be necessary to develop upstream electrification of several key projects:

- Peace Region Electricity Supply Project;
- North Montney Power Supply Project; and
- Other upstream electrification infrastructure.

Electrification of natural gas developments in the Montney formation in Northeast B.C. is currently proceeding with existing infrastructure to avoid GHG emissions by up to an estimated 1.6 million tonnes per year. Full electrification of the Montney Basin could avoid up to 4 million tonnes of emissions per year, minimizing the GHG footprint of upstream natural gas development to ensure that B.C. has the cleanest LNG in the world.

Broader electrification of the Montney formation will require considerable capital investments in electricity transmission from both the federal government and B.C. It will also require the design of programs to make electricity costs comparable to natural gas costs for upstream applications. To support this action, the B.C. government is in dialogue with the federal government to provide the necessary capital to develop the required infrastructure. Programs are also being developed to close the gap between electricity and natural gas costs. Construction of this infrastructure would begin once LNG companies make their final investment decisions.

Action Area: Transportation

WHY TRANSPORTATION MATTERS

Transportation is essential to our economy and way of life. It also accounts for 37 per cent of B.C.'s total emissions, making it a key area where climate action can make a significant impact.

Climate action in the transportation sector must focus on supporting interconnected communities and the efficient movement of goods and people. That means: encouraging adoption of efficient vehicles and creating associated cost savings; supporting innovation in clean vehicles and fuels that improve our air quality, while creating new jobs in the clean tech industry; and working to guide the development of safe and reliable transportation infrastructure that is built to withstand extreme weather events.

We have already made significant progress in this action area. Our low carbon fuel requirement is driving innovation and growing the diversity of commercially available low carbon fuels, leading to the avoidance of over 2.3 million tonnes of GHG emissions between 2010–2012.

B.C.'s 10-year transportation plan includes a commitment to one third of the funding for new rapid transit projects and expanding compressed natural gas fleets. Building on the success of the 2009 rapid transit Canada Line, the new Evergreen rapid transit line will link the communities of Burnaby, Port Moody and Coquitlam with Vancouver, increasing transit integration and capacity in Metro Vancouver.

We have also invested in an incentive program for clean energy vehicles, supported by aggressive charging infrastructure installations, which has led to the purchase of 2,700 electric and hydrogen fuel cell vehicles and the development of over 1,100 charging stations in the province. We now lead the country in clean energy vehicle sales per capita.

As our economy grows, so will our transportation needs. It is imperative that we maximize the efficiency of the entire goods movement chain, to lower our impact on the environment and ensure the competitiveness of our economy.

We also need to provide more transit alternatives to British Columbians, to reduce the overall rate of vehicle kilometres travelled per capita.

REDUCING DIESEL USE IN NANAIMO

Public transit helps people get where they need to go, while lowering the number of emission-producing vehicles on the road.

The Regional District of Nanaimo (RDN) is taking this a step further by committing to switching its remaining diesel-powered buses to buses powered by compressed natural gas (CNG) by 2017.

This switch will cut greenhouse gasses and make the RDN Transit the first conventional fleet in Canada to be completely CNG powered. The co-benefits of CNG buses include lower fuel costs and quieter engines.

Photo Credit: BC Transit

TAKING ACTION: INCREASING THE LOW CARBON FUEL STANDARD

British Columbia's Low Carbon Fuel Standard is reducing the carbon intensity of transportation fuels by 10 per cent by 2020, relative to 2010.

The Climate Leadership Team recommended that we increase this requirement in the future to continue to drive greenhouse gas reductions.

We are now taking action to increase British Columbia's Low Carbon Fuel Standard to 15 per cent by 2030. This action is expected to achieve up to a 3.4 million tonne reduction in annual greenhouse gas emissions.

TAKING ACTION: INCENTIVES FOR USING RENEWABLE NATURAL GAS

Natural gas is considered renewable when it is produced from sources of biogas such as organic waste or wastewater. B.C. will be amending the Greenhouse Gas Reduction Regulation to encourage emission reductions in transportation. This amendment will allow utilities to double the total pool of incentives available to convert commercial fleets to natural gas, when the new incentives go towards vehicles using 100 per cent renewable natural gas. The program will also:

- Promote investments in natural gas fuelling stations at customers' facilities; and
- Support the production of renewable natural gas resources through increased demand.

MOVING PEOPLE WITH TRANSIT

Transit is the backbone of a low carbon community and an integral part of a healthy built environment. That is why the Province is working to improve public transportation infrastructure in Metro Vancouver and in BC Transit communities across the province. This will include the purchase of more SkyTrain cars, improvements to bus exchanges and SkyTrain stations, enhanced SeaBus service, initial work towards new major rapid transit in Vancouver and Surrey, and the modernization of a variety of TransLink's transit infrastructure. Outside of the Lower Mainland, the Province will build new maintenance yards and bus depots, and purchase new, cleaner and more efficient buses. Combined with contributions from federal and local governments, these improvements will benefit residents across the province opening up more affordable, transit-friendly communities.

TAKING ACTION: INCENTIVES FOR PURCHASING A CLEAN ENERGY VEHICLE

B.C.'s Clean Energy Vehicle program is designed to encourage the use of zero emission vehicles (ZEVs) throughout the province. Residents, businesses, organizations and local governments that purchase or lease qualifying new ZEVs are eligible for incentives off the pre-tax sticker price for battery electric, fuel cell electric, plug-in hybrid electric, and hydrogen fuel cell vehicles. These incentives can be combined with B.C.'s SCRAP-IT program to get older, higher emission vehicles off the road.

The Clean Energy Vehicle program is being expanded to support new vehicle incentives and infrastructure, as well as education and economic development initiatives.

GET INVOLVED: BUY A CLEAN ENERGY VEHICLE

Thinking of buying a clean energy vehicle? Learn about point-of-sale incentives that are available to help you purchase one through the Clean Energy Vehicle Program: www.gov.bc.ca/cleanenergyvehicleprogram.

Also, if you have an old gas guzzler that needs to be scrapped, see how we can help at: scrapit.ca.

If you're purchasing a clean energy vehicle and scrapping a gas guzzler, you could be eligible for both incentive programs.

TAKING ACTION: SUPPORTING VEHICLE CHARGING DEVELOPMENT FOR ZERO EMISSION VEHICLES

Since vehicles represent such a significant portion of our emissions profile, policies that facilitate the adoption of zero emission vehicles like electric cars can make a significant impact in the fight against climate change. A major challenge for adoption of these vehicles is ensuring that owners can access charging stations.

That is why we are taking action to support the development of charging stations across the province. These actions include:

- Developing regulations to allow local governments to require new buildings to install adequate infrastructure for electric vehicle charging; and
- Developing policies to facilitate installing electric vehicle charging stations in strata buildings and developments.

TAKING ACTION: 10-YEAR PLAN TO IMPROVE B.C.'S TRANSPORTATION NETWORK

B.C. on the Move is our 10-year plan to improve the province's transportation network that is already underway. It includes a comprehensive set of strategies that were driven by engagement of the public and key stakeholders, including actions that will help drive GHG reductions in a number of areas.

» Transitioning to low carbon fuels:

- Increasing the number of B.C. Transit compressed natural gas (CNG) buses and fuelling stations; and
- BC Ferries is investing in 3 new vessels and conversion of 2 large vessels to dual fuel capable ferries that can run on either liquefied natural gas or ultra-low sulphur diesel.

» Expanding transit:

- Supporting the construction of new rapid transit in Vancouver; and
- Developing rapid transit in Surrey.

» Reducing congestion:

- Replacing the George Massey Tunnel to reduce idling; and
- Optimizing movement through Canada's Pacific Gateway.

To review the entire B.C. on the Move plan, visit: https://engage.gov.bc.ca/transportationplan/.

GET INVOLVED: RIDE THE HOV LANE AND FIND A CHARGING STATION

Did you know B.C. allows approved electric vehicles to use high occupancy vehicle (HOV) lanes? Getting around in your electric vehicle has never been easier — especially with an ever growing network of charging stations. To find a station, go to: http://pluginbc.ca/charging-stations/finding-stations/.

CLEANING UP WASTE COLLECTION IN SURREY

In 2012, the City of Surrey mandated that its waste collection services be carried out using compressed natural gas vehicles. As a result, the city's contractor, Progressive Waste Solutions (PWS), launched a state-of-the-art CNG fleet for waste collection in Surrey, helping reduce emissions while diverting waste from landfills. These trucks emit 23 per cent less carbon emissions and 90 per cent less air particulates compared to diesel trucks. The city is also developing the first fully integrated organic waste biogas processing facility in North America that will be completed in 2017. The facility will turn organic waste collected at curbside into biogas and nutrient rich compost. The biogas will in turn be used to fuel the waste collection fleet, while the compost will be used by local farmers to produce fruits and vegetables. It is another step Surrey is taking to close the loop and become a zero-waste city.

Action Area: Forestry and Agriculture

WHY FORESTRY AND AGRICULTURE MATTER

Forestry and agriculture are foundational sectors of the B.C. economy, and areas that offer significant opportunities to take action against climate change.

Agriculture accounts for about three per cent of our emissions, arising from manure management, agricultural soils, and the methane produced when animals such as cattle and sheep digest food.

Greenhouse gas emissions from vehicles and mills used in forestry are counted as a component in the transportation and industrial sectors. The level of carbon stored in British Columbia's forests fluctuates from year to year based on natural factors such as fires, pests or weather.

In 2014, forestry offset projects alone removed 1.8 million tonnes of CO_2 from the atmosphere, creating jobs and unlocking new revenue streams for First Nations, communities, forest companies and private owners.

In the agriculture sector, changes in fertilizer use and soil management hold the promise of reducing greenhouse gas emissions. Many greenhouse growers are taking innovative steps to reduce their use of fossil fuels by incorporating clean tech solutions such as biomass boilers, thermal curtains and heat storage systems. Provincial offset standards and carbon pricing are making these changes more economically viable, driving their adoption in the sector.

Furthermore, many farmers in B.C. are also reducing emissions while creating new business opportunities by maximizing the value of agricultural byproducts, turning their waste into valuable resources and demonstrating the way one of our oldest industries is adapting to climate change.

PRINCE GEORGE'S WOOD INNOVATION AND DESIGN CENTRE

The award-winning Wood Innovation and Design Centre in Prince George was designed to demonstrate the way that innovative forms of wood production and use can lead to a more sustainable and beautiful future.

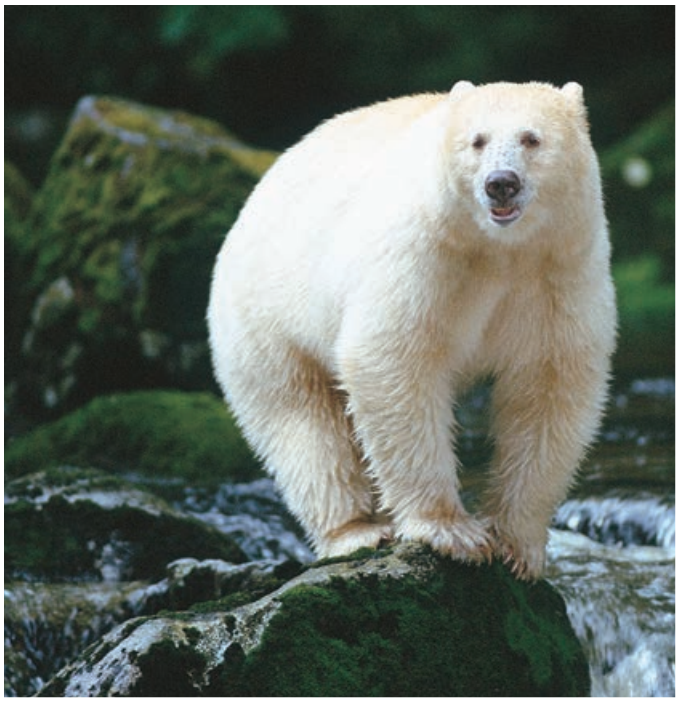
It makes use of mass timber, a wood product made from laminating together many smaller pieces of spruce, pine or fir. This centre showcases how British Columbia forest products can be made to order with powerful structural properties, while having a much smaller carbon footprint than steel or concrete.

Most recently, it was awarded the Governor General's Medal in Architecture in 2016 for its use of innovative and sustainable building technologies, the highest honour that can be given to an architectural project in Canada.

PROTECTING THE GREAT BEAR RAINFOREST TO REMOVE GREENHOUSE GASSES

The Great Bear Rainforest is one of British Columbia's most spectacular natural wonders — and an effective means of removing significant GHG emissions from the atmosphere. Great Bear's North and Central Mid-Coast, South Central Coast and Haida Gwaii forest carbon projects use ecosystem-based management practices that protect areas of the forest that were previously slated for logging.

These projects were enabled through the British Columbia Forest Carbon Offset Protocol and atmospheric benefit sharing agreements, developed in collaboration with First Nations leaders. In addition to reducing emissions, they also support the area's biodiversity and cultural heritage, while creating local economic opportunities.



TAKING ACTION: ENHANCING THE CARBON STORAGE POTENTIAL OF B.C.'S FORESTS

B.C.'s forest ecosystem covers more than 54 million hectares and provides us with significant potential for climate change mitigation.

We can harness this opportunity to sequester atmospheric carbon dioxide in this tremendous public asset through intensive forest management practices and storing carbon in long-lived wood products. That is why the Climate Leadership Team recommended that we update current forest policy and regulation to increase carbon sequestration.

So we are taking action to do even more to harness the incredible power of our forests through the new Forest Carbon Initiative, which will:

- Enhance the carbon storage potential of British Columbia's public forests; and
- Increase the rate of replanting and fiber recovery by 20,000 hectares per year.

This initiative will focus on enhancing the carbon sequestration of Mountain Pine Beetle and wildfire impacted sites — capturing the carbon benefits of new reforestation, while avoiding emissions from burning slash. This work will build on existing forest management programs, such as the recently announced Forest Enhancement Society and Forest for Tomorrow.

The Forest Carbon Initiative will rehabilitate up to 300,000 hectares of impacted sites over the first five years of the program. By 2050, the ten-year program is expected to lead to an annual reduction in greenhouse gas emissions of up to 11.7 million tonnes.

IMPROVED WOOD FIBRE USE

B.C.'s Fibre Action Plan is helping to generate more value and less greenhouse gas emissions from the province's forest resources. Through a pilot project with primary harvesters and Zellstoff Celgar Pulp Mill in Castlegar, approximately 500,000 cubic metres of residual wood (the equivalent of over 12,000 loaded logging trucks) that would once have been left in the forest were utilized as a source of fibre for the mill over the past three years. This not only helped to decrease the risk of wildfire, it saved approximately 185,000 tonnes of CO_2e from reduced slash pile burning. Additionally, the project created new jobs and economic benefits for the forest sector.

THE CHEAKAMUS COMMUNITY FOREST

The Cheakamus Community Forest carbon offset project is located adjacent to the Resort Municipality of Whistler, within the traditional territories of the Squamish and Lil'wat Nations.

The project retains more carbon in the forest by using ecosystem-based management practices that include increasing protected areas and using lower-impact harvesting techniques. Revenues from this B.C. offset project help overcome barriers to balancing environmental and economic sustainability, boosting additional uses for the forest such as recreation, tourism, and habitat protection.

Photo Credits: Bob Brett

TAKING ACTION:
DEVELOPING A NUTRIENT MANAGEMENT PROGRAM TO REDUCE EMISSIONS

In the agriculture sector, a nutrient management program is being developed to demonstrate best practices to reduce fertilizer use and GHG emissions, and is expected to lead to a nearly 100,000 tonne reduction of annual GHG emissions. This Nutrient Management Program will include:

- Expanding trials to develop and demonstrate nutrient management best practices to the agriculture industry;
- Increasing funding to the sector to implement Beneficial Management Practices that will promote better nutrient management and further reductions in GHG emissions; and
- Scaling up monitoring of nutrient management benefits and developing longer term performance indicators to measure their success.

GET INVOLVED:
ADAPT YOUR FARM FOR CLIMATE CHANGE

The Farm Adaptation Innovator Program supports projects that help build capacity for British Columbia farmers to adapt to climate change. Learn more about this and other resources to enhance agriculture's ability to adapt to climate change: www.bcagclimateaction.ca/farm-level/adaptation-innovator-program/.

GET INVOLVED:
BECOME A MORE SUSTAINABLE FARM

Farming sustainably is good for the planet and good for business. The Environmental Farm Plan Program supports farm operations to complete agri-environmental risk assessments. After completing an Environmental Farm Plan, farmers can apply for funding to implement Beneficial Management Practices that help to increase agricultural and environmental sustainability. Learn more at: https://www.bcac.bc.ca/ardcorp/program/environmental-farm-plan-program.

CREATING RENEWABLE NATURAL GAS FROM MANURE AND ORGANIC WASTE

Expanding agricultural production in the Lower Mainland requires solutions to the issue of manure produced by the large numbers of dairy cattle. With support from the Ministry of Agriculture's innovation program, Seabreeze Farms in Delta has built an anaerobic digester that is turning manure and other organic waste into biogas, digestate (organic fertilizer) and bedding for cows.

The biogas is created by capturing methane that would otherwise have gone into the atmosphere. The biogas is cleaned and upgraded into renewable natural gas that displaces conventional natural gas with a renewable energy source.

Photo Credit: Delta Farmers Institute

Action Area: Industry and Utilities

WHY INDUSTRY AND UTILITIES MATTER

B.C. industry creates thousands of good jobs, but requires significant amounts of energy to drive their production systems. These large-scale users of energy represent almost 18 per cent of our total emissions.

We are already driving innovation in this area with our carbon tax, which covers approximately 60 per cent of the emissions in this sector. As the world shifts to a low-carbon economy, B.C.'s low-carbon electricity has become a competitive advantage for B.C.'s businesses, driving industry to create green jobs and products that are helping the world reduce GHG emissions.

The portion of BC Hydro's power generation portfolio that comes from clean or renewable resources is currently 98 per cent, already above the 93 per cent requirement in B.C.'s Clean Energy Act. Furthermore, B.C.'s abundant supply of clean burning natural gas represents enormous potential to shift our industrial sectors and global partners off the use of more GHG intensive fuels, particularly in areas such as fuelling marine transportation vessels.

British Columbia has also established the Innovative Clean Energy Fund, through which we have invested over $70 million to support the development of clean energy and energy efficiency technologies in the electricity, alternative energy, transportation and oil and gas sectors.

TAKING ACTION: MAKING B.C.'S ELECTRICITY 100% RENEWABLE OR CLEAN

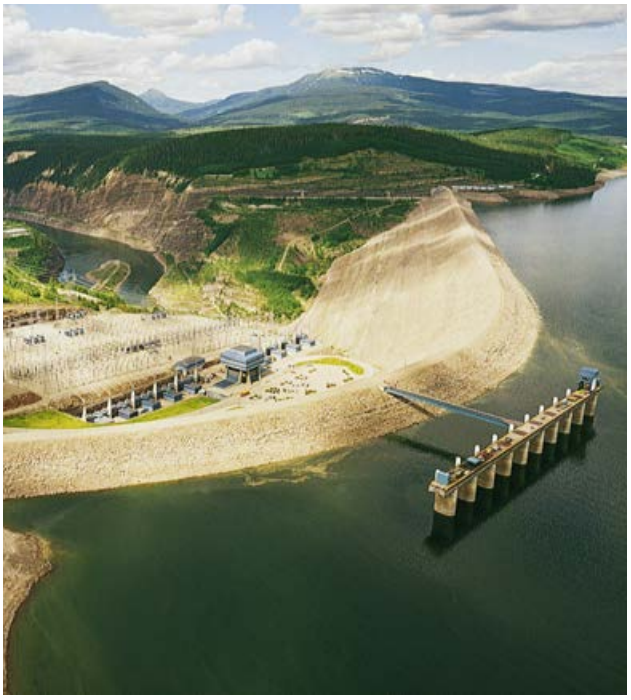
B.C.'s clean electricity supply is activating numerous opportunities to reduce GHG emissions across our industrial sectors. When an industry switches to electricity instead of fossil fuels, their emissions go down. The CLT recommended that we increase the target to 100 per cent clean energy on the integrated grid by 2025, while allowing for the use of fossil fuels for reliability. BC Hydro will focus on acquiring firm electricity from clean sources.

Going forward, 100 per cent of the supply of electricity acquired by BC Hydro in British Columbia for the integrated grid must be from clean or renewable sources, except where concerns regarding reliability or costs must be addressed. Acquisition of electricity from any source in British Columbia that is not clean or renewable must be approved by government through an Integrated Resource Plan, where it will be aligned with the specific reliability or cost concerns.

TAKING ACTION: EFFICIENT ELECTRIFICATION

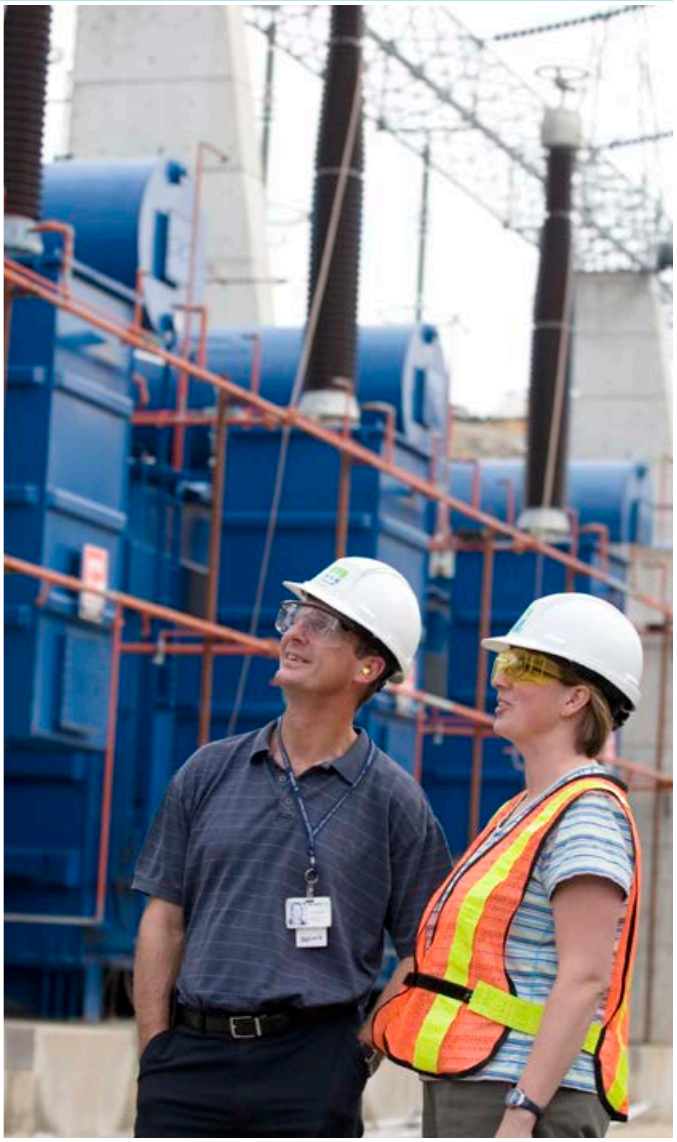
Demand-side management (DSM) programs help customers reduce energy bills by fostering awareness of energy use and providing incentives to increase energy efficiency. These programs can take on an expanded role in climate leadership, helping customers to understand their GHG emissions and providing incentives for efficient electric technologies to reduce GHG emissions.

To advance efficient electrification, we are taking action by working with BC Hydro to expand the mandate of its DSM programs to include investments that increase efficiency and reduce GHG emissions.



RENEWABLE ENERGY IS CREATING GREEN JOBS

British Columbia's clean energy producers have reported investment of more than $6 billion in First Nations communities and local economies, while fighting climate change and creating thousands of jobs throughout the north and interior regions. This growing sector has to date supported 15,970 direct, full-time equivalent (FTE) person years of construction employment in every region of the province, with another 4,543 FTE person years of employment projected for forthcoming projects. Furthermore, renewable power companies now employ 641 people in operational roles around the province, and new projects now under construction will support an additional 165 positions once completed. About 25 per cent of BC Hydro's energy supply now comes from independent power producers. The Province is also working with our neighbours in Alberta to investigate the opportunity for greater integration of our power systems, which would allow British Columbia to deliver more clean electricity to Alberta to reduce their reliance on fossil fuels to power industrial processes, thereby reducing their climate impact. British Columbia is truly demonstrating the business opportunity of renewable energy, while lowering our impact on the environment in the process.



SOLAR-POWERED T'SOU-KE

In 2013, T'Sou-ke Nation became the first Aboriginal community in the world to be designated a solar community. They have installed three solar demonstration projects. One demonstrates how remote 'off grid' communities can economically switch from diesel to solar. Another demonstrates how to be 'Net Zero' — which means no more electricity bills. Solar panels on their reservation are used to power all the administrative buildings, while sending their excess solar power back to the grid to contribute to British Columbia's clean energy profile. On sunny days, that excess can be up to 90 per cent of the power produced.

The profits of selling this power back to B.C. Hydro offsets their power bills during darker months. The project received $400,000 in funding from the Province's Innovative Clean Energy Fund. Solar programs in Colwood, the Capital Regional District and several First Nations throughout B.C. have been modelled after T'Sou-ke's leadership. T'Sou-ke is now working on harnessing the energy of the wind and waves to create more clean energy for their community and the province. T'Sou-ke Eco Tourism has been boosted by this project, with over 2,000 people from all over the world visiting each year for solar tours and workshops.

TAKING ACTION: FUELLING MARINE VESSELS WITH CLEANER BURNING LNG

B.C.'s abundant supply of natural gas represents a significant opportunity for industry to lower their impact on the environment. For example, B.C. can help the world replace high-emission marine transport fuels with cleaner burning natural gas, leading to global reductions in GHG emissions.

The Greenhouse Gas Reduction Regulation allows utilities to invest in clean transportation and infrastructure to reduce GHG emissions by replacing the use of higher emitting diesel with natural gas in a variety of sectors.

In particular, FortisBC has been expanding the use of compressed natural gas (CNG) and liquefied natural gas (LNG) in the heavy duty transportation sector since 2012, under its Natural Gas for Transportation initiative. Since 2012, FortisBC has committed $48 million in incentive funding towards the purchase of CNG and LNG vehicles.

These incentives translate to 485 CNG vehicles, 138 LNG vehicles, 6 mine haul trucks and 7 marine vessels that are in operation currently or will be in operation soon. These efforts will result in the reduction of over 74,000 tonnes of GHG emissions annually.

Recent amendments to the regulation will allow utilities to provide further incentives for the marine, mining and remote industrial power generation sectors. It is expected that by 2022 there will be an additional reduction of at least 300,000 tonnes of annual GHG emissions.

GET INVOLVED: MINIMIZE YOUR CARBON FOOTPRINT WITH AN ENERGY MANAGEMENT SYSTEM

Companies that implement energy management systems reduce energy costs and increase business competitiveness, while also minimizing their environmental impacts. The ISO 50001 Implementation Incentive offers up to $80,000 of assistance to implement energy management projects that help facilities pursue compliance with the ISO 50001 standard. Learn more at: www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/innovative-clean-energy-solutions/innovative-clean-energy-ice-fund/iso-50001-implementation-incentive.

LNG FOR THE GLOBAL MARINE SECTOR

FortisBC is proposing to facilitate new investments in LNG marine bunkering in order to further transform the adoption of LNG as a marine fuel. This will also help position B.C. as a global marine bunkering centre on the west coast capable of providing LNG to a large number of natural gas vessels. The current level of global GHG emissions from ships coming into British Columbia is 70 million tonnes per year — higher than the total GHG emissions attributed to British Columbia in its entirety.

TAKING ACTION: NEW ENERGY EFFICIENCY STANDARDS FOR GAS FIRED BOILERS

Gas fired package boilers are used in industrial systems across the province, contributing to B.C.'s overall emissions profile. New technologies can be used to improve the efficiency of these boilers, which will reduce emissions and operating costs. As such, the Province will develop a regulation to be implemented by 2020 that will set energy efficiency requirements for new and replacement gas fired package boilers, driving down emissions across a number of industries.

GET INVOLVED: SAVE YOUR BUSINESS MONEY BY BECOMING MORE ENERGY EFFICIENT

Reduce the operating costs of your business by making energy efficiency upgrades. BC Hydro and FortisBC offer a variety of programs to help you improve your business' energy efficiency, including incentives for upgrades and opportunities to learn from experts. Find out more at: https://www.bchydro.com/powersmart/business/programs.html *and* https://www.fortisbc.com/Rebates/RebatesOffers/Pages/default.aspx.

TAKING ACTION: EXPANDING INCENTIVES TO PROMOTE ADOPTION OF EFFICIENT GAS EQUIPMENT

Gas fired equipment is used for a variety of purposes, from space and water heating in industrial processes, to home fireplaces and commercial cooking equipment. FortisBC offers incentives to promote adoption of more efficient gas equipment for the residential, commercial and industrial sectors.

Now the Province is taking action to amend the Demand-Side Measures Regulation and allow FortisBC to expand their incentives by at least 100 per cent, to encourage further adoption of technologies that reduce the emissions of gas fired equipment.

MINING THE SUN IN KIMBERLEY

The City of Kimberley launched an innovative project to convert Teck's former Sullivan Mine Concentrator site into a solar energy project called SunMine. It includes 4,032 solar-cell modules, mounted on 96 solar trackers that follow the sun's movement to maximize the amount of energy captured. This has made it B.C.'s largest solar project and Canada's largest solar tracking facility. It was also the first solar project in British Columbia to begin selling power back to the BC Hydro grid. This important project was made possible through the Province's Innovative Clean Energy Fund, as well as an investment from Teck, who provided the land and site infrastructure, as well as a $2 million contribution. SunMine is a community owned project that is well suited to capitalize on Kimberley's clear and sunny conditions.

Photo Credits: City of Kimberley

Action Area: Communities and Built Environment

WHY COMMUNITIES AND BUILT ENVIRONMENT MATTER

Communities and our built environment are key factors in the fight against climate change. While the built environment is a significant contributor to our overall emissions profile, it also represents a real ongoing opportunity for change.

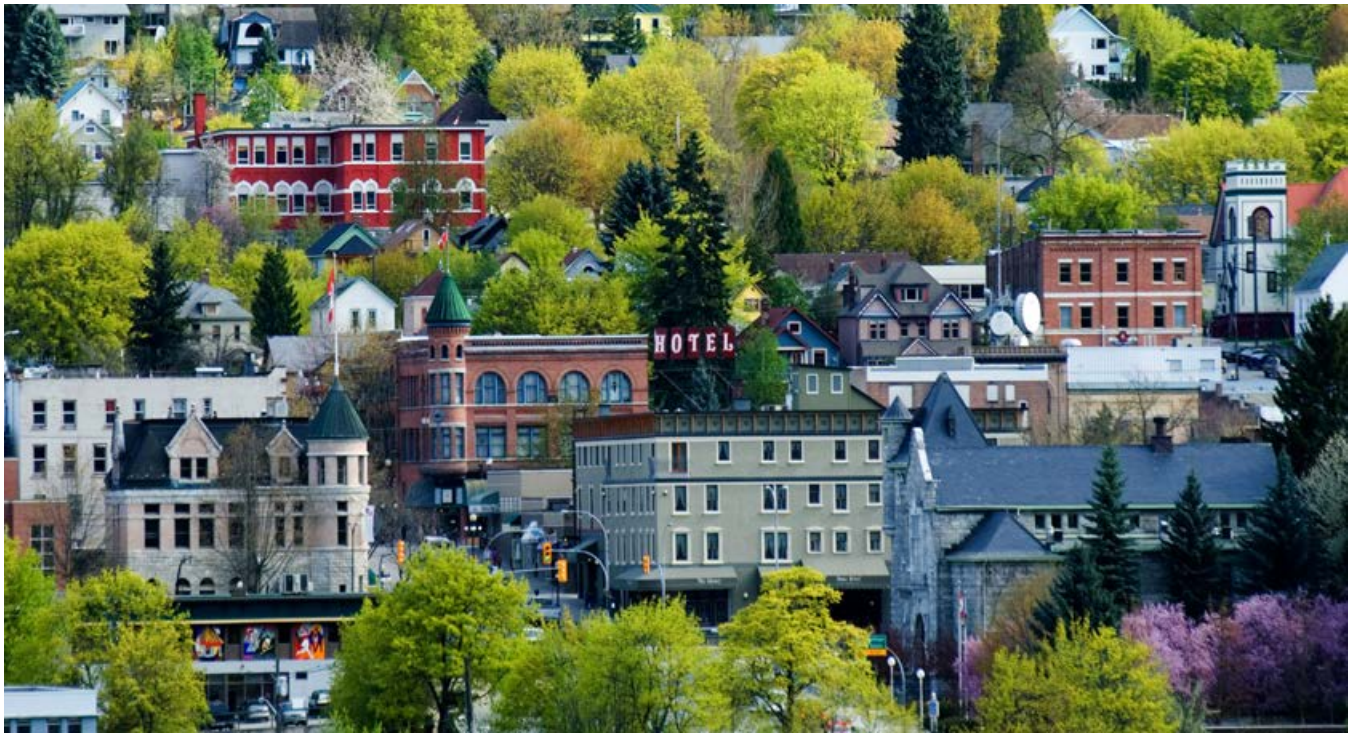
From the way we construct buildings to the way we develop communities and manage our waste, our built environment is a significant area where new innovations are demonstrating what a sustainable future could look like. However, we must balance our choices, to ensure that our climate solutions are affordable.

Emissions from the built environment (including buildings, deforestation and waste) represent 24 per cent of British Columbia's total emissions. Yet emissions in this area are down 9.4 per cent since 2007, due to climate action in community planning, building regulations and waste diversion.

Changes in the realm of communities and the built environment have been driven by policies such as Official Community Plans and Regional Growth Strategies, the Climate Action Charter, and the Climate Action Revenue Incentive Program, which returns the carbon tax to local governments to support GHG reduction projects.

The Building Code and Energy Efficiency Act have improved standards for residential and commercial buildings, while programs like LiveSmart BC and the Home Energy Retrofit Offer have promoted efficiency upgrades. In the area of waste, B.C.'s Landfill Gas Management Regulation has required landfill operators to increase the amount of methane they capture. 60 per cent of British Columbians have access to curbside organic diversion programs that are helping us reduce the amount of methane that will be emitted from waste we send to landfills every year.

With life spans of 50–100 years, today's buildings and infrastructure will impact our energy use and emissions for the next century. Incorporating climate action in planning and development leads to less energy and infrastructure spending. Over time, these actions will result in lower emissions and reduced congestion, as well as improved air quality, liveability and health.



NORTH VANCOUVER'S CLIMATE ACTION LEADERSHIP

The City of North Vancouver has shown how communities can make impressive strides to lead in the fight against climate change. It prides itself on being a compact community that puts pedestrians, cyclists, and transit first, and for reducing its corporate emissions by 19 per cent since 2007. Overall community emissions have decreased by 6 per cent between 2005 and 2010. The city has made this progress through initiatives that focus on sustainable energy, development planning that enhances public transit, building bike and pedestrian routes, and making upgrades to city buildings to make them more energy efficient.

TAKING ACTION: REGULATIONS FOR MORE ENERGY EFFICIENT BUILDINGS

Combustion of fossil fuels for heating in buildings accounts for the majority of building emissions. When we use fossil fuels, we need to make sure we are using them as efficiently as possible.

With 98 per cent of electricity generated in British Columbia coming from clean sources, promoting the efficient use of electricity represents another opportunity to cut emissions further. At the same time we must ensure that we do not intensify issues around housing affordability. That is why we are amending the energy efficiency standards regulation to include:

- Increased efficiency requirements for gas fireplaces and air source heat pumps, effective in 2018; and
- High-efficiency technology requirements for natural gas space and water heating equipment, effective in 2020 and 2025 respectively.

GET INVOLVED: USE THE FIRST NATIONS CLEAN ENERGY TOOLKIT

First Nations in British Columbia are well placed to take advantage of the clean energy sector.

The British Columbia First Nations Clean Energy Toolkit is a step-by-step manual designed to inform First Nations about the kinds of clean and renewable energy sources available, how to begin looking into doing a clean energy project, and where to find resources.

Check it out at: https://www.cleanenergybc.org/wp-content/uploads/2016/04/BC-FN-Toolkit.pdf.

TAKING ACTION: ENCOURAGING DEVELOPMENT OF NET ZERO BUILDINGS

Cleaner, more energy-efficient buildings can save owners and tenants money in the long run by lowering energy costs and avoiding carbon costs. Additionally, improved building envelopes and efficient technologies such as new heat pumps can make significant improvements in buildings. As such, we are implementing a number of policies to encourage the development of net zero buildings, including:

- Accelerating increased energy requirements in the BC Building Code by taking incremental steps to make buildings ready to be net zero by 2032;
- Developing energy efficiency requirements for new buildings that go beyond those in the BC Building Code, called Stretch Codes, that interested local governments could implement in their communities; and
- Creating innovation opportunities and financial incentives for advanced, energy-efficient buildings, including an increase in funding for design and innovation.

The international Passive House standard is one of the most rigorous and advanced building performance standards in the world, achieving reductions in heating energy of up to 90 per cent compared to other buildings. Through a partnership between the Province's Innovative Clean Energy Fund and the Canadian Passive House Institute, architects, builders and building inspectors are receiving training in Passive House design principles.

GET INVOLVED: LEARN ABOUT PASSIVE HOUSING DESIGN

Take a passive house design course and find out about training subsidies for building professionals at: http://canphi.ca/passive-house-courses/.

TAKING ACTION: REFRESHING THE CLIMATE ACTION CHARTER FOR COMMUNITIES

The Climate Leadership Team recommended that British Columbia update the Climate Action Charter to align provincial and community goals. In response, we are refreshing our actions under the Climate Action Charter this year, which sets out a framework for British Columbia communities to become carbon neutral and to create complete, compact, energy-efficient urban and rural communities.

The Province will work with local governments to expand the progress made to date on reducing GHG emissions. The goal is to establish a plan for community action that takes advantage of provincial and federal actions, to maintain momentum at the community level through policies, programs and regulations that will:

- Focus growth near major transit corridors for large urban communities;
- Increase the use of decision support tools that provide the information needed to create more resilient green infrastructure; and
- Strengthen the ability of communities to adapt to the impacts of climate change.

GET INVOLVED: UPGRADE YOUR HOME'S ENERGY EFFICIENCY

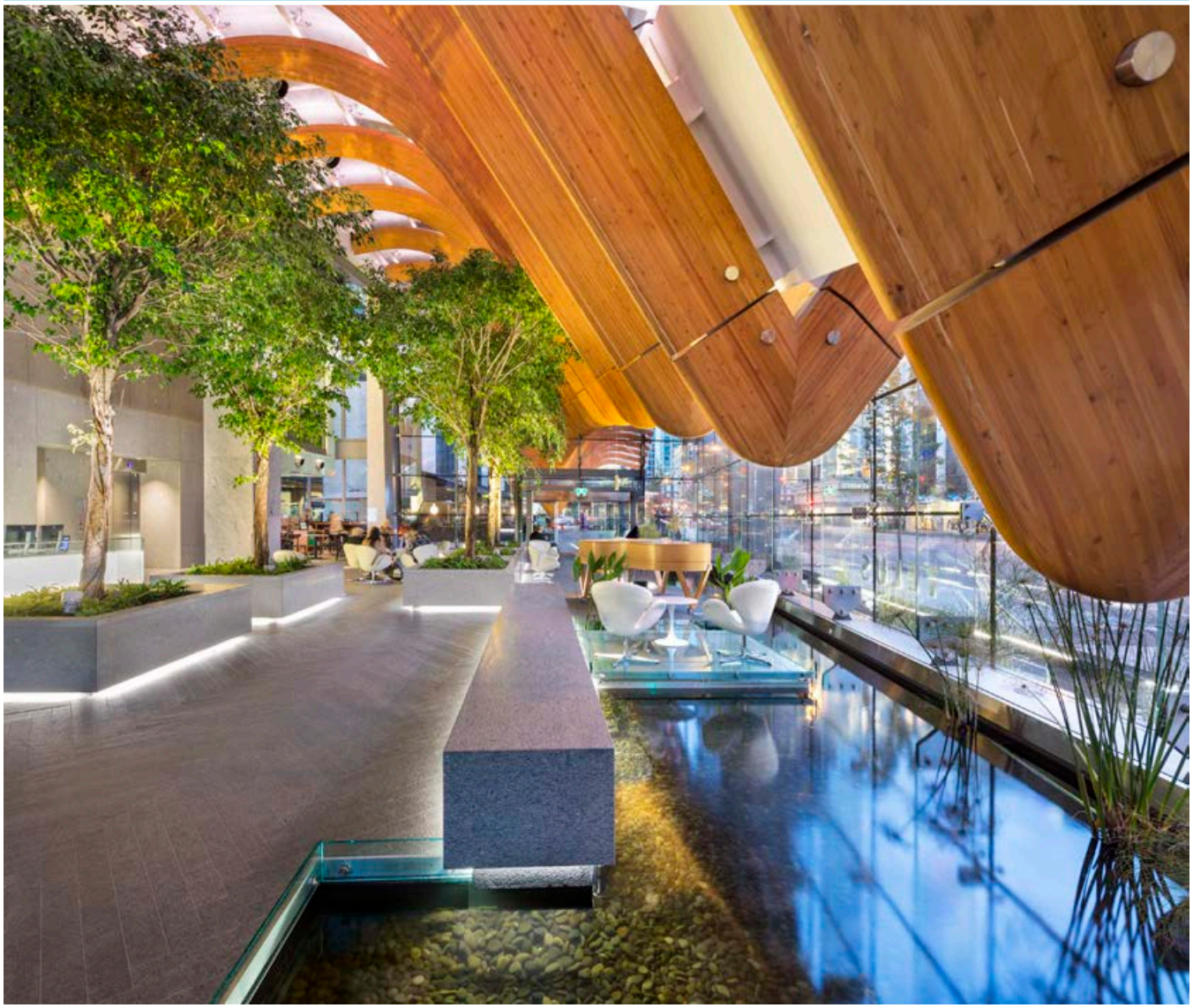
Home energy efficiency upgrades are a great way to save money and protect the environment. Did you know you can receive a rebate of up to $1,700 for upgrading from oil heating to an electric heat pump?

For more information on this and other programs, check out British Columbia's energy efficiency programs: www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/energy-efficiency-conservation/programs.

TELUS GARDEN AWARDED LEED PLATINUM CERTIFICATION

TELUS Garden, the company's new office in downtown Vancouver, is one of North America's greenest buildings. That is why the Canada Green Building Council awarded it the prestigious Leadership in Energy and Environmental Design (LEED) Platinum certification and it also received the impressive 2016 Architizer A+ Award for Office High Rise. Its innovative design includes: a district energy system that recovers energy that would normally be wasted and uses it to heat and cool air and water for both the office and residential towers, as well as the retail space; Vancouver's largest solar panel array; a rainwater capture system to irrigate its 10,000 sq. ft. of garden terraces; high-efficiency motion sensor lighting; charging stations for electric vehicles; and numerous other design elements that improve its environmental performance.

These sustainability features will contribute to a reduction in carbon emissions of more than 1,000 tonnes annually. Its innovative design was inspired by nature and advances the company's mission to create a healthier, more sustainable future, demonstrating what the built environment of the future could look like.



TAKING ACTION: CREATING A STRATEGY TO TURN WASTE INTO RESOURCES

Landfill waste is a significant source of emissions, and an area where significant opportunity for improved performance on GHG emissions exists. The CLT recommended that British Columbia create a waste-to-resource strategy that reduces GHG emissions from organic waste. In response, we are taking the following actions:

- Supporting materials exchange pilot projects that create innovative uses for waste products;
- Creating a waste-to-resource strategy to reduce waste sent to landfill; and
- Establishing a food waste prevention target of 30 per cent and increasing organics diverted from landfills to 90 per cent.

These actions are expected to reduce annual GHG emissions by up to 1.4 million tonnes.

TURNING WASTE INTO ENERGY

Emergent Waste Solutions (EWS) is a B.C. business that is deploying clean tech solutions to turn waste into valuable products and reduce greenhouse gas emissions, without using incineration.

Using a process called thermolysis, EWS's technology produces carbon from waste, such as wood fibre, rubber and plastics, for a wide variety of applications including biochar for agricultural uses, activated carbon for filtration, and carbon black for rubber product applications. The energy byproducts are syngas, used primarily to power its own operations, as well as bio oil and light diesel fuel, which can be used for home heating and other applications. Beyond the potential applications of this technology in B.C., EWS is opening a plant in Alberta, helping our neighbours turn their waste into valuable resources.

Action Area: Public Sector Leadership

WHY PUBLIC SECTOR LEADERSHIP MATTERS

Public sector operations are present in almost every community in the province, through schools, universities, colleges, crown corporations, health care services and others. B.C.'s public sector is also a significant buyer of clean tech goods, equipment and services.

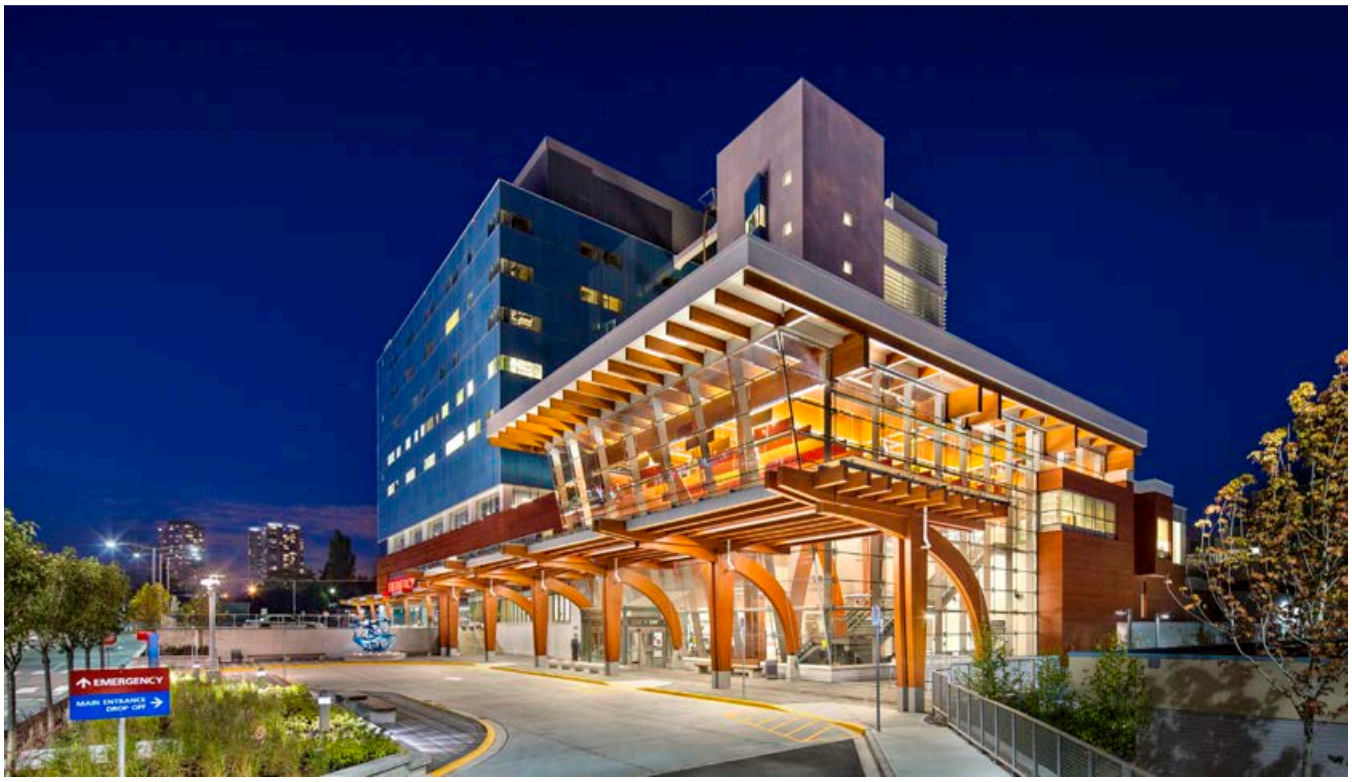
As such, the Province is well positioned to serve as a catalyst for climate action at both the community and provincial levels. Public sector leadership engages 300,000 public servants to take action on climate change, and in turn reaches the two million British Columbians that work, learn or visit government buildings each year. Buildings account for almost 77 per cent of B.C.'s provincial public sector emissions.

That is why as of 2010, the Greenhouse Gas Reduction Targets Act has required all public sector organizations (PSOs) to operate at carbon neutral. The Carbon Neutral Government commitment is achieved by measuring and reducing PSO emissions and offsetting the remainder by purchasing carbon offsets.

Over the first six years of this commitment, the provincial public sector has successfully achieved carbon neutrality each year, reducing a total of 4.3 million tonnes of emissions through reduction activities and investment of $51.4 million in offset projects.

SURREY'S HIGH PERFORMANCE HOSPITAL

In 2014, the Fraser Health Authority partnered with Integrated Team Solutions to deliver a state-of-the-art critical care tower at Surrey Memorial Hospital. Recently LEED Gold certified, the eight storey tower incorporates efficient and sustainable design solutions, including air-to-water heat pumps, central lighting controls and electric vehicle charging stations. The tower, with estimated annual emissions of less than 1,100 tonnes $C0_2e$, is predicted to save nearly 4 GWh equivalent of energy each year compared to a standard building.



PhotoCredit: Ed White Photographics

TAKING ACTION: PROMOTING USE OF LOW CARBON AND RENEWABLE MATERIALS IN INFRASTRUCTURE

Public sector infrastructure represents a considerable portion of B.C.'s built environment and is an area where the Province is demonstrating leadership in taking action to reduce GHG emissions. That is why we are developing policies to increase the use of low carbon and renewable materials in all public sector infrastructure, including:

- Approving use of Portland-limestone cement in public sector infrastructure. This material reduces GHG emissions associated with existing cement manufacturing by approximately 10 per cent, while producing concrete with similar strength and durability. This cement has been popular in Europe for over 25 years now, but is new to Canada; and
- Increasing use of B.C.'s wood products that store carbon and reduce emissions, through our Wood First program that drives innovation in forestry products, while promoting climate-friendly construction and supporting our forest-dependent communities.

GET INVOLVED: IMPROVE YOUR ENERGY MANAGEMENT PRACTICES

Looking for ways to improve the energy efficiency of your organization?

Check out FortisBC's Commercial Custom Design Program to learn about natural gas upgrade opportunities and their Custom Business Efficiency Program for electricity upgrade opportunities for customers. Learn about the full range of energy management programs for BC Hydro customers.

Find out more at:
https://www.fortisbc.com/Rebates/RebatesOffers/Pages/default.aspx?type=business *and* https://www.bchydro.com/powersmart/business/programs/partners.html.

TAKING ACTION: REDUCING EMISSIONS AND PLANNING FOR ADAPTATION IN THE PUBLIC SECTOR

It is important for the Province to lead the way on developing emission reductions and adaptation planning strategies, and demonstrating them through our public sector operations. Not only does it reduce the overall emissions profile of our province, it helps industry and individuals understand how they can join the fight against climate change. These areas were clear priorities for public sector leadership that were identified in the CLT's recommendations.

To continue capitalizing on this opportunity, the Province is committing to:

- Developing guidelines for public sector operations to reduce emissions and plan for climate change adaptation; and
- Mandating the creation of 10-year emissions reduction and adaptation plans for provincial public sector operations.

CANADA'S GREEN UNIVERSITY

A forestry seedling greenhouse started the University of Northern British Columbia (UNBC) on the road to using renewable energy. Now the Prince George university is the first in Canada with its own wood-fuelled district heating system and has been branded as "Canada's Green University." This system, designed by Vancouver-based clean tech company Nexterra, uses wood pellets made from wood waste such as sawmill shavings from Prince George's local forestry industry to create bioenergy. This energy is then used to heat water, which is circulated to the existing hot water district heating system that heats the UNBC campus. This has reduced fossil fuel consumption at UNBC by 72 per cent, avoiding 3,700 tonnes of carbon emissions every year. This has shown both the City of Prince George, as well as visiting students and faculty, what is possible when you use wood waste as a fuel.

GOING SOLAR AT THE COLLEGE OF THE ROCKIES

The College of the Rockies has installed solar panels on the roof of the Cranbrook campus' Kootenay Centre, which will allow it to generate electricity year-round. This solar technology will produce 109,000 kilowatt-hours per year of electricity, enough to power 14 houses in the region for a year. It will also act as a teaching tool for students, both during construction and once the system is running. This project will continue the college's mission to be leaders in alternative energy, having already installed solar technology to power the heating system for their residence building, and a solar wall at Pinnacle Hall that draws heat into the building, improving air quality and reducing heating costs.

Next Steps on Climate Leadership

Taking action on climate change is a critical priority for the Province of British Columbia and the citizens we serve. In B.C., we know that climate action is necessary to protect our environment, while seizing the opportunity of a low carbon economy that creates good jobs for British Columbians.

We are committed to achieving B.C.'s goal of reducing GHG emissions to 80 per cent below 2007 levels by 2050. However, the pathway to that goal is not always clear, as true sustainability means balancing environmental, economic and social concerns. An action that improves environmental performance cannot be considered sustainable if it works against our economic competitiveness, driving jobs and emissions to other jurisdictions, or if it raises the cost of living so that British Columbians struggle to make ends meet. There is no silver bullet here — real climate action demands careful planning, a flexible approach, and coordination with our partners here in Canada and around the world.

The federal government has signalled a reinvigorated commitment to climate action, and we look forward to the opportunity to help develop a Pan-Canadian Framework later this year, which will align provincial policies to work together to achieve our GHG reduction goals.

While there are areas we know we still need to take action on, many are dependent on our work with the federal government, whether that means identifying additional available funding opportunities or developing policies that align with our provincial and territorial partners to protect B.C.'s economic competitiveness.

A key area that we know will require further action is carbon pricing. Our carbon tax already leads the country — now we must work with our provincial and federal partners to develop a carbon pricing model that works for all. It is a complex issue that will require extensive coordination to ensure that it is effective.

We know that First Nations are interested in ensuring their communities are prepared to adapt to climate change, and are able to capture the economic benefit of mitigation activities, including reforestation and clean energy projects. With the establishment of this new framework for provincial action on climate change, the Province will be seeking the participation of First Nations in the economic and adaptation opportunities we have identified. We look forward to collaborating with them to capitalize on these new opportunities.

Another key area where you can expect to hear more in the coming year is adaptation. In 2010, the Province created a comprehensive strategy to address the changes we will see in B.C. as a result of climate change. We are now working with the federal government and other Canadian jurisdictions to improve our management of the risks associated with a changing climate.

The Province is also collaborating internationally through the Regions Adapt Initiative and the Pacific Coast Collaborative. Recent investments in flood protection and forest stewardship here in British Columbia will also increase our resilience to a changing climate.

Adapting to a changing climate depends on action by all levels of government, the private sector and civil society. As we move forward on climate action, we will look to maximize opportunities to extend our leadership in responding to the impacts of a changing climate.

While the actions we have outlined here represent what we can do today, it is important that we lay the foundation to support solutions with the potential to make an even bigger impact. That is what programs like British Columbia's Innovative Clean Energy (ICE) Fund are designed to do.

A recent investment from the ICE Fund is generating a lot of excitement — Carbon Engineering Ltd. has built the world's first direct air capture plant in Squamish. This technology captures atmospheric carbon dioxide right out of the air, and targets emissions that traditional fluestack carbon capture cannot reach. Their demonstration plant is already capturing and purifying a tonne of CO_2 every day. Carbon Engineering is looking at ways to turn the captured CO_2 into fuels like gasoline and diesel, which upon combustion would simply return the carbon to the air.

These innovations, along with continued deployment of clean and renewable electricity generation, could allow for the mass production of low carbon fuels, helping the world become less reliant on fossil fuel production and consumption. The technology represents an enormous opportunity for B.C. to bolster its economy while fighting climate change.

The Province will continue to identify opportunities where we can reduce GHG emissions today, while working with our partners to plan for the future, and investing in innovative projects that can help us reach our 2050 target even sooner. Additionally, our Climate Leadership Plan will be updated over the course of the following year as work on the Pan-Canadian Framework on climate action progresses.

We hope that you will get engaged, do your own part where you can, and continue to work with us on this important mission. If we want to ensure a great future for our children and grandchildren, then climate action must be a key priority. Join us in imagining what this bright future looks like and in taking action to make it a reality.

Sincerely,

HONOURABLE MARY POLAK
MINISTER OF ENVIRONMENT

Photo Credit: Stephen Hui

Appendix

Summary of Action Areas

The table on the following page summarizes the 21 climate actions across 6 sectors.

Emission reductions have been forecast through economic modelling or direct calculation by the responsible ministries. Input/output modelling was used to forecast cumulative direct and indirect economic activity (Gross Domestic Product) and jobs resulting from policies, except forest sector policies, which were forecasted by the Ministry of Forests, Lands and Natural Resource Operations.

The input/output modelling was undertaken using relevant economic and jobs factors provided by BC Stats.

All numbers in the following table are forecasts and subject to final policy decisions and budgets.

* *25,000,000 tonnes CO_2e is equal to 8.3 million new cars off the road for a year.*

An average B.C. house creates 2 tonnes CO_2e per year. 25,000,000 tonnes CO_2e is equal to the emissions from 12.5 million B.C. homes in one year.

Action Areas	Emission Reductions in 2050 (Millions of tonnes CO_2e)	Job Creation	Economic Activity ($ Millions)
NATURAL GAS	**5**	**4,043**	**527**
» Strategy to Reduce Methane Emissions » Regulating Carbon Capture and Storage » Electricity to Power Natural Gas Production and Processing			
TRANSPORTATION	**3**	**41,525**	**4,573**
» Increasing the Low Carbon Fuel Standard » Incentives for Renewable Natural Gas » Incentives for Purchasing a Clean Energy Vehicle » Charging Stations for Zero Emission Vehicles » 10-Year Plan to Improve B.C.'s Transportation Network			
FORESTRY & AGRICULTURE	**12**	**19,942**	**681**
» Enhancing the Carbon Storage Potential of B.C.'s Forests » Nutrient Management Program			
INDUSTRY & UTILITIES	**2**	**554**	**53**
» Making B.C.'s Electricity 100% Renewable or Clean » Efficient Electrification » Fuelling Marine Vessels with Cleaner Burning LNG » New Energy Efficiency Standards for Gas Fired Boilers » Expanding Incentives for Efficient Gas Equipment			
BUILT ENVIRONMENT	**2**	**230**	**19**
» Regulations for More Energy Efficient Building » Encouraging Development of Net Zero Buildings » Refreshing the Climate Action Charter for Communities » Strategy to Turn Waste into Resources			
PUBLIC SECTOR LEADERSHIP	**1**	**3**	**–**
» Promoting Use of Low Carbon and Renewable Materials in Infrastructure » Reducing Emissions and Planning for Adaptation in the Public Sector			
TOTAL	**25***	**66,297**	**5,853**

Notes

Notes

FOR MORE INFORMATION VISIT THE WEBSITE:

GOV.BC.CA/CLIMATELEADERSHIP

BRITISH COLUMBIA

A Simple Guide To Electric Vehicle Charging

By Eric Schaal Posted August 3, 2016 In EV Charging

If you talk to green car enthusiasts, many will tell you the biggest thing holding back electric vehicle adoption is a lack of public charging stations. You can't simply plug in whenever and wherever you'd like, and these limitations can keep people and organizations from buying EVs for their daily driving.

In fact, the number of stations is only one of the issues EV drivers currently face when it comes to charging in 2016. Variables in pricing, separate parking fees, and limited access hours further complicate the matter.

Yet driving an electric car does not have to be difficult or expensive. You can get the most out of driving electric when you have:

- A plug for home or workplace charging
- Accounts for public EV charging
- A clear idea of the cost and time needed to charge

EVs make the most sense when fueling (i.e., charging) costs remain low and access is convenient.

In this guide to electric vehicle charging, we will break down the different things you need to enable charging at home, keep your vehicle charged while on the road, and make it all happen at an affordable price.

Among other things, we'll take a look at: How long does it take to charge an electric car? How much does it cost to charge an electric car? And what do electric car charging stations cost?

Appendix 3

Defining the Terms

Before we get into detail about different aspects of charging, let's define some of the key terms:

On-board charger: The actual charging device for Level 1 and Level 2 charging comes factory-installed and is called the "on-board charger." It converts AC power from the wall to DC power that charges the battery in the vehicle. The charging speed may vary, but the most common on-board chargers are 6.6 kW on battery electric vehicles (BEVs) and 3.3 kW on plug-in hybrid electric vehicles (PHEVs). DC Fast Charging uses its own off-board charger.

EVSE: Stands for "electric vehicle service equipment." It is the intermediary between a power source and the vehicle's charging port, and is typically mounted on a wall or up on a pedestal. Its role is to simply relay the AC power to the vehicle safely.

Level 1 Charging: The slowest form of charging. Uses a plug to connect to the on-board charger and a standard household (120v) outlet. This setup provides between 2 and 5 miles per hour. While this does not sound at all impressive, it can work for those who travel less than 40 miles a day and have all night to charge.

Level 2 Charging: Uses an EVSE to provide power at 220v or 240v and up to 30 amps. Drivers can add 10-25 miles of range in an hour of charging at home or at a public station.

DC Fast Charging: Some refer to this charging as Level 3 charging. In this case, the charger is a gas pump-sized machine. There is no single standard for fast-charging – Tesla has the Supercharger network; Nissan Leaf and other models get their quickest jolt using CHAdeMO, and another group uses SAE Combo. All of the above fast chargers deliver about 80% charge in 30 minutes.

EVSE Product Manufacturer: A company that manufactures charging station hardware. Note that this doesn't necessarily mean they provide a network as well (see below).

Electric Vehicle Service Provider (EVSP): An EVSP provides the connectivity across a network of charging stations. Connecting to a central server, they manage the software, database, and communication interfaces that enable operation of the station.

How much does it cost to charge an electric car at home?

Most consumer-owned electric vehicles are primarily charged at home, where installing a Level 2 system is often recommended. These systems cost approximately $500-600 from manufacturers, though you will see slightly lower prices (and more expensive options) on the market.

In addition to the EVSE are the installation costs, which can start at around $300 depending on the setup of your home and the electrician providing the service. Once you are ready to charge, electricity prices in your area dictate what you pay for power.

Business owners who want to install charging equipment for employees and consumers face similar costs.

Note: Federal and state incentives are available for both commercial and home chargers. At least 30% of charging station costs may be covered by tax credits and other rebates. In Ontario Canada, the government covers 50% of EVSE and installation costs up to $1000.

Assuming you pay near the national average of $0.11 per kilowatt hour (kWh), adding 75 miles to a Nissan Leaf would cost less than $3.00. Put another way, the EPA estimates this vehicle costs $0.96 to drive 25 miles.

The Tesla Model S, which has a range exceeding 250 miles in several trims, would cost closer to $5 for a range of 125 miles and $10 for a full battery from zero. Compared to the average fuel cost of $2.25 per gallon and the average fuel economy of 25 miles per gallon, it would take about $22.50 to get the same range (250 miles) on a gasoline car.

If you are charging a lower range PHEV, the cost is negligible. You can forego the Level 2 charger and plug into any outlet at home. In models like the Ford Fusion Energi (9 hours), you can plug in overnight and find yourself with 19 miles of range in the morning.

How much does it cost to charge an electric car at a public station?

When you drive your EV into the wild and look for a charge, the situation gets a bit more complicated. Electric car owners often hold multiple charging station provider accounts to cover various needs when traveling.

If you only drive your EV in and around the city, a ChargePoint account is likely to cover your daily needs with Level 2 plugs. While membership is free, ChargePoint has users pay in $25 increments. The stations have different price levels set by the actual property owner or lessee. (ChargePoint has no control over pricing.)

In the course of your travels, you may see pricing set at $1 per hour up to $5 per hour for Level 2 stations. Some stations are also free. These prices do not include the cost of access to the parking facility, which depends on the location.

Electric vehicle drivers who hope to save time with DC fast-charging will usually pay more for the convenience. A popular provider in this department is NRG EVgo, which has plans available in Los Angeles for $15 per month plus $0.10 per minute for fast-charging sessions ($1 per hour for Level 2 charging). Other plans come without a monthly fee and cost $11 for 30 minutes of fast-charging.

Note: New EV buyers can take advantage of free charging packages from manufacturers that run through the first two years of ownership.

How long does it take to charge an electric car?

It takes less than 10 minutes to fill up a tank and pay for gasoline at the average fuel pump. EV drivers face longer charging times, no matter which speed you have at your disposal. To make things clearer for prospective electric car owners, we break down typical charging times for popular vehicles on the various power sources, leaving aside Level 1 charging.

- Nissan Leaf: 11-22 miles per hour
- Ford Focus Electric: 22 miles per hour
- Volkswagen e-Golf: 24 miles per hour
- BMW i3: 28 miles per hour
- Tesla Model S: 29-60 miles per hour
- Chevy Volt: 11 miles per hour

- Nissan Leaf: 60-95 miles in 30 minutes
- Ford Focus Electric: (no fast-charging)
- Volkswagen e-Golf: 60-83 miles in 30 minutes
- BMW i3: 60-82 miles in 30 minutes
- Tesla Model S: 170 miles in 30 minutes
- Chevy Volt: (no fast-charging)

Level 1 charging times don't get better than four miles an hour, which makes standard outlet charging only viable for low range plug-in hybrids or a minor top-off for EVs when stopping somewhere for several hours.

Where can I find public charging stations?

Most charging station providers do not show competing brands on their station locator maps, which can be less than ideal for the consumer looking for the closest available station.

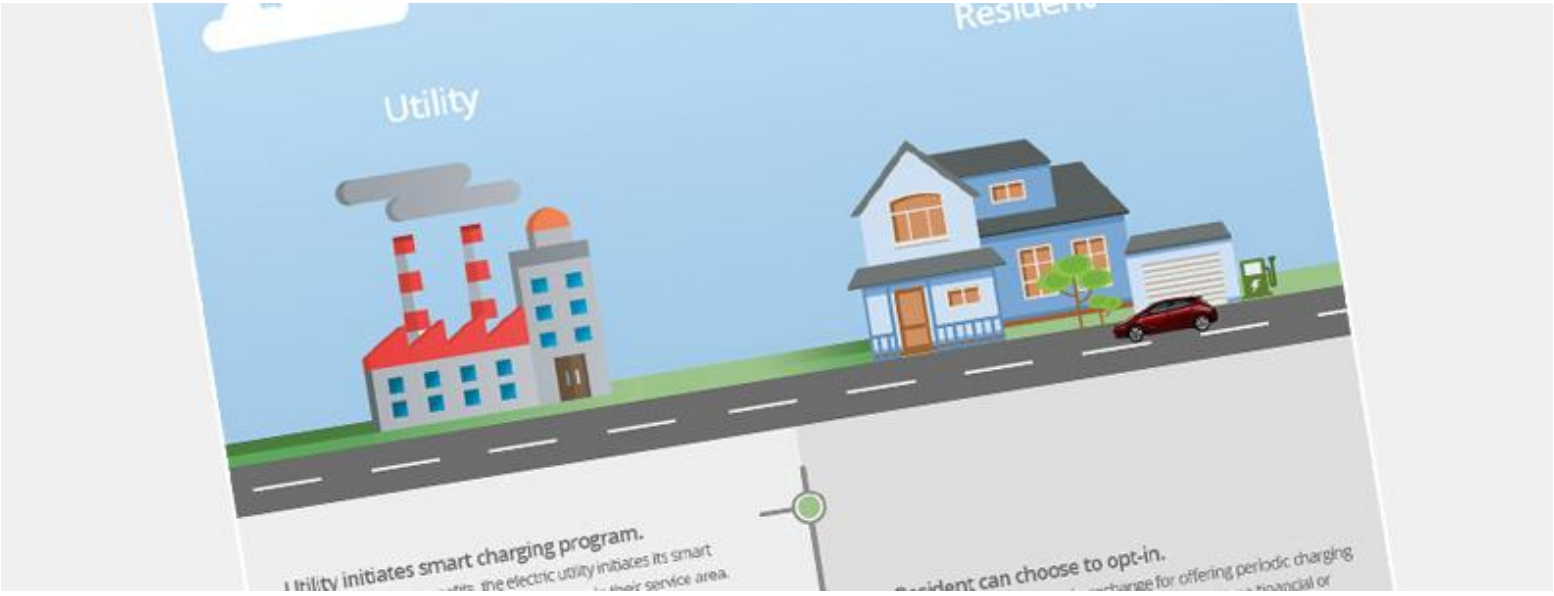
Fortunately, third-party providers have aggregated the data to create maps that are all-inclusive. While each offers its own set of features, three of the most common apps are PlugShare, ChargeHub, and CAA (Canada Only). Having one or two of those apps installed should give you coverage of most of the charging stations available in your area.

EV Charging: How to Prepare

Getting started with plug-in cars can seem intimidating, especially when there are so many factors that go into charging your vehicle. Here are a few ways to avoid common mistakes:

- **Know the incentives before you buy.** This tip applies to purchase incentives as well as charging incentives. Knowing your final (post-incentive) price will make your decision easier. Factor in the reduction in fuel and maintenance costs as well to project cost-of-ownership over the upcoming years. Many incentives start phasing out in 2017.
- **Make sure your electrical system is ready**. Amperage is important when installing a charging station, so make sure that the area in which you plan to put the station can handle 30amps. Check around with electricians in your area to find out how much installation will cost.
- **Find stations near work and other regular stops**. Knowing you have charging options near your job, favorite park, or another regular stop will make it easy to get Level 2 power while you go about your routine.
- **Know where the free chargers are**. In addition to the many fee-based public stations, there are numerous free options available. Find out where they are in your area and take advantage when the circumstances make sense. In some cases, dealerships selling your EV model allow customers to charge for free.
- **Note convenient fast chargers**. Having a fast-charger near your home will come in handy when you need a full battery on demand. Before you subscribe to a charging provider's package, have an idea where you can power up in a flash.
- **Investigate savings at off-peak times**. Peak electricity costs may be as much as three times the cost during off-peak periods. Find out if your utility provider offers any programs for EV drivers to find the lowest rates.

What Is Smart Charging?



To handle heavy grid demand without turning to expensive, dirty electricity sources, many utilities have initiated time-of-use (TOU) pricing for business and residential customers. The idea is to charge higher rates for peak periods in order to encourage users to move high-demand power needs to off-peak hours.

Smart charging goes one step further in that it allows for variable power use within peak and off-peak times. Some pilot programs have already begun with EV owners who want to charge their vehicles at the lowest possible price. Using such a program, a utility provider will slow charge when demand gets high, then return to regular charging when demand on the grid lightens.

Solar Power and EV Charging

Since even the greenest U.S. energy grids use some fossil fuel power, EV drivers looking for true zero-carbon driving have looked for the answer in solar panel installations at home. Where there is sufficient sunlight, electric car owners may be able to get a significant amount of charge from the sun.

To encourage this type of zero-emissions driving, Ford and SunPower offer incentives for Focus Electric buyers who opt for solar panel installations. Likewise, Tesla offers its Powerwall battery solution for solar power consumers hoping to store energy to use later in an EV or other application.

When Tesla finalizes its merger with SolarCity, consumers can expect more products geared toward a zero-emissions lifestyle with electric car-charging as a key focus.

The Future of Electric Vehicle Charging

If access to charging stations and vehicles with longer ranges are the main obstacles for consumers hoping to adopt EVs, the situation should change as affordable 200-mile EVs arrive and more charging stations are deployed. In July 2016, President Obama announced $4.5 billion in loan guarantees to accelerate the deployment of charging infrastructure.

With more capable EVs entering the mainstream by 2018, consumers could begin to see lines at public charging stations, and the focus could shift heavily to DC fast charging. Wireless charging is another upgrade that could change the status quo for good.

PLUG 'N DRIVE

Electric Vehicles Available in Canada

With over 30 models available from leading manufacturers, there is an EV for EVeryone!

Welcome to Plug'n Drive's catalogue of electric cars. This catalogue contains information on all of the plug-in electric cars available for sale in Canada. Please note that this catalogue does not include electric car models that are only available for sale in other countries, electric car models that have been discontinued or gasoline/diesel hybrids.

Fully Electric: A fully electric car runs entirely on electricity and has zero tailpipe emissions. Most fully electric cars will travel 200+ km on a full charge.

Plug-in Hybrid: A plug-in hybrid has both electric and gasoline technologies on-board. Plug-in Hybrids deliver dedicated all-electric driving distances of 20-80 km (depending on model) before a gasoline engine/generator turns on for 400+ km of additional gasoline range.

British Columbia News

FACTSHEET: Clean Energy Vehicle Program/Innovative Clean Energy Fund

https://news.gov.bc.ca/13812
Monday, March 27, 2017 3:35 PM

Victoria - The Clean Energy Vehicle Program is investing in vehicle incentives, charging and fuelling infrastructure, fleet support, public outreach and education to encourage more British Columbians to drive a zero-emission vehicle and reduce greenhouse gas emissions.

Facts:

Clean Energy Vehicle Program:

- The Province introduced the Clean Energy Vehicle (CEV) Program in 2011 and has since invested more than $71 million to make clean energy vehicles more affordable and reduce greenhouse gas emissions.
- B.C. has the highest per capita adoption of electric vehicles in Canada, and the largest public charging infrastructure network in Canada.
- Transportation accounts for nearly half of the emissions by the average B.C. family, and light-duty vehicles account for 14% of B.C.'s overall emissions.
- With 98% of the electricity generated in B.C. coming from clean or renewable sources, stimulating the purchase of electric vehicles is one of the most effective ways to reduce greenhouse gas emissions.
- Each electric vehicle on the road in B.C. displaces 4 tonnes of CO2 annually.
- Under the Climate Leadership Plan, the CEV program is being expanded to support new vehicle incentives and charging infrastructure, as well as education and economic development initiatives.
- In February 2016 the Province announced an investment of $40 million for the CEV Program. The funding will be distributed over three years (2017-18, 2018-19, 2019-20) to:
    - Continue point-of-sale purchase incentives of up to $5,000 for battery electric vehicles and $6,000 for hydrogen fuel cell electric vehicles. When combined with SCRAP-IT program incentives, total savings could be up to $11,000 for a new electric vehicle, and $12,000 for a hydrogen fuel cell vehicle.
    - Expand public, residential and workplace charging and hydrogen fuelling infrastructure.
    - Continue purchase incentives for specialty-use vehicles used in vehicle fleets such as light-duty zero-emission trucks, buses and motorcycles.
    - Provide incentives of $500 for bikes, electric bikes, electric scooters, car share credits and transit passes when someone scraps an older vehicle.
    - Support research, economic development and job training in the zero-emission vehicle (ZEV) sector.
    - Increase public awareness of the benefits of ZEVs.

- A major challenge for adoption of electric vehicles is ensuring that owners can access charging stations. The Province is also taking action under the Climate Leadership Plan to:
    - Develop regulations to allow local governments to require new buildings to install adequate infrastructure for electric vehicle charging; and,

  - Develop policies to facilitate installing electric vehicle charging stations in strata buildings and developments.

- The CEV Program supports actions under the Climate Leadership Plan to encourage electrification, reduce harmful emissions and enable the development of a new low-carbon economy.
- In order meet the strong demand for incentives and help more British Columbians purchase a lower-cost CEV, in March 2016 government introduced a vehicle price cap – any CEV priced above $77,000 is not eligible for a purchase incentive from the CEV Program.
- Eligible electric and hydrogen fuel cell vehicles displaying an official decal are allowed in high occupancy vehicle (HOV) lanes throughout the province regardless of the number of passengers in the vehicle. The decals are free and are issued to eligible owners through an application process.
- Electric vehicle owners save about 75% on fuel costs. That translates to approximately $1600/year in fuel savings for the average B.C. driver. (Analysis was done for gas priced at approximately $1 per litre)
- B.C. now has over 4,800 battery electric, plug-in hybrid electric, and hydrogen fuel cell vehicles registered in the province.
- Currently the CEV sector in BC consists of approximately 198 companies involved in all aspects of the CEV supply chain resulting in a total direct employment of approximately 3,850 FTEs.
- The CEV sector provides approximately $702.0 million in total direct economic activity in B.C.
- At COP 21 in Paris in December 2015, British Columbia signed on to the Zero Emission Vehicle Alliance with 13 other international jurisdictions that has set a target for 100% of passenger vehicle sales to be zero emission vehicles by 2050.
- British Columbia is a member of the West Coast Electric Fleets, an initiative of the Pacific Coast Collaborative, a joint initiative of California, Oregon, Washington and British Columbia to accelerate a low-carbon economy. The West Coast Electric Fleets Pledge is designed to help fleet managers incorporate zero-emission vehicles and provide access to a peer-to-peer network to help operators learn from one another as they scale up use of electric vehicles and associated infrastructure.

Innovative Clean Energy Fund:

- $17.5 million in funding for the CEV Program has come from the Province's Innovative Clean Energy (ICE) Fund.
- The ICE Fund is a legislated Special Account established in 2007 and is designed to support government's energy and environmental priorities.
- The ICE Fund receives funding through a 0.4% levy on the final sale of specified energy products: natural gas, fuel oil and grid-delivered propane. The estimated average impact of the levy on residential natural gas and propane customers is currently about 45 cents per month and about 66 cents per month for residential fuel oil customers.
- ICE Fund partnerships have included universities, First Nations, municipalities and many emerging clean tech companies across British Columbia. Technology demonstrations have included bioenergy, solar, ocean tidal, geo-exchange, desalination, energy management, smart grid, and waste-to-energy.

- Since 2008, the ICE Fund has committed approximately $97 million to support pre-commercial clean energy technology projects, clean energy vehicles, research and development, and various energy efficiency programs.

Learn More:

Clean Energy Vehicle Program: www.gov.bc.ca/cleanenergyvehicleprogram

Innovative Clean Energy Fund: http://www.gov.bc.ca/innovativecleanenergyfund

Contacts

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Appendix 3

Province announces $7.5M in incentives for clean-energy vehicles

Edmond Lu / Business in Vancouver
MARCH 23, 2015 02:28 PM

From left, Energy Minister Bill Bennett, Canadian Hydrogen and Fuel Cell Association CEO Eric Denhoff and BC New Car Dealers Association president Blair Qualey examine an electric car at the Vancouver Convention Centre.

Phase two of B.C.'s Clean Energy Vehicle program will include $7.5 million in point-of-sale incentives for electric and hydrogen cell vehicles, Energy Minister Bill Bennett announced Monday (March 23) ahead of the opening of the Vancouver International Autoshow.

According to the minister, phase one of the program supported the sale of 915 electric cars and the development of over 1,000 charging stations in the province the result of which was approximately 57,000 tonnes of direct emission reductions.

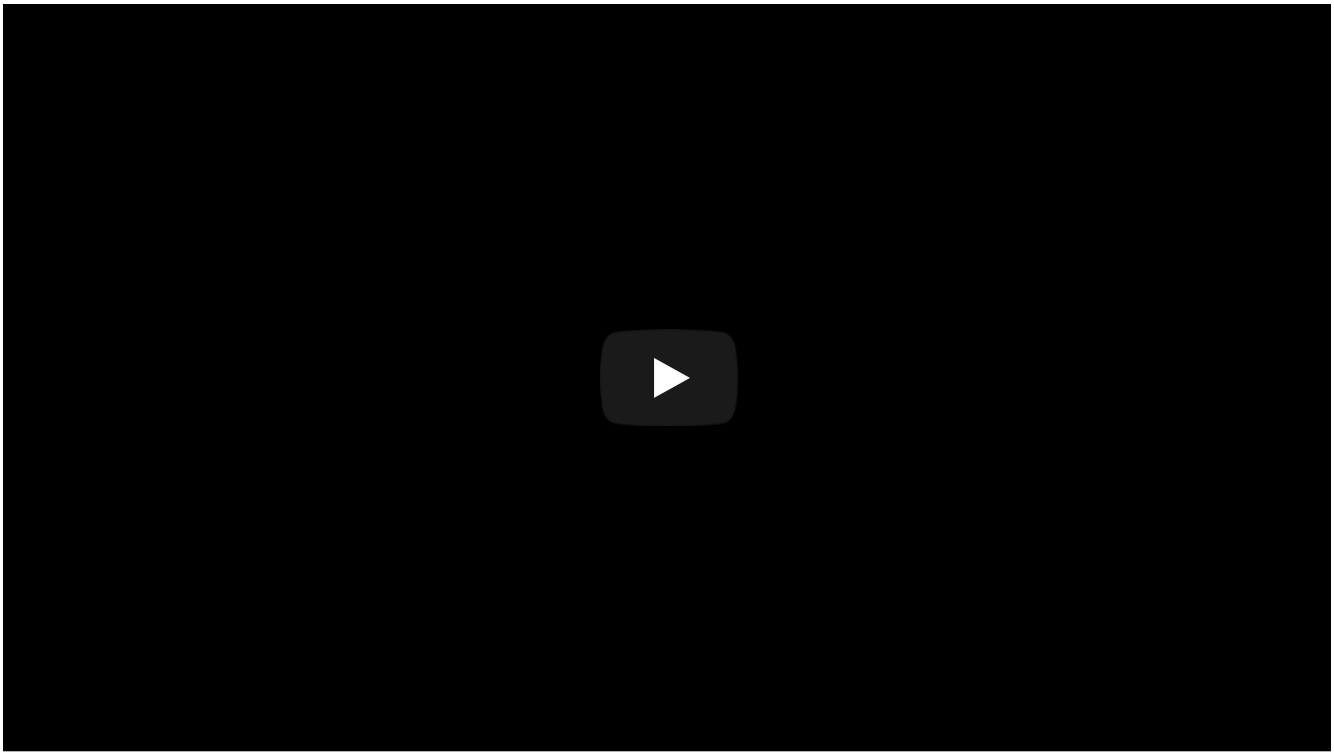
The largest portion of that budget, $7.5 million, is going towards incentives for buying or leasing an electric vehicle, where up to $5,000 will be offered for plug-in hybrids and battery electrics and up to $6,000 for a hydrogen fuel cell vehicle.

In addition, B.C.'s Scrap-It Program announced Monday it would provide those who retire their year 2000 or older cars up to $3,000 towards the purchase of a new electric car.

*This story first appeared in our sister publication Business in Vancouver. Click **here** to read more.*

Electric Vehicle Sales In Canada, Q3 2017

By Matthew Stevens Posted November 7, 2017 In EV Industry



The Canadian plug-in electric vehicle (EV) sales for the third quarter are in! We've divided the analysis into ***The Fast Five*** (the five numbers that you need to know) and ***The Details***.

The Fast Five

+56%

Canadian year-over-year sales growth. Canadian EV sales for the first 9 months of the year are up 56%. 9-month sales in 2016 were 7,996. By contrast, 9-month sales in 2017 were 12,470. 2017 sales have been accelerated by an expanding lineup of fully electric vehicles, including the Chevrolet Bolt, Hyundai Ioniq, and Volkswagen e-Golf.

+96%

Ontario year-over-year sales growth. Ontario EV sales for the first 9 months of the year are up 96%. On a %-of-sales basis, Ontario has historically lagged BC and Quebec despite having a strong sales incentive. As a result of the provincial EVCO program, the number of fast chargers in Ontario has risen from 5 to 140 over the past year, not including Tesla Superchargers. This dramatic and recent rise in fast charging infrastructure puts Ontario on par with infrastructure in Quebec and BC and appears to be having an impact on EV sales. In addition, the promise of free overnight charging has resonated with potential EV owners and there remains excitement within the industry on how and when that program will be rolled out.

41,695

Total EVs in Canada. The number of EVs in Canada surpassed 40,000 in the third quarter. Canada crossed the 20,000 mark in early 2016. A year and a half later, that number has doubled.

>1%

EVs as a fraction of overall vehicle sales in September. EV sales in September were 2,171. The first time monthly sales have topped 2,000. While Statistics Canada hasn't published the final September total motor vehicle sales numbers, the final tally is expected to be between 185,000 and 195,000. The result is that EV sales have topped 1% of total motor vehicle sales for the first time in Canadian history. FleetCarma generally presents 3-month trailing average due to end-of-quarter surges in Tesla registration; however, the September numbers are remarkable enough to present as a stand-alone result. *please note: this post will be updated once the final numbers are posted to the Statistics Canada website.

41

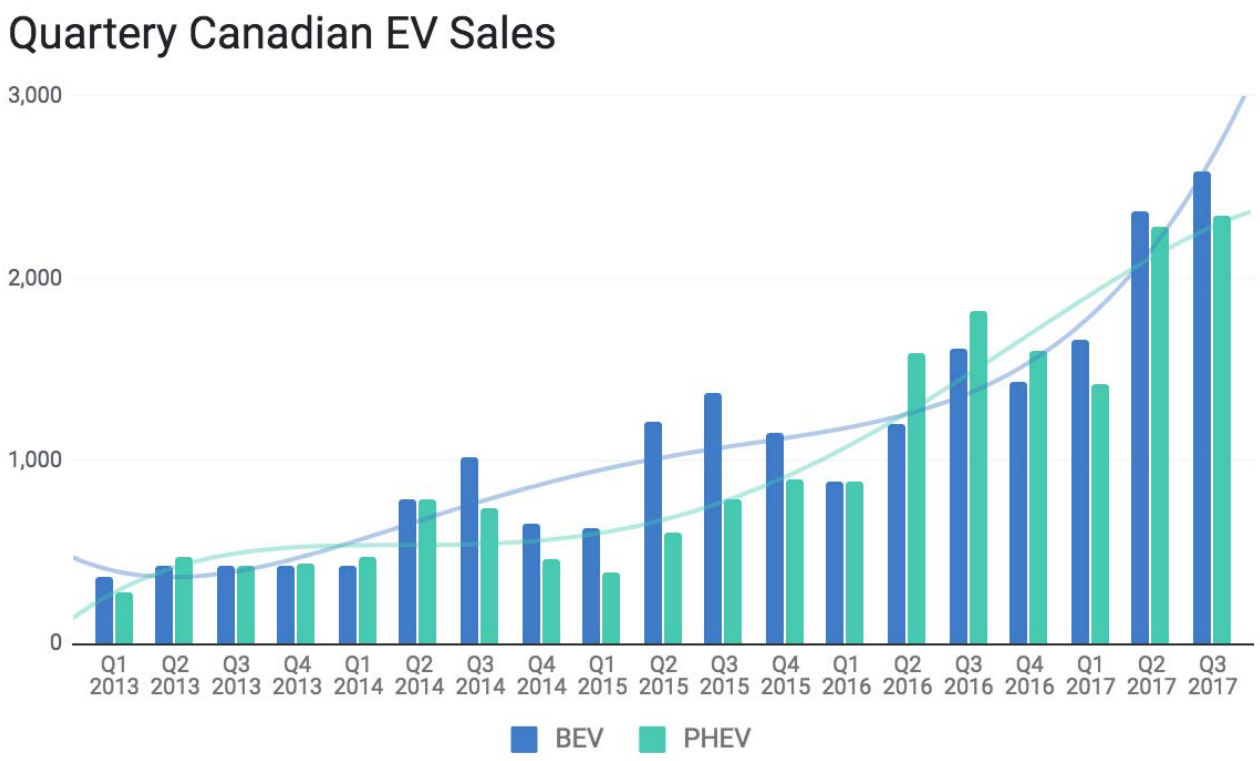
The number of electric vehicle models currently on Canadian roads. 26 plug-in hybrids and 15 battery electric vehicles. The new addition in the third quarter was the Cadillac CT6.

Overall, Canada continues to see EV sales continue to grow and set new records every quarter.

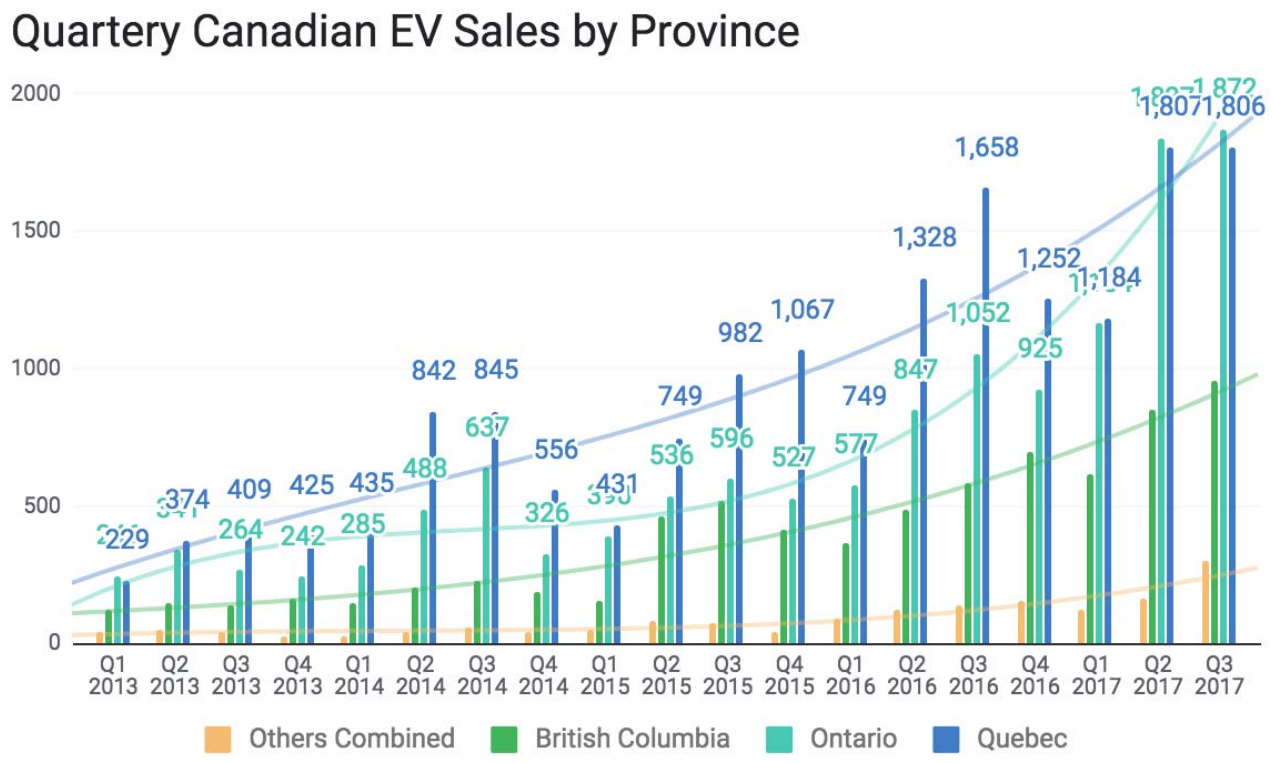
The Details (for the data nerds)

Staying true to the trend of 2017, EV sales have continued to climb through the months of July, August, and September. Plug-in EV sales are comprised of battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) while excluding non-plug-in hybrid vehicles (HEV). The total number of plug-in EVs sold in Canada in the third quarter is 4,756. This represents a 38.62% increase over the same quarter in the previous year, Q3 2016.

Looking at a breakdown of battery electric vehicles and plug-in hybrid electric vehicles we can see the change in consumer preference over time. BEV sales in Q3 2017 total 2,590 an increase of 9.2% over the previous quarter, Q2 2017. Plug-in Hybrid sales performed slightly worse, 2,166 sold in the quarter. This represents a slight decrease of 4.17% from the previous quarter, Q2 2017. Electric-only vehicles, BEVs, have outsold plug-in hybrids for the previous three of four quarters. As we look at future projections, it appears as if the momentum of BEV sales will continue to outperform and outpace PHEV sales.

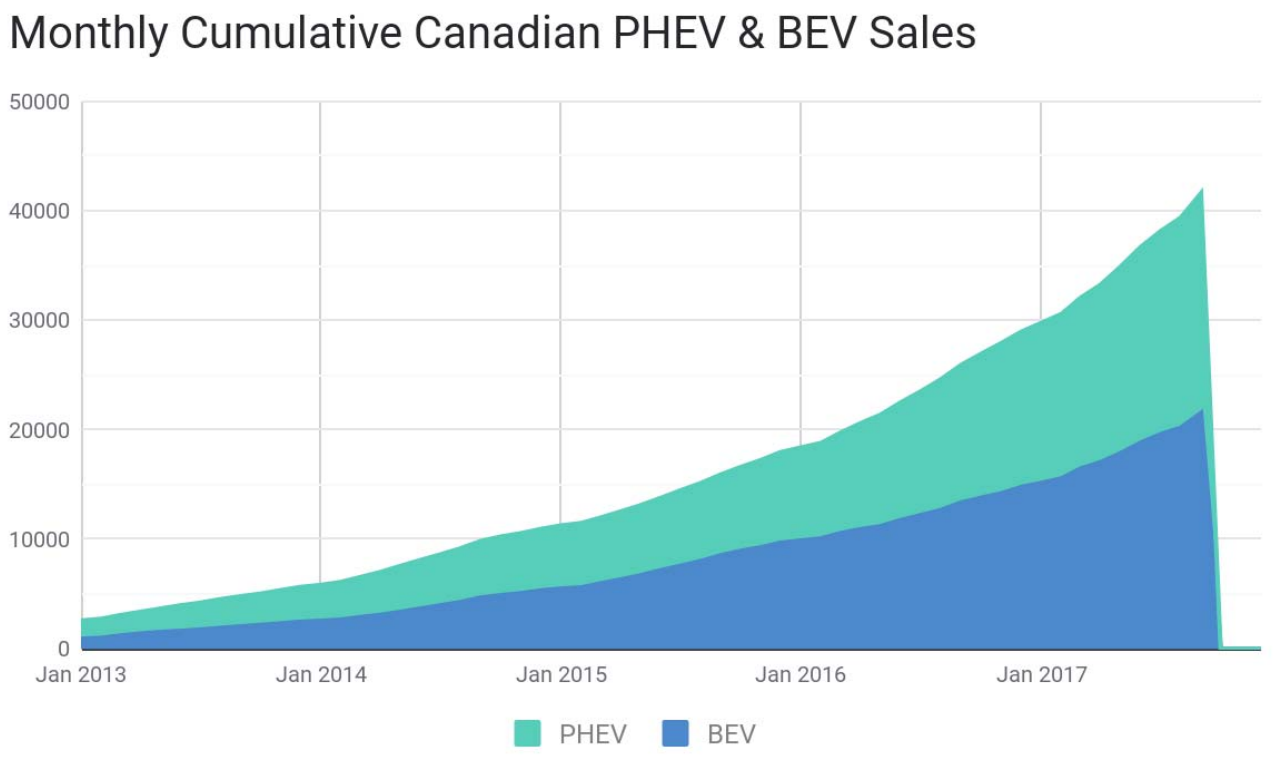


A provincial breakdown of EV sales in the Canadian market reveals which provinces are maintaining momentum towards EV adoption goals. Quebec plug-in EV sales in the third quarter of 2017 total 1,806, one vehicle shy from sales in the previous quarter. Ontario EV sales saw 1,872 new vehicles on the road in Q2. British Columbia, despite selling less overall EVs saw the highest rate of EV adoption growth in the quarter. 927 new EVs hit the road in BC in Q3. The consistency of growth for EV adoption among the provinces has continued to change over time. The chart below illustrates the changing rates of adoption. While Quebec has consistently led the country for overall EV adoption, a recent trend from the first quarter of 2016 illustrates the results of recent efforts Ontario has placed on EV growth rates. The trajectory of growth for EV adoption in Ontario now outpaces Quebec.

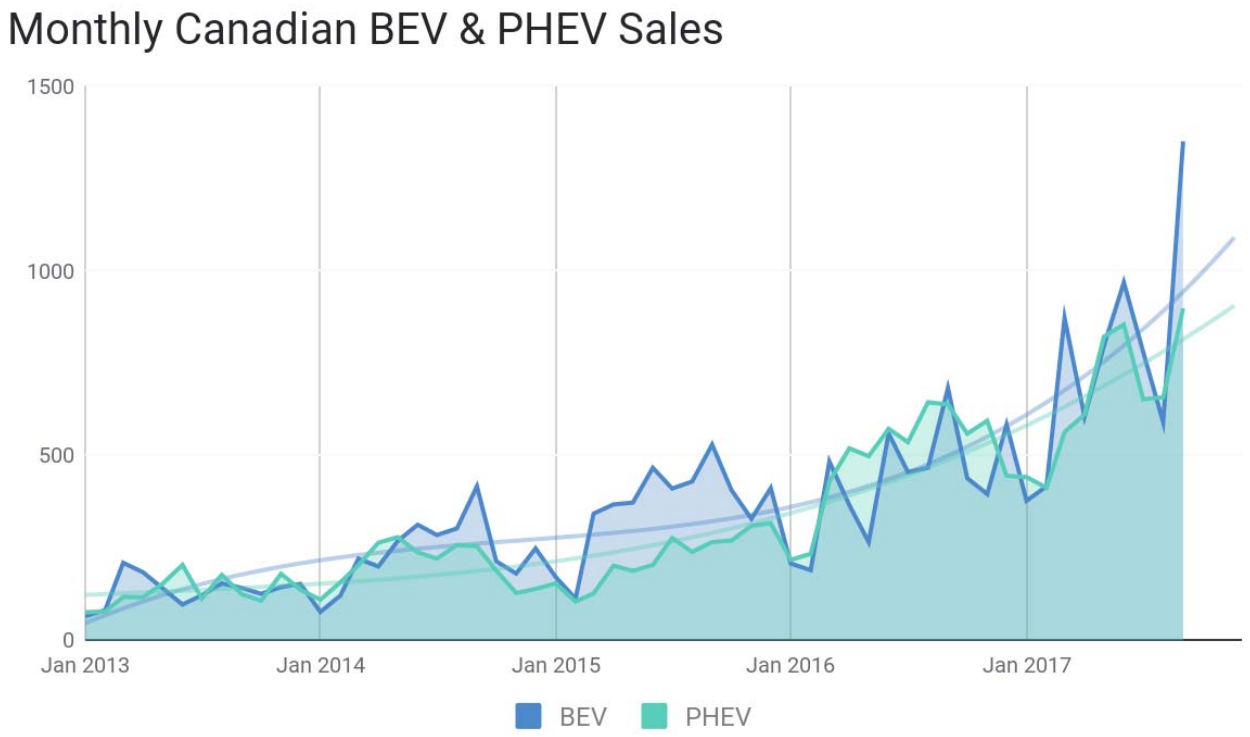


The big picture Canadian EV sales stats

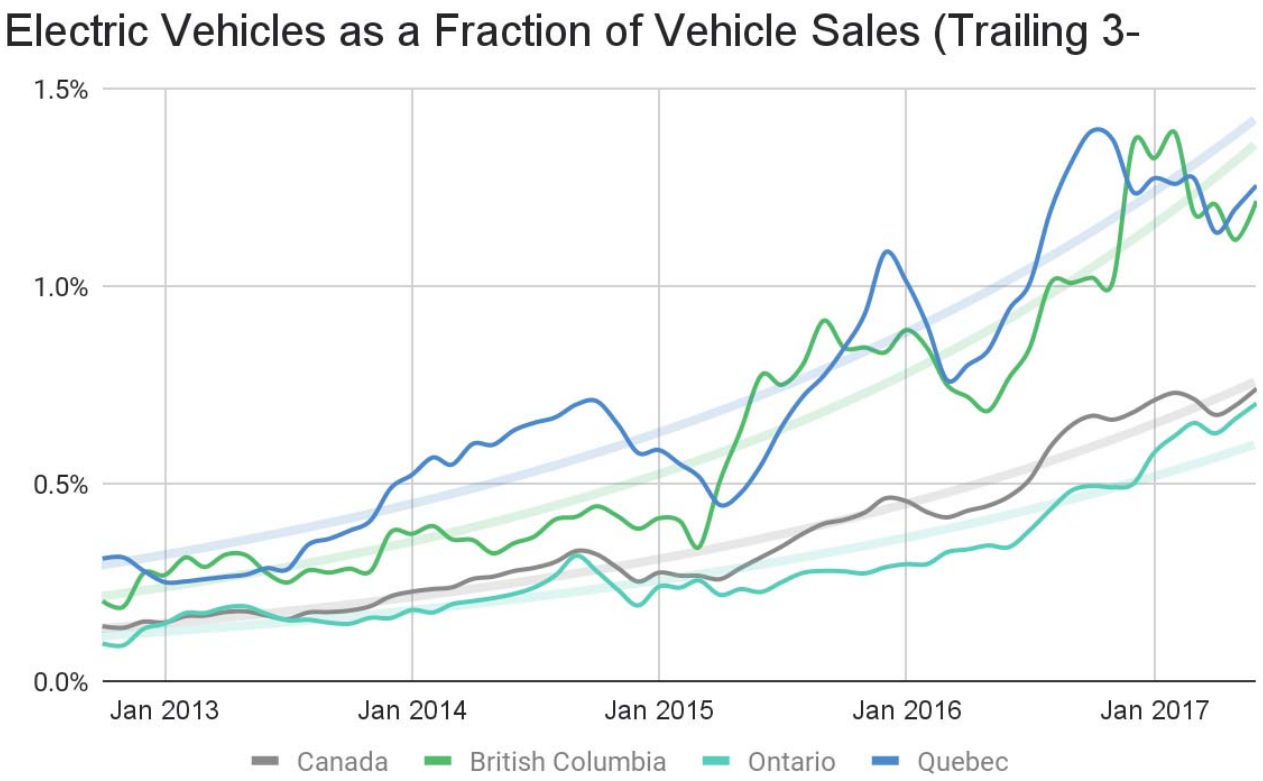
BEV and PHEV have seen different rates of growth in the past three months. BEV sales in Canada now total 21,538. Total PHEV sales in Canada now total 20,164.



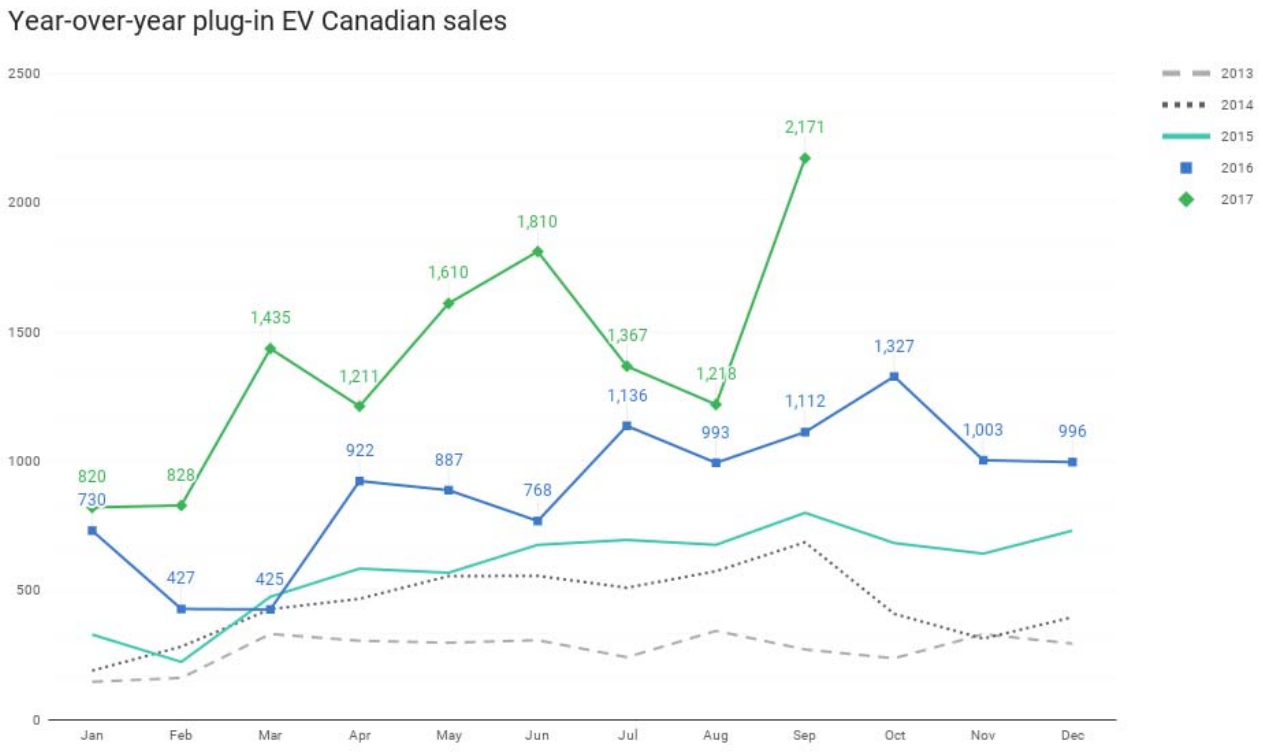
The monthly fluctuation of BEV and PHEV sales in Canada illustrate the difference of market preference over time. September of 2017 represents a record high for both BEV and PHEV sales. A total of 1,289 BEVs were sold in September, beating a previous high of 969 sales in June of 2017. PHEV sales also reached a record high in September of 882 vehicles. This beats the previous high of 853 sales in June of 2017. The plug-in electric vehicle market is definitely not slowing down.



Let's take a look at electric vehicle sales in comparison with overall vehicle sales for the major provincial markets. The third quarter of 2017 saw BEV and PHEV sales total a national average of 0.8% of all cumulative vehicles sales, an increase from 0.7% average in the previous quarter. On a provincial level, EV sales in BC have reached 1.5% of the vehicle market, an increase from 1.2% in the previous quarter. Quebec has reached an average of 1.4% market share, up from 1.2% in Q2. Ontario, the largest province has edged up from 0.7% to 0.8% in Q3.

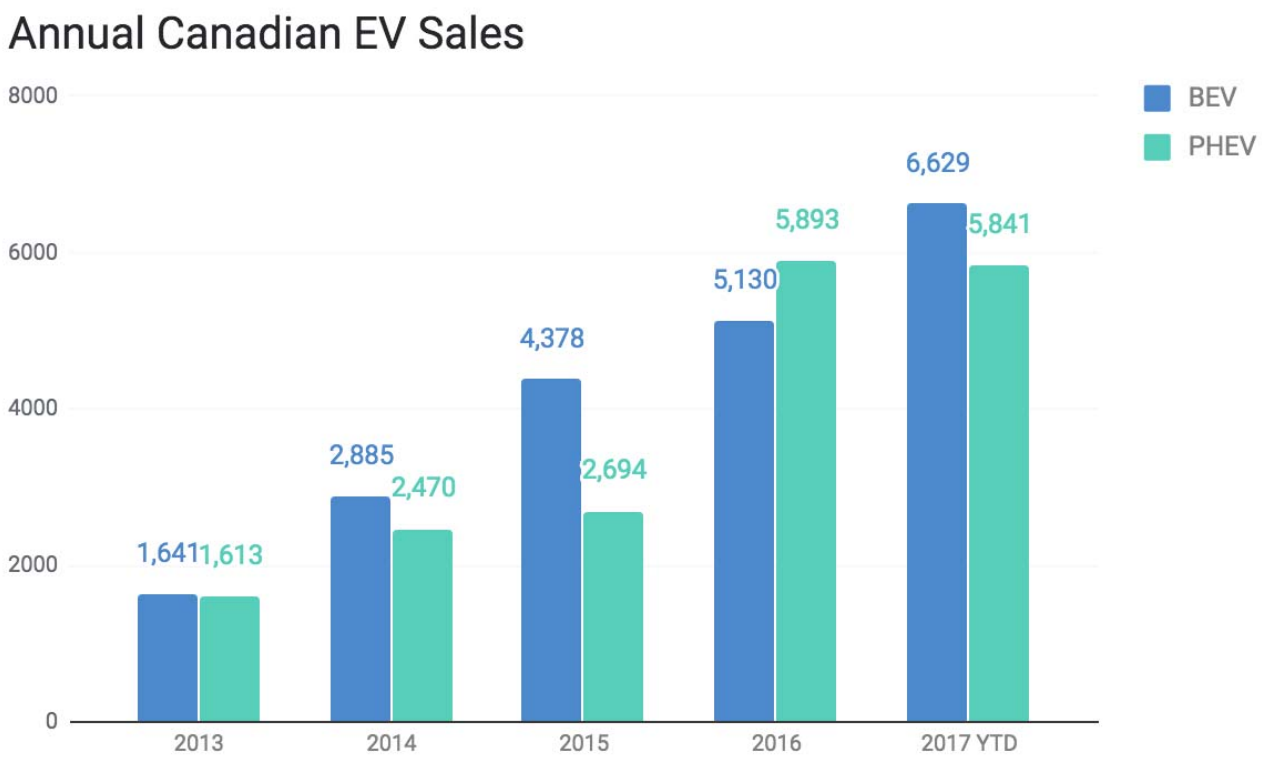


A monthly breakdown of EV sales for the previous five years illustrates the growth of the EV market. From a nearly flat sales trend in 2013 total sales and rate of growth in the market has increased each and every year. Our latest data up to September 2017 marks a high point for the overall market. If this year follows a similar trend as 2016 we can expect another record month in October followed by a seasonal cool-down in November and December.

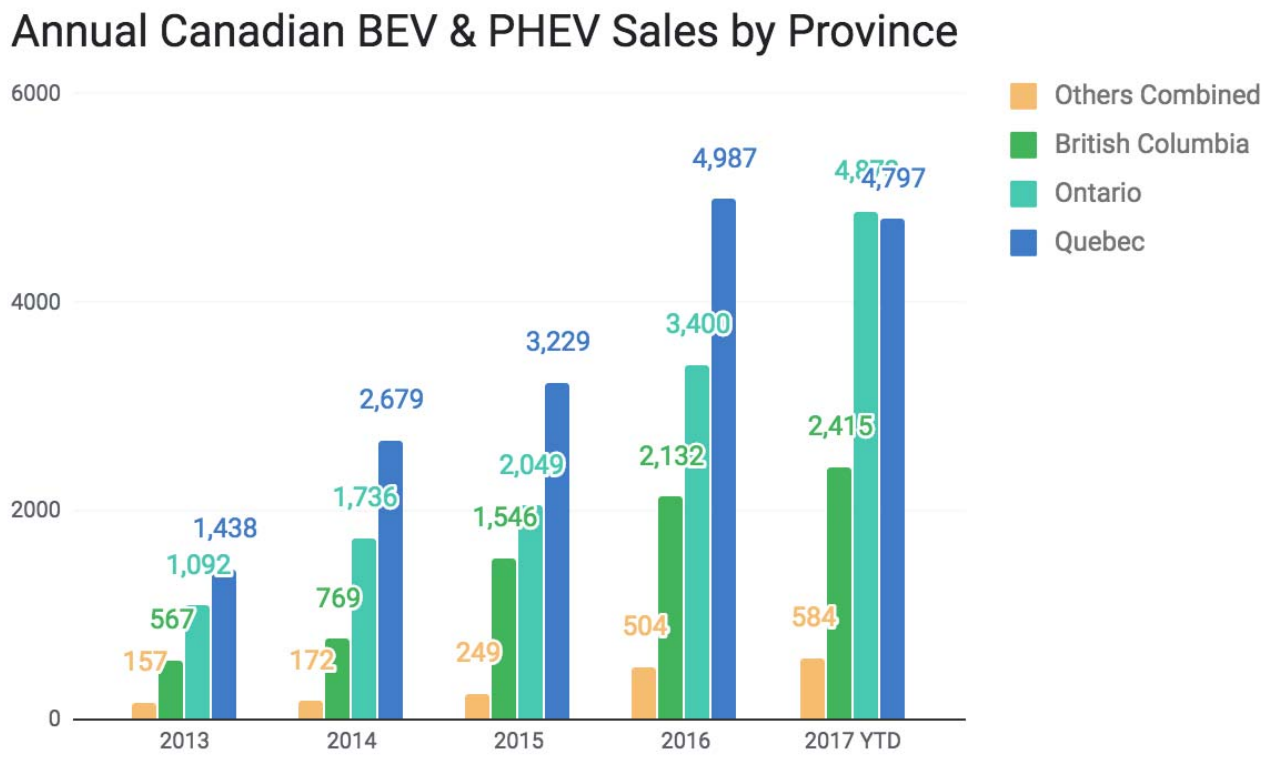


Year to date numbers and year-end forecast

Three-quarters of the way through the year, EV sales numbers for BEVs and PHEVs have surpassed totals for all of 2016. BEV sales totaled 6,629 at the end of September, an increase of 29.22% over 2016 totals. For the same timeline, PHEV sales have also surpassed the previous year totals at 5,841 YTD, now on par with 2016 totals. With three more months in the year EV sales for the 2017 year end are expected to reach 16,627 vehicles, a 50.83% increase over 2016. 2017 BEV sales will mark the largest growth rate of a 72% over 2016 totals, with an estimated 8,800 vehicles sold. PHEV sales are expected to see a 33% rate of growth over 2016 totals, with an estimated 7,700 vehicles sold.



Back down the Provincial level, the top three provinces for EV adoption will each, of course, blow past the previous year totals. Based on current rates of growth, year-end 2017 will see Ontario EV adoption growth rates increase the most. An estimated6,497 more EVs are projected to be on Ontario roads by the end of 2017, a 91.08% increase over 2016 totals. The Province of British Columbia will see the second highest increase in the rate of adoption, a 48.59% increase over 2016, totaling 3,167 new EV sales. Quebec is projected to experience a 28.27% rate of increase over 2016 totals with 6,396 new EV sales.



Q3 Canadian EV sales highlights

- A new milestone, over 40,000 plug-in EVs in Canada.
- BEV sales have outpaced PHEV sales for the previous three of four quarters.
- The national market share of EV sales is nearly 1% of the total market on a 3-month trailing average. And exceeded 1% in September.
- September 2017 marks the highest month for EV sales with 2,171 new EVs sold.
- The province of Ontario, for the second quarter in a row, sold the most EVs and is catching up to BC and Quebec on a %-of-sales basis.

Q3 Canadian BEV & PHEV Sales by Province

		AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Total
	BEV Total	54	662	10	7	0	2	0	0	981	0	868	6	0	2,590
1	TESLA MODEL S	21	112	2	0	0	0	0	0	241	0	66	2	0	444
2	NISSAN LEAF	3	103	1	3	0	0	0	0	63	0	177	0	0	350
3	TESLA MODEL X	18	196	1	0	0	0	0	0	220	0	69	3	0	507
4	KIA SOUL	0	37	0	0	0	0	0	0	40	0	89	0	0	166
5	CHEVROLET BOLT	1	69	2	0	0	0	0	0	109	0	217	0	0	398
6	SMART FORTWO	0	8	0	0	0	0	0	0	6	0	2	0	0	16
7	FORD FOCUS	0	34	0	0	0	0	0	0	126	0	54	1	0	215
8	MITSUBISHI IMIEV	0	1	0	0	0	0	0	0	3	0	14	0	0	18
9	HYUNDAI IONIQ	11	37	3	4	0	2	0	0	103	0	171	0	0	331
10	BMW I3	0	8	0	0	0	0	0	0	8	0	7	0	0	23
11	VOLKSWAGEN E-GOLF	0	50	1	0	0	0	0	0	62	0	0	0	0	113
12	CHEVROLET SPARK	0	0	0	0	0	0	0	0	0	0	1	0	0	1
13	FIAT 500	0	7	0	0	0	0	0	0	0	0	1	0	0	8
14	TESLA ROADSTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	TOYOTA RAV4	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Total
	PHEV Total	50	265	9	6	1	1	0	0	891	0	938	5	0	2,166
1	CHEVROLET VOLT	5	94	1	1	0	0	0	0	417	0	482	0	0	1,000
2	FORD C-MAX	3	11	1	0	0	0	0	0	34	0	53	0	0	104
3	VOLVO XC90	12	29	1	1	0	0	0	0	55	0	27	3	0	128
4	PORSCHE CAYENNE	6	14	0	0	0	0	0	0	23	0	18	0	0	61
5	BMW I3	0	0	0	0	0	0	0	0	30	0	17	0	0	47
6	AUDI A3	1	21	2	0	0	0	0	0	39	0	27	0	0	90
7	TOYOTA PRIUS	9	29	3	1	0	1	0	0	91	0	143	1	0	278
8	FORD FUSION	3	9	1	0	0	0	0	0	28	0	44	0	0	86
9	BMW X5	5	16	0	0	0	0	0	0	16	0	9	0	0	46
10	BMW I8	2	5	0	0	0	0	0	0	10	0	6	0	0	23
11	CHRYSLER TRUCK PACIFICA	-1	9	0	2	0	0	0	0	95	0	81	0	0	186
12	BMW 330	1	8	0	0	0	0	0	0	18	0	2	0	0	29
13	FISKER KARMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	CADILLAC ELR	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	BMW 530	0	10	0	0	0	0	0	0	20	0	10	0	0	40
16	PORSCHE PANAMERA	0	1	0	0	0	0	0	0	0	0	0	0	0	1
17	MERCEDES S550E	2	0	0	0	0	0	0	0	2	0	0	0	0	4
18	HYUNDAI SONATA	0	1	0	0	0	0	0	0	2	0	3	0	0	6
19	MERCEDES GLE550	0	4	0	0	0	0	0	0	0	0	1	0	0	5
20	HYUNDAI IONIQ	0	1	0	0	0	0	0	0	4	0	6	0	0	12
21	BMW 740	0	1	0	0	0	0	0	0	0	0	1	0	0	2
22	PORSCHE 918	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	MINI COOPER COUNTRYMAN	0	0	0	0	0	0	0	0	7	0	7	0	0	14
24	MCLAREN P1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	KIA OPTIMA	0	1	0	0	0	0	0	0	0	0	0	0	0	2

26	CADILLAC CT6	1	1	0	0	0	0	0	0	0	0	0	0	0	**2**
27	ACURA ILX	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
28	TOYOTA AVALON	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
29	TOYOTA CAMRY	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
30	TOYOTA HIGHLANDER	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Total
BEV Total	54	662	10	7	0	2	0	0	981	0	868	6	0	2,590
PHEV Total	50	265	9	6	1	1	0	0	891	0	938	5	0	2,166
Total	104	927	19	13	1	3	0	0	1,872	0	1,806	11	0	4,756

Canadian BEV & PHEV Sales by Province

2010 thru to the end of Q3 2017

		AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Total
	BEV Total	524	5,246	105	29	7	69	4	0	7,248	11	8,251	42	2	21,538
1	TESLA MODEL S	277	1,427	37	7	1	33	2	0	2,942	2	1,547	16	0	6,291
2	NISSAN LEAF	55	1,623	42	9	4	25	1	0	1,281	6	3,224	12	1	6,283
3	TESLA MODEL X	133	734	9	2	2	3	1	0	989	0	421	5	0	2,299
4	KIA SOUL	1	397	0	0	0	0	0	0	303	0	830	0	0	1,531
5	CHEVROLET BOLT	4	200	2	0	0	0	0	0	376	0	672	0	0	1,254
6	SMART FORTWO	10	231	2	0	0	0	0	0	549	0	340	0	0	1,132
7	FORD FOCUS	8	139	0	1	0	0	0	0	278	0	323	4	0	753
8	MITSUBISHI IMIEV	12	135	5	4	0	5	0	0	133	1	460	1	0	756
9	HYUNDAI IONIQ	13	78	6	5	0	3	0	0	172	1	261	1	0	540
10	BMW I3	1	167	0	0	0	0	0	0	105	0	57	1	0	331
11	VOLKSWAGEN E-GOLF	0	57	1	0	0	0	0	0	75	0	0	0	0	133
12	CHEVROLET SPARK	0	4	0	1	0	0	0	0	15	1	106	0	1	128
13	FIAT 500	2	43	0	0	0	0	0	0	0	0	3	0	0	48
14	TESLA ROADSTER	8	9	1	0	0	0	0	0	27	0	7	1	0	53
15	TOYOTA RAV4	0	2	0	0	0	0	0	0	3	0	0	1	0	6

		AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Total
	PHEV Total	544	2,523	111	68	20	48	2	1	6,792	4	9,991	60	0	20,157
1	CHEVROLET VOLT	152	996	47	35	10	17	1	0	3,534	3	7,419	25	0	12,239
2	FORD C-MAX	42	131	12	6	2	3	0	0	415	0	653	6	0	1,270
3	VOLVO XC90	123	184	8	8	0	11	0	1	361	0	203	10	0	909
4	PORSCHE CAYENNE	63	170	9	3	1	6	0	0	363	0	162	7	0	784
5	BMW I3	0	232	0	1	1	0	0	0	311	0	205	0	0	750
6	AUDI A3	11	171	5	2	2	1	1	0	368	0	199	0	0	760
7	TOYOTA PRIUS	23	74	7	3	1	2	0	0	233	0	366	3	0	713
8	FORD FUSION	23	73	7	3	1	2	0	0	231	0	364	3	0	707
9	BMW X5	42	138	7	2	1	1	0	0	213	0	60	3	0	467
10	BMW I8	12	161	1	1	0	0	0	0	218	0	73	0	0	466
11	CHRYSLER TRUCK PACIFICA	8	29	0	3	0	0	0	0	282	0	129	0	0	451
12	BMW 330	8	35	2	0	0	0	0	0	66	0	9	0	0	120
13	FISKER KARMA	9	24	0	0	0	0	0	0	40	0	27	0	0	100
14	CADILLAC ELR	2	12	2	1	0	0	0	0	26	0	40	0	0	83
15	BMW 530	0	13	0	0	0	0	0	0	37	0	13	0	0	63
16	PORSCHE PANAMERA	4	20	1	0	0	6	0	0	15	0	3	0	0	49
17	MERCEDES S550E	8	17	1	0	0	0	0	0	12	0	0	0	0	38
18	HYUNDAI SONATA	2	6	1	0	0	0	0	0	18	0	28	0	0	55
19	MERCEDES GLE550	2	16	0	0	0	0	0	0	6	0	10	1	0	35
20	HYUNDAI IONIQ	1	2	0	0	0	0	0	0	8	0	12	0	0	24
21	BMW 740	0	6	0	0	0	0	0	0	11	0	3	0	0	20
22	PORSCHE 918	4	6	1	0	0	0	0	0	9	0	3	1	0	24
23	MINI COOPER COUNTRYMAN	0	0	0	0	0	0	0	0	13	0	8	0	0	21
24	MCLAREN P1	3	2	0	0	0	0	0	0	3	0	1	0	0	9

25	KIA OPTIMA	1	4	0	0	0	0	0	0	0	0	0	0	0	5
26	CADILLAC CT6	1	1	0	0	0	0	0	0	0	0	0	0	0	2

	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Total
BEV Total	524	5,246	105	29	7	69	4	0	7,248	11	8,251	42	2	21,538
PHEV Total	544	2,523	111	68	20	48	2	1	6,792	4	9,991	60	0	20,157
Total	1,068	7,769	216	97	27	117	6	1	14,040	15	18,242	102	2	41,695

Sources

As always, the data is sourced from R.L. Polk & Company registration data, industry executive interviews, and rounded out by Matthew Klippenstein's Canadian EV Sales Summaries.

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Thanks for the info. Do you track sales of hydrogen fuel-cell vehicles in Canada? Ottawa is spending $1,625,000 to fund two hydrogen fueling stations near Toronto. How many fuel-cell vehicles are in a 500-km radius of the stations?

Appendix 3

Electric-Car Drivers Will Pay For DC Fast-Charging 12-To-1 Over Level 2

Stephen Edelstein 79 Comments Nov 9, 2015

NRG eVgo Freedom Station at Whole Foods Market, Fremont, California

A growing fleet of electric cars will need a comprehensive network of public charging stations, but those who build and maintain those stations have some choices to make.

They have to provide charging infrastructure that will be useful to the public, but is also financially sustainable.

Level 2 AC charging stations are relatively inexpensive and straightforward to install, but require cars to stay put for a fairly long time, usually at least a few hours.

DON'T MISS: **Public Electric-Car Charging: Business Models, Profits Still In Debate**

DC fast-charging stations allow much quicker charges, but are more expensive and place greater demands on electricity infrastructure.

Now a survey of driver habits in one region with high electric-car adoption shows that DC fast-charging may be the better way to attract patronage.

Network operator NRG eVgo recently surveyed a handful of its stations in the San Francisco Bay Area, and found that drivers vastly preferred DC fast charging.

NRG eVgo electric-car charging station

It analyzed 10 of its Freedom Station sites--which offer both Level 2 AC and DC fast charging--sited at Whole Foods stores in the region.

When comparing the number of DC fast-charging sessions to Level 2 sessions, it found drivers preferred fast charging 12 to 1.

In September 2015, there were 6,900 DC fast-charging sessions at those stations, NRG eVgo said.

ALSO SEE: Can Electric-Car Fast Charging Be Profitable? Answer: Unclear

For drivers, the speed of DC fast charging is obviously a plus.

Stations can charge most electric-car battery packs to 80-percent capacity in around 30 minutes, compared to hours for Level 2 AC charging.

That means they can fit a fast-charging session in while running a quick errand, while Level 2 charging requires a greater time commitment.

Nissan Leaf at eVgo Freedom Station Daly City, California

But the extra time required for Level 2 charging means drivers linger longer at the businesses hosting stations, arguably letting them spend more money there.

That's often the only way they can make money off of electric-car charging, as many sites--both Level 2 and DC fast-charging--are currently free for customers to use.

Over time, advocates suggest, some businesses may simply decide that Level 2 charging is an amenity they can afford to provide for free.

MORE: Electric-Car Fast-Charging Networks: Competition Heats Up

That means Level 2 charging may become like WiFi service in hotels: free in some, where it becomes an expected amenity, but with a fee at others where the market supports it.

Over time, though, a sustainable business model will have to be developed for public DC fast charging.

Businesses will have to weigh the extra initial costs and operating expenses of providing DC fast charging against their potential to draw in new customers.

Expect more studies.

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Is TOU Pricing Enough For Electric Vehicle Charging?

By Sunny Trochaniak Posted November 17, 2015 In Electric Utilities, EV Charging, EV Industry

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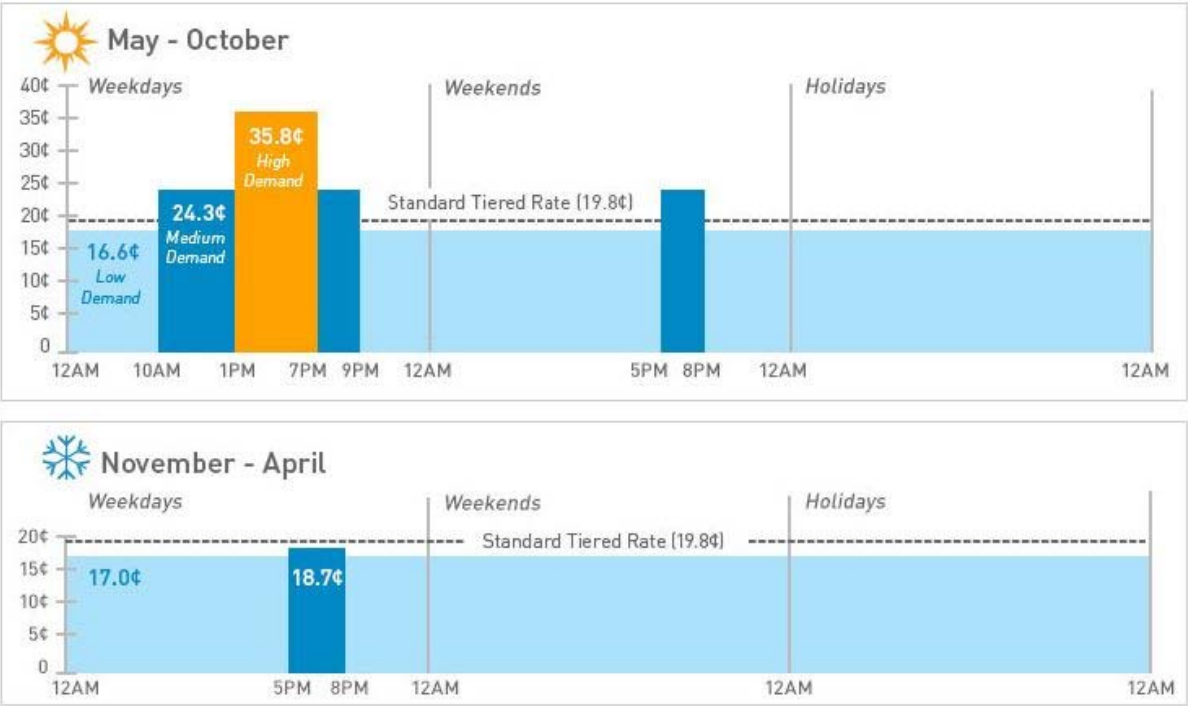
This summer, the California Public Utilities Commission (CPUC) made a move to transform how utilities charge their residential customers for electricity.

Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric – known as the "big three" – will all soon be switching their tiered pricing scheme over to time-of-use (TOU) pricing; the same system used by their commercial and industrial customers.

TOU pricing is currently already offered by some utilities, but setting it as the default residential rate is expected to have a significant impact. The pilots are set to begin in 2016, with full deployment targeted for 2019.

TOU pricing simply means that customers are billed based on the time of day that the electricity is consumed. For example, PG&E has a summer off-peak period from 9pm–10am, a partial-peak period from 10am-1pm, an on-peak period from 1pm-7pm, and another partial peak from 7pm until 9pm. Depending on the utility, rates can sometimes more than double based on the time of day.



So far the move has been greeted with favorable applause, and TOU pricing can certainly bring substantial benefit to Californians and the electric grid.

For consumers, it offers the opportunity to save money simply by shifting their consumption to off-peak hours.

For utilities, it means avoiding costly infrastructure upgrades required to support peak demand.

For the environment, it means diminishing the use of dirty "peaker" power plants (currently only used a few days a year), and integrating more solar and wind-sourced electricity into the grid.

With California seen as the lead test subject for many environmental policies, utilities are keeping a close eye on the results of the pilots.

Does TOU pricing work?

A recent study conducted by the Sacramento Municipal Utility District (SMUD) confirmed that TOU pricing effectively shifted electricity consumption to off-peak hours among study participants.

> *"Customers turned off appliances and lights and were less likely to crank up their air conditioners during peak pricing times. SPO's TOU rates reduced demand by nearly 12 percent during the peak period. Consistent with the larger price differential, CPP (critical-peak pricing) was able to shave around 25 percent of load during peak hours on peak days."*

Pilot customers also strongly agreed that they believed their pricing plans enabled them to save money.

Plugging EVs into the grid

As residential customers continue to adopt electric vehicles, the case for TOU pricing becomes even stronger. Consumers can come home from work and schedule their vehicles to charge at night with cheap, clean electricity.

But what happens in 5 years when EVs begin to represent a much greater share of the vehicle market, and everyone plugs in at 9pm?

The peak simply shifts to the beginning of 'off-peak' hours.

Taking TOU one step further

A simple approach to mitigate this issue is to offer EV owners monetary and/or non-monetary benefits in exchange for enrollment in a program that permits utility-controlled charging at the times when curtailment capacity is needed for the grid – also known as **smart charging**.

Let's play out an example scenario:

TOU Pricing Only

Doug, Bob, and Jane all finish their work day at 5pm, and arrive back home by 6 pm. Instead of plugging in their EV right away, they wisely wait until 9pm; the beginning of off-peak hours in their region.

Doug, Bob, and Jane: have taken advantage of off-peak pricing, and have a full charge ready for them in the morning.

The utility: has effectively shifted their demand to off-peak hours, but has consequently created a new peak period.

With the Addition of Smart Charging

Doug, Bob, and Jane all finish their work day shift at 5pm, and arrive back home by 6pm. They plug-in right away, and have previously stated in an app that they need a full charge ready for them by 8am the next morning. The utility, still in peak hours, automatically shifts Doug's charging to 10pm, Bob's charging to 11pm, and Jane's charging to 12am.

Doug, Bob, and Jane: have taken advantage of off-peak pricing, and have a full charge ready for them in the morning.

The utility: has effectively shifted their demand off-peak, without creating a new peak period. They also now have control over assets to take load off the grid if needed.

We've already seen similar programs in place with smart thermostats. Southern California Edison rolled out a popular Bring-Your-Own-Thermostat program in 2013, offering customers a $1.25 bill credit for every kilowatt-hour saved during peak days. Customers offer the utility control over their thermostat, who in-turn offer a financial incentive and promise minimal impact.

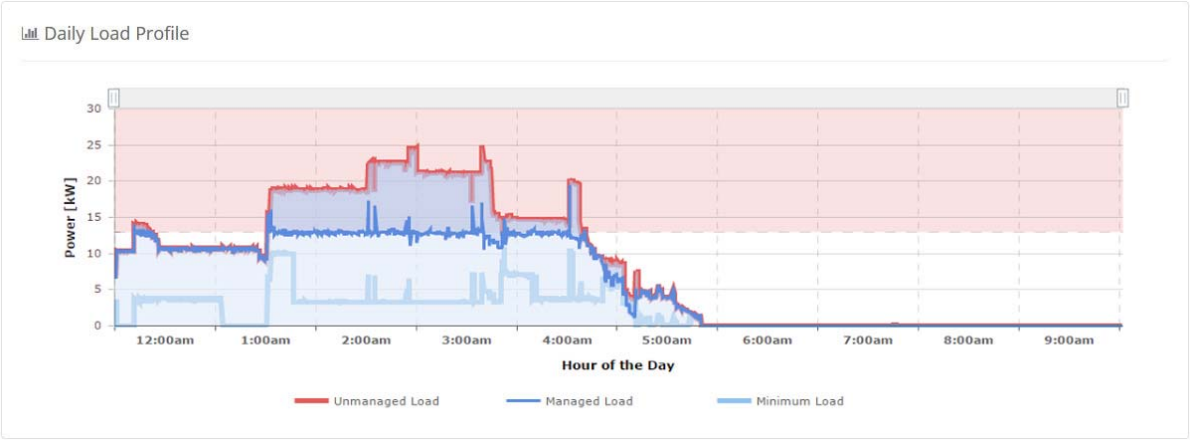
The challenge with EVs

The challenge with EVs is getting vehicle-side data – particularly the vehicle's battery state-of-charge. Without it, customers are faced with the risk of not having a charge when they need it most.

A third-party smart charging system with real-time battery state-of-charge can serve as an intermediary. It can help the utility determine whether a vehicle is a good candidate for curtailment or not, and add a privacy layer to protect the resident's needs.

We've been testing this solution, and have been running a number of smart charging pilot projects in Canada, the United States and in Europe. One example is the "ChargeTO" residential smart charging pilot in collaboration with Toronto Hydro – the first of its kind.

We clipped in one of our EV monitoring devices into each vehicle and supplied each resident with a networked charging station. With both the vehicle and charging station communicating to our cloud platform (the control path varies based on the setup), we've been able to reduce peak demand while protecting the customer's needs. More analysis on that should be coming out next year.



Wrapping it up

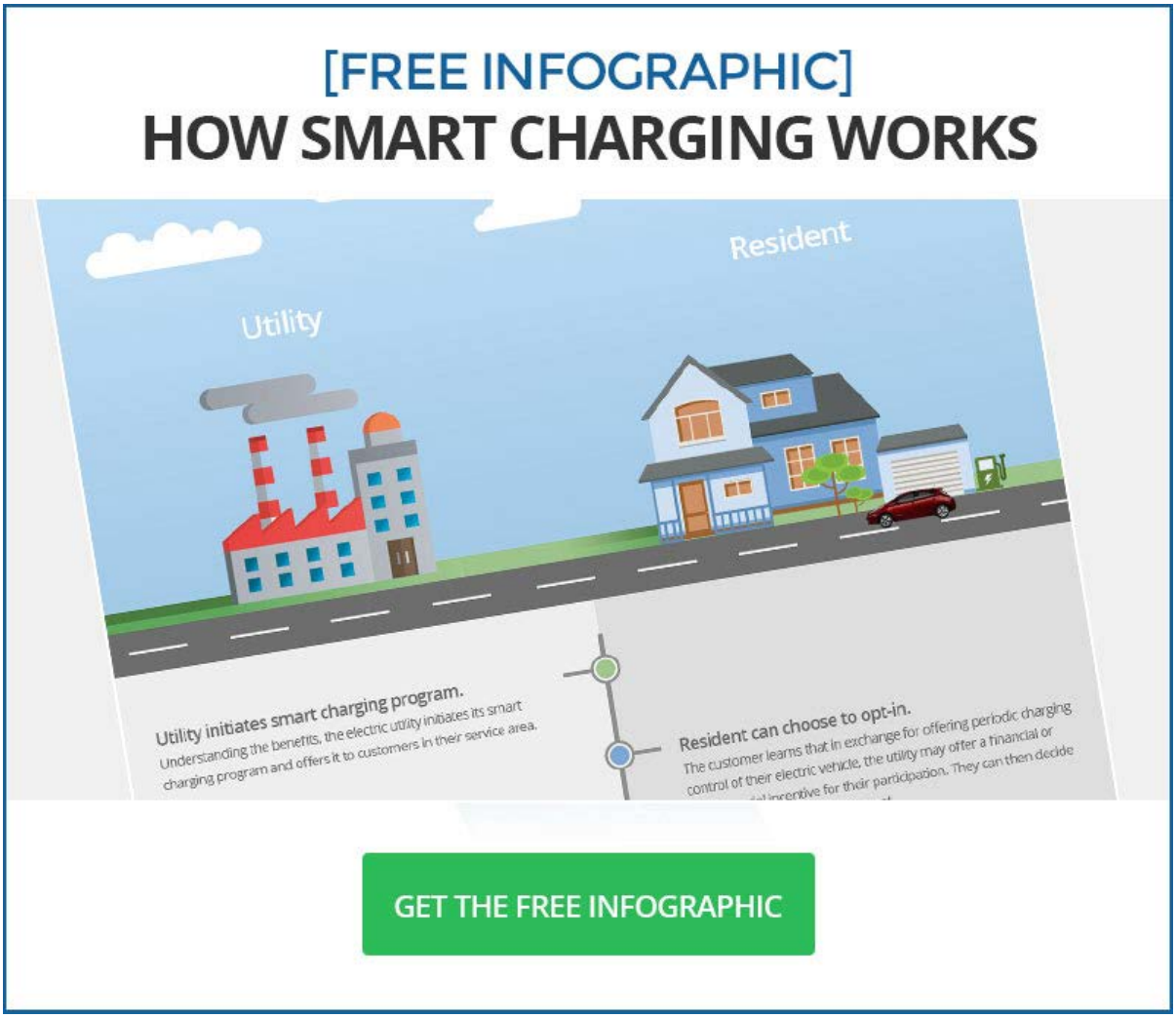
Time-of-use pricing is a huge step forward for utilities and residents alike, and will become widely adopted as pilot studies continue to prove its case.

As EVs gain mainstream attention, utilities will need to adapt to the increased load on the grid that the vehicles bring. Using vehicle-side data, they'll be able to systematically curtail vehicles based on grid loads, posing zero negative impact to the end user. This represents new revenue opportunities with fewer infrastructure requirements.

The future of grid load management is exciting.

Next Steps:

- **Utilities:** download the How Smart Charging Works infographic below
- **Consumers:** what are your thoughts on TOU pricing? Would you allow utilities to shift your charging if they provided an incentive and a means to set your preferences? Let us know in the comments below!



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Government of Canada Gouvernement du Canada

Electric vehicle charging stations

Electric vehicle charging stations allow consumers to charge their electric car by buying electricity. Various levels of government and private industry organizations have started to install these stations to invest in clean technologies.

Many of these charging stations use measurement systems that involve new technologies. These new technologies must comply with different federal measurement laws depending on how the electricity is sold.

Electricity sold on the basis of time

Charging stations that are only intended to sell prepaid energy on the basis of time must:

- charge the customer for time within the limits of error set in the Weight and Measures Act
- state the price per unit of time

Electricity sold on the basis of energy

Charging stations that sell electricity on the basis of energy (kWh) or time-related demand (kW) are considered meters. This means that device owners must:

- use defined units of measurement
- make sure the meter type is approved by Measurement Canada
- find an authorized service provider to inspect a new meter before using it and to reinspect the meter periodically
- make sure the meter is sealed properly
- register as a contractor to sell electricity

Date modified:

2017-06-19

ALJ/EDF/ge1 **PROPOSED DECISION** Agenda ID #15334 (Rev. 1)
Ratesetting
12/15/16 Item # 57

Decision **PROPOSED DECISION OF ALJ FARRAR** (Mailed 11/14/2016)

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of Pacific Gas and Electric Company for Approval of its Electric Vehicle Infrastructure and Education Program (U39E).	Application 15-02-009 (Filed February 9, 2015)

DECISION DIRECTING PACIFIC GAS AND ELECTRIC COMPANY TO ESTABLISH AN ELECTRIC VEHICLE INFRASTRUCTURE AND EDUCATION PROGRAM

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DECISION DIRECTING PACIFIC GAS AND ELECTRIC COMPANY TO ESTABLISH AN ELECTRIC VEHICLE INFRASTRUCTURE AND EDUCATION PROGRAM

Summary

Today's decision provides guidance and direction to Pacific Gas and Electric Company (PG&E), for its Electric Vehicle (EV) infrastructure and education program. Today's decision provides for:

- PG&E ownership of EV supply infrastructure ("make-ready" infrastructure) to support up to 7,500 EV charging ports in multi-unit dwellings, disadvantaged communities and workplaces;
- PG&E ownership in multi-unit dwellings and disadvantaged communities of up to 2,625 EV charging ports;
- Expenditure of up to a total $130 million in Phase 1 of PG&E's Electric Vehicle Program;
- Rate recovery by PG&E;
- Varying levels of site host participation payments rebates; and
- A Program Advisory Council.

This decision closes the proceeding.

1. Background

Executive Order B-16-2012, signed by California Governor Brown on March 23, 2012, directed the California Public Utilities Commission (Commission) and other state agencies to establish benchmarks to help achieve the build-out of Zero Emission Vehicle (ZEV) infrastructure capable of supporting up to one million vehicles, and to integrate Plug-in Electric Vehicle (PEV) charging into the state's electricity grid by 2020. Executive Order B-16-2012 further directs the state agencies to establish benchmarks to help achieve the goal of having over

1.5 million ZEVs on California's roads by 2025.[1] These goals are also set forth in the Governor's Executive Order, and in various California statutes.[2]

On February 9, 2015, Pacific Gas and Electric Company (PG&E) filed Application (A.) 15-02-009, seeking approval of its proposed Electric Vehicle Infrastructure and Education Program (EV Program) proposing to deploy, own, and manage approximately 25 percent of the charging stations it deems necessary to support its share of the Executive Order B-16-2012 goals.[3] Responses and protests were filed on March 11, 12, and 13, 2015. On May 5, 2015, the assigned Commissioner held an all-party meeting in this and two related proceedings. Motions filed across the various proceedings and the merits of consolidating the proceedings were discussed at the all-party meeting. On June 12, 2015, the assigned Administrative Law Judge (ALJ) held a prehearing conference (PHC) to discuss the parties, issues, schedule, and other procedural matters. At the PHC, parties were asked to consider phasing PG&E's proposed EV Program, and by ruling dated June 16, 2015, the assigned ALJ requested formal comments on phasing PG&E's proposed EV Program. Parties

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[1] The Governor's Executive Order subsequently became the focus of the Governor's Interagency Working Group on Zero-Emission Vehicles, which issued a report entitled the "2013 ZEV Action Plan" in February 2013. The 2013 ZEV Action Plan identified specific strategies and actions that various state agencies would take to meet the milestones set forth in the Executive Order.

[2] *See* for example, Public Utilities Code Sections (Pub. Util. Code) 399.11, 740.2, 740.3, and 740.8; Health & Safety (H&S) Code §§ 38501, 38550, 38551; Public Resources Code Section 25740; and Stats. of 2013, Ch. 418, § 1. On January 14 and 28, 2016, the Commission issued decisions approving modified EV program proposals for the Southern California Edison Company (SCE) and the San Diego Gas and Electric Company (SDG&E) (*see* Decision (D.) 16-01-023 and D.16-01-045 respectively).

[3] A.15-02-009; Exh. 1.

filed comments on this issue on July 2 and 3, 2015, and reply comments on July 10, 2015.

On October 9, 2015, the assigned ALJ directed Clean Coalition to file an amended NOI, after finding that the bylaws filed by Clean Coalition were not up to date and that Clean Coalition needed to provide more information to substantiate a finding of significant financial hardship.[4] By Ruling dated June 30, 2016, the assigned ALJ denied Clean Coalition's *Amended Notice of Intent to Claim Intervenor Compensation* (filed November 09, 2015, hereinafter *NOI*). Clean Coalition filed its *Motion to Reconsider the June 30, 2016 Ruling* (*Motion to Reconsider*) filed on August 1, 2016.

On September 4, 2015, the assigned Commissioner and assigned ALJ issued a Scoping Memo and Ruling (Scoping Ruling) requiring, among other things, that PG&E file and serve a supplement to its application no later than October 12, 2015 that included: 1) an initial phase of electric charging station deployment, limited to a maximum of 2,510 charging stations, to be deployed over no more than 24 months; 2) a transition plan that provides at least 18 months of data for evaluation by the Commission, and that identifies steps to minimize market uncertainty and discontinuity during the regulatory review period; and 3) responses to specific questions described in the Scoping Ruling.

On October 12, 2015, PG&E served supplemental testimony and responses to the questions in the Scoping Ruling.[5] PG&E's supplemental testimony

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[4] Prior Commission Rulings similarly directed Clean Coalition to update its NOI and provide additional documentation and information related to customer status and significant financial hardship. *See* Ruling on Clean Coalition's NOI, February 17, 2015 in R.14-07-002; Ruling on Clean Coalition's NOI, March 03, 2015 in R.14-10-003.

[5] Exh. 3.

included both the requested Compliant Proposal and an Enhanced Proposal. PG&E's Compliant Proposal limited Phase 1 to 2,510 charging stations (10 percent of PG&E's Original Proposal) to be deployed over a 24-month period (from the date of first construction), provides for 18 months of data collection, and includes a plan for transitioning from Phase 1 to Phase 2. PG&E's Compliant Proposal totals $70 million in capital costs and $17 million in expense amounts. PG&E's Enhanced Proposal provides for deployment of a maximum of 7,530 EV charging stations over no more than 36 months from the date of first construction. The Enhanced Proposal requires a total of $187 million in capital costs and $35 million in expenses, with deployment over a 36-month timeframe.[6]

On October 23, 2015, The Utility Reform Network (TURN), Office of Ratepayer Advocates (ORA), and Marin Clean Energy (MCE) moved to strike portions of PG&E's supplemental testimony on claims that the testimony was outside the scope of this proceeding because it presents not only a phased program limited to 10 percent of the total number of charging stations proposed by PG&E in its application, but also an "enhanced" phased proposal that consists of approximately 30 percent of the total charging stations proposed in its application. (TURN, et al. Motion at 4- 5.) On November 2, 2015, Green Power Institute (GPI), The Joint Minority Parties, and ChargePoint filed responses supporting the October 23, 2015 motion, while PG&E filed a response opposing the motion.

[6] Exh. 3 at 1 (Corey).

On November 30, 2015, 14 parties served testimony responding to PG&E's supplemental testimony.[7] None of these parties expressed unequivocal support for the Enhanced Proposal PG&E proposed in its supplemental testimony. On December 21, 2015, PG&E served rebuttal testimony responding to the intervenor testimony.[8]

On March 21, 2016, PG&E, American Honda Motor Co., CUE, General Motors LLC, Greenlining, Marin Clean Energy, NRDC, Plug In America, the Sierra Club, the Alliance of Automobile Manufacturers, Greenlots, the Center for Sustainable Energy, and Sonoma Clean Power (collectively, the Settling Parties) executed the Settlement Agreement and filed their "Joint Motion for Adoption of Charge Smart and Save Proposal."[9] On March 29, 2016, the ALJ issued his Ruling Setting Hearing Schedule and Directing the Joint Settling Parties to Respond to Various Questions. On April 12, 2016, Settling Parties filed their responses to the ALJ's questions.[10] Also on April 12, 2016, TURN, ORA, ChargePoint, EVCA, TechNet, Consumer Federation of California, JMP, GPI, filed comments on the Settlement Agreement. On April 18, 2016, the 13 Settling Parties filed Reply Comments in response to the April 12, 2015 Opening Comments on the Settlement Agreement.

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[7] These parties included Joint Minority Parties (JMP), ORA, TURN, ChargePoint, Vote Solar, the Electric Vehicle Charging Association (EVCA), TechNet, GPI, American Honda Motor Co., the Coalition of California Utility Employees (CUE), General Motors LLC, The Greenlining Institute (Greenlining), Marin Clean Energy, Natural Resources Defense Council (NRDC), Plug In America, the Sierra Club, the Alliance of Automobile Manufacturers, Greenlots, the Center for Sustainable Energy, Marin Clean Energy, and Sonoma Clean Power.

[8] Exh. 2.

[9] The Settlement Agreement is attached to the Joint Motion.

[10] *See* Joint Response by Settling Parties to Administrative Law Judge's Ruling Directing Joint Settling Parties to Respond to Various Questions, April 12, 2016.

Between April 25-28, 2016, parties participated in hearings on the Settlement Agreement and other EV charging proposals put forth by PG&E. On June 17, 2016, parties filed opening briefs. While JMP, ORA, TURN, ChargePoint, Vote Solar, EVCA, TechNet, and GPI did not submit a joint proposal to the Commission, their individual briefs contained several shared recommendations.[11] On July 12, 2016, parties filed reply briefs.

By Ruling dated July 7, 2016, the assigned ALJ reopened the record of the proceeding and directed PG&E and the Joint Settling Parties to respond to a series of questions attached to the Ruling. The proceeding was deemed submitted on August 1, 2016, when the Non-Settling Parties provided replies to the responses provided by PG&E and the Joint Settling Parties.

2. Summary of EV Charging Program Proposals

Over the course of this proceeding, parties have submitted what we construe as a total of five different EV charging proposals. These proposals differ in terms of size, cost, duration, target segments, load management strategies, and other factors. Following a brief overview of the salient features of each proposal,[12] we consider the parties' arguments in support of each of the defining characteristic of the proposals.

2.1. PG&E's Original Proposal

PG&E originally proposed to deploy, own and maintain approximately 25,000 Level 2 EV charging stations and approximately 100 Direct Current Fast

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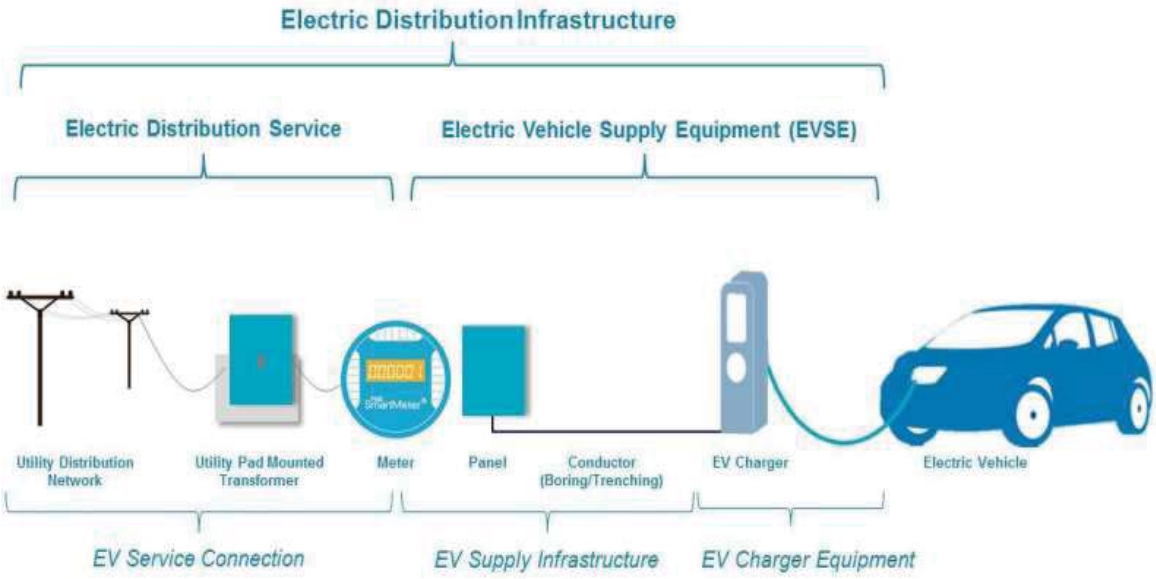
[11] Some of these parties' briefs contained additional recommendations that while generally consistent with, go beyond the shared points of agreement.

[12] This and other pertinent program information is set forth in summary form in Table 1 below.

Chargers (DCFCs) and supporting infrastructure.[13] The infrastructure needed for EV charging is described by PG&E in their prepared testimony using Figure 1.

Figure 1. EV Charging Infrastructure[14]



PG&E's original proposal targeted public facilities, workplaces and multi-unit dwellings and with a goal of installing approximately 10 percent of the charging infrastructure in disadvantaged communities. This proposal used time-variant pricing and offered education and outreach materials to drive EV

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[13] Level 2 charging offers charging through 240 V or 208 V electrical service and typically adds about 10 to 20 miles of driving range per hour of charging time. Since most homes have 240 V service available and Level 2 chargers can charge a typical EV battery overnight, they will commonly be installed at EV owners' homes. DCFCs enable rapid charging along heavy traffic corridors and at public stations. DCFCs typically add about 50 to 70 miles of driving range per 20 minutes of charging time. *See* http://www.afdc.energy.gov/fuels/electricity_infrastructure.html.

[14] Exh. PG&E-2, Chapter 1, Figure 1-1. For purposes of this decision, Electric Vehicle Service Equipment, or EVSE, is defined as the EV charger equipment as opposed to the supply infrastructure, which we refer to as the make-ready infrastructure. In addition, the term "EV charging port" refers to the number of plugs per EVSE (e.g., there could be one or multiple "ports" per EVSE.)

adoption. PG&E's Original Proposal provided for a minimum of 10 percent deployment in disadvantaged communities plus $5 million for related programs in these communities. PG&E requested $551,151,000 in capital costs and $102,695,000 in expense costs, for a total of $653,846,000, to fund the EV program it originally proposed. PG&E argued that a program of this magnitude was necessary to achieve its share of the build-out of ZEV infrastructure called for in Executive Order B-16-2012.

The Scoping Ruling found that a more measured approach to utility ownership was warranted and, in directing PG&E to supplement its original application and set forth a more phased deployment approach, effectively rejected PG&E's original proposal.[15]

2.2. PG&E's "Compliant Proposal"

In response to the September 4, 2015 Scoping Ruling, on October 12, 2015, PG&E submitted its "Compliant Proposal." As directed by the Scoping Ruling, PG&E's Compliant Proposal provides for an initial deployment of 2,510 charging stations, "10 percent of the total originally proposed number of charging stations."[16] Rather than reduce its proposal to 10 percent for each type of charger across the board, PG&E's Compliant Proposal reduces the number of Level 2 charging stations to 9.8 percent, from 25,000 to 2,460, and the number of DCFCs by only 50 percent, from 100 to 50 for a reduction in the total number of chargers to 10 percent. Similar to PG&E's Original Proposal, the Compliant Proposal provides for PG&E's ownership of all the Level 2 and DCFCs it proposes to build, with a minimum of 10 percent deployment in disadvantaged

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[15] Scoping Ruling at 7.

[16] Scoping Ruling at 7.

communities, plus $3.3 million for related programs in these communities. The Compliant Proposal provides for a program advisory council similar to those adopted for SCE and SDG&E in D.16-01-023 and D.16-01-045 (respectively). PG&E estimates the cost of its Compliant Proposal at $87 million.

While some parties argue that this proposal should be rejected on claims that PG&E failed to comply with the Scoping Ruling's directive to provide for an initial phase deployment of "10 percent of the total originally proposed number of charging stations," more pressing issues raised about this proposal include whether and why PG&E should own the assets, how the number of DCFCs provided for in the proposal was determined, and whether each charger should have one or two ports.

2.3. PG&E's Enhanced Proposal

The PG&E Enhanced Proposal provides for a substantial build-out over the Compliant Proposal. In addition to almost triple the number of Level 2 chargers (7,430), and twice as many DCFCs (100), the Enhanced Proposal provides for an additional $0.5 million for programs related to the 10 percent deployment in disadvantaged communities, compared to the Compliant Proposal. Like the Compliant Proposal, the Enhanced Proposal provides for a Program Advisory Council. PG&E estimates the costs of the Enhanced Proposal at $222 million.

In addition to the foundational question of whether consideration of this proposal violates our rules of practice and procedure and/or parties' due process rights, other issues that have been raised about this proposal include: what appear to be higher per charger costs; how the number of DCFCs provided for in the proposal was determined; what, if any justification exists for utility ownership; the appropriateness of the definition of Disadvantaged Community

(DAC) used; site host rate-plan flexibility, and; whether each charger should have one or two ports.

2.4. The Settlement Agreement

The Settlement Agreement provides for the installation of 7,500 Level 2 ports and 100 DCFCs at an estimated cost of $160 million in Phase 1 which will run for three years after construction of the first installation. In addition to being estimated to cost $62 million dollars less than PG&E's comparable (in terms of number of chargers built) Enhanced Proposal, the Settlement Agreement also provides for load management through Time of Use (TOU) rates, site selection, and the capacity to integrate Distribution Resource Plan (DRP) Integration Capacity Analysis. The Settlement Agreement also provides for greater site host involvement. In addition to allowing site hosts to choose between TOU Rate-to-Driver and Rate-to-Host options, the Settlement Agreement allows a site host the choice of charging technology, and provides for differing participation payments (10 percent for Multi-Unit Dwellings (MUDs), 20 percent for private entities, and waivers for DACs, non-profits, and government entities). Also, the Settlement Agreement provides for a 15 percent minimum in DACs, plus an additional 5 percent stretch goal for deployment of infrastructure in disadvantaged/California Alternative Rates for Energy (CARE) communities, plus $5 million for additional programs (DCFC stations outside of DACs will count towards this target if they demonstrate co-benefits). Finally, the Settlement Agreement provides specific segment target goals of 20 percent for MUDs, with a 50 percent stretch goal, and a program advisory council such as was established in D.16-01-045.

2.5. Non-Settling Parties' Recommendations

The Opening Briefs filed by JMP, ORA, TURN, ChargePoint, Vote Solar, EVCA, TechNet, and GPI contain several common proposed modifications to the PG&E Compliant Proposal. For example, the Non-Settling Parties propose a budget of $87 million with Phase 1 up and running for three years after initial construction. From this starting point, the Non-Settling Parties provide for 2,500 Level 2 Chargers[17] each with two ports for a total of 5,000 ports, along with 10 DCFCs,[18] and propose load management through the DRP Integration Capacity Analysis (ICA). The Non-Settling Parties also provide for greater site host involvement. In addition to allowing site hosts to determine the rates and structure of driver charging rates,[19] the Non-Settling Parties would allow the site host to choose equipment and network services, and identify the site host as the customer of record.[20] The Non-Settling Parties' recommendations also appear to encourage participation in traditionally challenging markets by waiving the participation payment for MUD site hosts that are in DACs, and establishing a 50 percent minimum target for this segment.[21] Finally, the Non-Settling Parties propose that PG&E be allowed to ratebase the make-ready, but not Electric Vehicle Supply Equipment (EVSE) portion of the sites, and that any PG&E

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[17] TURN, one of the Non-Settling Parties, suggests these may be Level 1 or Level 2 chargers.

[18] GPI suggests up to 300 DCFC.

[19] TechNet and GPI do not comment on this aspect of the proposal.

[20] TURN, EVCA, and GPI do not comment on customer of record.

[21] For the most part, the Non-Settling Parties define a DAC as the top quartile in the CalEnviroScreen. TechNet and GPI do not comment on this aspect of the proposal.

ownership be limited to sites in MUDs and/or DACs.[22] In their reply briefs, the Settling Parties take issue with the proposals made by the Non-Settling Parties.

2.6. Conclusion

A summary of each proposal is presented below in Table A. No proposal is supported by all parties, and no party supports all of the proposals made. While, at least in theory, each proposal has particular strengths, certain weaknesses can also be attributed to each proposal. Rather than approve any one of the proposals as presented, we will adopt an EV program, drawing from elements of all proposals that is more consistent with the proceeding record and the public interest.

Table A: **Comparison of Proposals in A.15-02-009**

	PG&E Original Proposal (February 9, 2015)	PG&E Enhanced Proposal (October 12, 2015)	PG&E Compliant Proposal (October 12, 2015)	Charge Smart and Save (March 21, 2016)	Non-Settling Parties (June 17, 2016 Briefs)[23]
Size	25,000 L2; 100 DCFC	7,430 L2; 100 DCFC	2,460 L2; 50 DCFC	7,500 L2 ports; 100 DCFC (Phase 1)	2,500 L2 chargers (5,000 ports);[24] 10 DCFC[25]
Cost	$654 million	$222 million	$87 million	$160 million (Phase 1)	$87 million
Duration	7 years	3 years after initial construction	2 years after initial construction	3 years after initial construction (Phase 1)	2 years after initial construction
Ownership	PG&E	PG&E	PG&E	PG&E	PG&E can ratebase

[22] GPI suggests there is no need for PG&E ownership since SDG&E is testing this approach.

[23] JMP, ORA, TURN, ChargePoint, Vote Solar, EVCA, TechNet, and GPI did not submit a joint proposal to the Commission, but their individual briefs supported several consistent recommendations, which are identified in this table. Some of these parties' briefs contained additional recommendations in addition to what was commonly agreed upon and are not included in this table.

[24] TURN suggests these may be Level 1 or Level 2.

[25] GPI suggests up to 300 DCFCs.

	PG&E Original Proposal (February 9, 2015)	PG&E Enhanced Proposal (October 12, 2015)	PG&E Compliant Proposal (October 12, 2015)	Charge Smart and Save (March 21, 2016)	Non-Settling Parties (June 17, 2016 Briefs)[23]
					make-ready, not EVSE; limit PG&E ownership to MUDs and/or DACs[26]
Segment Targets	None. Will serve MUDs, workplaces, fleets, public Facilities	None	None	20% at MUDs with 50% MUD stretch goal. 15% at DACs with 20% stretch goal.	50% minimum at MUDs[27]
Load Management	TOU Rates	TOU Rates	TOU Rates	TOU Rates and Load Management Plans; site selection uses DRP Integration Capacity Analysis	Load management plan;[28] use DRP ICA[29]
Site Host Flexibility in Rate Plans	No	No	No	Yes, may choose rate to host or rate to driver	Site host determines rate structure and driver charge[30]
Site Host Participation Payments	No	No	No	Yes, 10% for MUDs, 20% for private entities; waived for DACs, non-profits, government, DCFC	MUDs in DACs receive full payment waiver[31]
Site Host Choice of Charging Technology	No	No	No	Yes, consistent with D.16-01-045	Yes, site host chooses equipment and network services. Site host is customer of record.[32]

[26] GPI suggests there is no need for PG&E ownership since SDG&E is testing this.

[27] GPI does not comment on the 50 percent MUD minimum.

[28] TechNet and GPI do not comment on this.

[29] GPI does not comment on this.

[30] TechNet and GPI do not comment on this.

[31] GPI does not comment on this.

[32] TURN, EVCA, and GPI do not comment on customer of record.

	PG&E Original Proposal (February 9, 2015)	PG&E Enhanced Proposal (October 12, 2015)	PG&E Compliant Proposal (October 12, 2015)	Charge Smart and Save (March 21, 2016)	Non-Settling Parties (June 17, 2016 Briefs)[23]
Disadvantaged Communities Deployment and Support	10%, plus $5 million for additional programs	10%, plus $3.8 million for additional programs	10%, plus $3.3 million for additional programs	15% minimum, plus additional 5% stretch goal in disadvantaged/CARE communities, plus $5 million for additional programs; DCFC stations outside of DACs will count towards target if they demonstrate co-benefits	Define as top quartile in CalEnviroScreen[33]
Program Advisory Council	No	Yes, similar to SCE and SDG&E	Yes, similar to SCE and SDG&E	Yes, consistent with D.16-01-045	Yes, reps from govt, industry, labor, ratepayer, environmental, DAC[34]

3. Burden of Proof and Legal Standards

At least three different legal standards are relevant to this discussion. First, consistent with § 451,[35] the Commission is charged with ensuring that all rates demanded or received by a public utility are just and reasonable.[36] Various parties argue, and PG&E appears to agree, that PG&E has the burden of proving that it is entitled to the relief sought in this proceeding, and affirmatively establishing the reasonableness of all aspects of its application.

In particular, PG&E is obliged to affirmatively establish that its proposal meets all of the requirements set forth § 740.3. Second, proponents of utility

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[33] TechNet and GPI do not comment on this.

[34] EVCA and GPI do not comment on this.

[35] Unless otherwise noted, all statutory references are to the Pub. Util. Code.

[36] Cal. Const., art. XII, § 6; also *see*, *Monterey Peninsula Water Management Dist. v. Public Utilities Com*. (2016) 62 Cal. 4th 693, 700.

ownership of EV charging infrastructure must affirmatively establish that this approach satisfies the test established in D.11-07-029 and reaffirmed in D.14-12-079, wherein the benefits of utility ownership of EV charging infrastructure is balanced against the competitive limitation that may result from that ownership (balancing test).[37] Finally, because a settlement is at issue, we must consider whether the settlement is reasonable, consistent with law, and in the public interest.[38]

In addition to these Rule 12.1(d), requirements, in reviewing the settlement, our analysis must also take into account that although several, but by no means all, of the parties have joined the settlement, the settlement is contested. In prior proceedings wherein a settlement affecting all PG&E customers was proffered, the Commission has stated that the factors used by the courts in approving class action settlements provide the appropriate criteria.[39] In order to determine whether a settlement is fair, adequate, and reasonable, the court balances factors such as risk, expense, the ability of opposing parties to gauge the strength and weakness of all parties, and the presence of a governmental participant.[40] In addition, other factors to consider are whether the settlement negotiations were at arm's length and without collusion; whether the major issues are addressed in the settlement; whether segments of the class are treated differently in the settlement; and the adequacy of representation.[41]

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[37] ChargePoint Opening Brief at 8, citing *Application of San Diego Gas & Electric Co. for Approval of its Electric Vehicle-Grid Integration Pilot Program,* D.14-12-079 at 5.

[38] Rule 12.1(d) of the Commission's Rules of Practice and Procedure.

[39] *See* D.09-12-045 at 33.

[40] D.09-12-045 at 33-35.

[41] D.09-12-045 at 33-35, citing Diablo Canyon, 30 CPUC2d, 189, 222.

Central to our analysis here, where the proposed settlement is contested, is the relevant objections or concerns of opposing parties and the question of whether the settlement agreement provides a negotiated resolution of all the disputed issues.

4. Review of the Settlement Agreement

As discussed above, the Scoping Ruling found that a more measured approach to utility investment in charging infrastructure than what was included in PG&E's Original Proposal was warranted. While the Scoping Ruling required PG&E to submit a program at 10 percent the size of the original application, it did not state that would be the upper limit of a program authorized by the Commission. Rather, it clearly referred to program phasing, which implies the Commission's intent to consider PG&E investment in this space above 10 percent of the original application.

The Settlement Agreement constitutes the Applicant's most recent program proposal, and is preferred by the Applicant and other Settling Parties to the Compliant and Enhanced Proposals. Therefore, we will first discuss whether the Settlement Agreement meets the aforementioned legal standards.

4.1. Ratepayer Interests – Generally

Consistent with D.14-12-079, ChargePoint argues that the Settling Parties have an obligation under § 740.3(c) to establish that the Settlement Agreement is "in the ratepayers' interest."[42] Ratepayers' interest is defined in § 740.8 as follows:

[42] Opening Brief of ChargePoint, Inc. at 7.

> As used in Section 740.3 or 740.12, "interests" of ratepayers, short- or long-term, mean direct benefits that are specific to ratepayers, consistent with both of the following:
>
> (a) Safer, more reliable, or less costly gas or electrical service, consistent with Section 451, including electrical service that is safer, more reliable, or less costly due to either improved use of the electric system or improved integration of renewable energy generation.
>
> (b) Any one of the following:
>
> (1) Improvement in energy efficiency of travel.
>
> (2) Reduction of health and environmental impacts from air pollution.
>
> (3) Reduction of greenhouse gas emissions related to electricity and natural gas production and use.
>
> (4) Increased use of alternative fuels.
>
> (5) Creating high-quality jobs or other economic benefits, including in disadvantaged communities identified pursuant to Section 39711 of the Health and Safety Code.

The Settling Parties propose the Settlement Agreement is in the interest of ratepayers, as defined by § 740.8, because it will provide:[43]

- Safer electrical service because "all of the construction and installation of the EV charging infrastructure will be performed safely, and to code, by licensed electrical contractors with EV infrastructure training certification;"
- More reliable electrical service by using time-of-use price signals and other load management strategies that shift EV load to hours of the day when there is spare capacity in the grid;

[43] Note that while Charge Smart and Save is designed to provide all of these enumerated benefits, § 740.8(a) only requires a showing of one of these benefits.

- More reliable electrical service by leveraging PG&E's Distributed Resource Plan Integration Capacity Analysis to improve site selection;
- Less costly electrical service due to improved integration of renewable generation that will result from using time-of-use rates as a foundation for load management upon which more sophisticated forms of load will be evaluated to identify an "Advanced EV Grid Support" program to be deployed in Phase 2;
- Less costly electrical service due to the improved use of the electric system that will result from time-of-use price signals and other load management strategies that shift EV load to hours of the day when there is spare capacity in the grid; and
- Less costly electrical service due to the improved use of the electric system that will result from leveraging PG&E's Distributed Resource Plan Integration Capacity Analysis to improve site selection.

The Settling Parties go on to argue that, consistent with D.16-01-045, the Settlement Agreement will, under § 740.8(b):

- Promote the accelerated adoption of EVs which will promote the efficiency of travel;
- Reduce the health and environmental impacts from air pollution because vehicle electrification results in "over 85 percent fewer ozone-forming air pollutants emitted;"
- For every mile driven on electricity in a typical EV, reduce emissions of greenhouse gases by a factor of four relative to the average new conventional vehicle in PG&E service territory;
- Deploy EV charging stations that will increase the use of an alternative fuel; and

- Create high-quality jobs or other economic benefits, including in disadvantaged communities, by using union labor and deploying in disadvantaged communities.

We find these contentions to be both true and sufficient to support a preliminary finding that the Settlement Agreement provides benefits that are in the public interest.[44]

4.2. Utility Ownership

4.2.1. Balancing Test

With the exception of the recommendations put forth by the Non-Settling Parties, all the proposals in this proceeding provide for ownership of the EV infrastructure by PG&E. As proposed by the Settling Parties:

> PG&E will purchase and install equipment procured from the competitive marketplace, and own the infrastructure, including the service connection, supply infrastructure and charging equipment.[45]

Consistent with this statement, under the Enhanced Proposal and Settlement Agreement PG&E would deploy and own 7,400 – 7,500 EV charging stations (respectively) in northern California, while under the Compliant Proposal PG&E would own 2,460 EV charging stations in northern California. These proposals appear to reflect our having provided for ownership of charging stations by SDG&E in its territory in D.16-01-045.

The utility ownership provided for in D.16-01-045 was permitted because the Commission recently overturned the broad prohibition against utility EV infrastructure ownership in D.14-12-079. However, rather than give the

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[44] Identical arguments were made and are equally applicable to the Compliant and Enhanced Proposals. *See* PG&E October 12, 2016 Supplement at 16-21.

[45] *See* Exh. PG&E-3 at 17.

utilities blanket authority to own EV infrastructure, D.14-12-079 also reaffirmed the balancing test applied in D.11-07-029, which requires the "[ratepayer] benefits" of utility ownership of EV charging infrastructure to be balanced against the competitive limitation(s) that may result from that ownership.[46]

The balancing test set forth in D.11-07-029, and reaffirmed in D.14-12-079 and subsequent related decisions, establishes that our review of the public interest must include an analysis of the impact of such ownership on competition where the proposals call for utility ownership of EV charging infrastructure.[47] Under these circumstances we must "take a more detailed, tailored approach to assessing any proposed utility program based upon the facts of specific requests, the likely competitive impact on the market segment targeted, and whether any anticompetitive impacts can be prevented or adequately mitigated through the exercise of existing rules and conditions."[48] At a minimum, this factual inquiry will include an examination of:

1. The nature of the proposed utility program and its elements; for example, whether the utility proposes to own or provide charging infrastructure, billing services, metering, or customer information and education;
2. Examination of the degree to which the market into which the utility program would enter is competitive, and in what level of concentration;
3. Identification of potential unfair utility advantages, if any; and

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[46] D.14-12-079 at 5-7.

[47] D.14-12-079, Conclusion of Law 3.

[48] D.14-12-079 at 8.

4. If the potential for the utility to unfairly compete is identified, the commission will determine if rules, conditions or regulatory protections are needed to effectively mitigate the anticompetitive impacts or unfair advantages held by the utility.[49]

The Settling Parties acknowledge the import and applicability of the balancing test set forth in D.14-12-079. Among other things, the Settling Parties state:

> To evaluate whether a utility should be permitted to own [EV supply equipment (EVSE)], the Commission in D.14-12-079 determined that this should be decided on a <u>case specific</u> approach, and that a balancing test weighing the benefits of electric utility ownership of EVSE against the potential competitive limitation that may result from that ownership, should be used.[50]

However, contrary to the acknowledged need for a case specific approach, in Briefs the Settling Parties repeatedly argue that the Settlement Agreement should be deemed to satisfy the anticompetitive inquiry of D.14-12-079's balancing test because it contains many if not all of the same elements found and approved of in pilot programs for SDG&E and SCE (D.16-01-045 and D.16-01-023, respectively). For example, after asserting that the "Charge Smart and Save program incorporates every element upon which the Commission relied in declaring that both the $103 million settlement proposed in the SDG&E proceeding and the scaled down version of the SDG&E program adopted by the Commission passed the balancing test established by D.14-12-079 and

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[49] D.14-12-079 at 8-9.

[50] Settling Parties' Opening Brief at 22-23 (emphasis and footnote added).

appropriately mitigated any potential competitive impacts" the Settling Parties note that the Settlement Agreement:

- Adopts language from D.16-01-045 (with "VGI" replaced with "TOU") that allows site hosts or their designees, to choose the TOU Rate- to-Host option, which allows site hosts to offer a similar TOU rate or other pricing option to EV charging customers.
- Like D.16-01-045, allows the site host or its designee to select the EVSE and related EV charging services from preapproved vendors, which allows third party providers to offer competing EVSE and EV charging services.
- Like D.16-01-045, allows the site host to pay a participation fee which will help offset a portion of EV charging infrastructure costs.
- Consistent with D.16-01-045, uses revenue from the participation payment to defray operation and maintenance expenses.
- Provides for PG&E ownership that compares favorably to the market concentration criteria presented in the record of the SDG&E proceeding.[51]

This approach is fundamentally flawed. First and foremost, while D.16-01-045 correctly determined that certain factors (i.e., market saturation rates, allowing site host a choice among EVSE and EV charging services providers, and TOU pricing options) are important and have been found to reduce anticompetitive impacts, there is nothing in D.16-01-045 or any other decision identified by the Settling Parties that suggest such factors obviate the

[51] Settling Parties Opening Brief at 27, citing D.16-01-045 at 109; Exh. JOINT SETTLING PARTIES-1, Charge Smart and Save Settlement Agreement, Section 6 at 9- 10.

need for anti-competitive mitigation measures.[52] Second, and more generally, claims that the Settlement Agreement should be adopted because it incorporates elements found in the SCE and SDG&E EVSE decisions (D.16-01-023 and D.16-01-045, respectively) fail to account for significant and highly relevant differences between the PG&E proposal and the programs adopted in those decisions such as, among other things, economic drivers, market composition, and number of customers. Indeed, we find the crafting of the Settlement Agreement in this "me too" manner is misleading because the Settlement Agreement significantly differs from the settlement reached in D.16-01-045. For example, the Settlement Agreement includes deploying fast charging infrastructure, and does not include the Vehicle-Grid Integration (VGI) rate structure found in D.16-01-045. Below, we further describe PG&E's proposals, including the Settlement Agreement, and address issues of competition pursuant to the balancing test.

4.2.2. Nature of the Proposed Utility Program

Parties agree that the Compliant Proposal, Enhanced Proposal, and Settlement Agreement provide for PG&E to deploy, own and manage new electric distribution infrastructure in its service area consisting of EV service connection, EV supply infrastructure and EV charging station equipment.[53] ChargePoint provides additional detail on these issues where, among other things, it notes:

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[52] D.16-01-045, Finding of Fact 84, at 169-170.

[53] *See* PG&E's Electric Vehicle Infrastructure and Education Program Application at 3; PG&E's Supplement to Application Pursuant to Joint Assigned Commissioner and Administrative Law Judge's Scoping Memo and Ruling at 16-17; Joint Motion for Adoption of Settlement Agreement at 3.

> The cost of the EVSE and network services, including a rate of return on capital investment, would be entirely paid for by PG&E's ratepayers. Site hosts at certain MUD and commercial sites would pay a nominal "participation payment" of 10-20 percent of the EVSE base cost. All other site hosts would pay nothing for the EVSE, network services, installation and [Operation and Maintenance] O&M.[54]

The Settling Parties note that the Settlement Agreement allows the site host or its designee to select the EVSE and related EV charging services from preapproved vendors, and argue that this allows third party providers to offer competing EVSE and EV charging services to offset the potentially anticompetitive impacts of PG&E's ownership.[55] ChargePoint disputes this contention and notes that PG&E's proposing to purchase EVSE and contract for services instead of providing them itself … does not change the fact that PG&E is directly participating in a competitive market, and marketing goods and services that it will own and operate to site hosts in direct competition with third party non-utility businesses.[56] In particular, ChargePoint argues that allowing third party providers to offer competing EVSE and EV charging services will do little to offset the anticompetitive aspect of PG&E's ownership on claims that "PG&E's apparent plans to apply an unexplained weighting system to pick winners and losers in the [Request for Proposal] RFP will determine what equipment and services PG&E will choose for its program."[57] Finally, ChargePoint notes that "PG&E's own/operate proposal will also have anticompetitive impacts on the

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[54] ChargePoint Opening Brief at 16, citing Exh.1, Settlement at 6.

[55] In addition, the Settlement Proposal also provides for Load Management Plans and site selection using DRP Integration Capacity Analysis. *See* Settling Parties Opening Brief at 16.

[56] ChargePoint Opening Brief at 19.

[57] ChargePoint Opening Brief at 24, citing Exh. 63 at 12-13.

separate competitive markets for demand response ("DR") and other load management services provided through EVSE and managed EV charging."[58]

We agree that the Settlement Agreement does not provide a fully-detailed RFP process, however, we find that PG&E should develop this detailed process in consultation with its Program Advisory Council, incorporating any lessons learned to date from the SDG&E Power Your Drive pilot or the SCE Charge Ready pilot.[59] Also, the Settlement Agreement states that the "RFP and qualification process will occur annually to allow for and encourage participation from new providers over time." Given the short duration of this pilot program, we do not believe an annual qualification process is frequent enough to qualify new vendors and models to ensure that customers have the best available EVSE choices. The qualification process should remain open on a rolling basis and the qualification should be completed at least quarterly. PG&E should not restrict the number of vendors or models that may be qualified through the RFP process. Finally, the Settlement Agreement intends to develop an "Advanced EV Grid Support Program" to facilitate the integration of variable renewables and support the electric distribution system. The Settlement Agreement proposes that PG&E would develop the program during Phase 1 of the pilot and deploy it during Phase 2.[60] PG&E should include specifications in its RFP to ensure that it selects EVSE equipment that is demand response-capable or can otherwise participate in the Advanced EV Grid Support Program.

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[58] ChargePoint Opening Brief at 25.

[59] PG&E should establish a "base cost" for the Level 1 and 2 EVSE, based on the price of the lowest cost EVSE model qualified through the RFP process. The base cost will be used to determine the rebate or participation payments amount as further described below.

[60] *See* Joint Motion for Adoption of Settlement, Section 6 at 13.

4.2.3. Market Competition and Concentration

The Settling Parties contend that utility ownership as provided for in the Settlement Agreement will not adversely impact the developing EV charging market. First, according to the Settling Parties, the number of PG&E-owned chargers (7,500 Level 2 charging ports) provided for under the Settlement Agreement is only 3 percent of the infrastructure required to meet California's 2025 transportation electrification goals. Second, the Settling Parties assert "PG&E's ownership of EV charging stations is more likely than not to actually reduce market concentration in EV charging station markets in PG&E's service area, thus improving competition."[61]

Rather than address anticompetitive impacts on the developing EV charging market, the Settling Parties' first argument references anticompetitive impacts in the market as it might exist almost ten years from now. We can neither now determine the exact number of EV charging stations that will exist ten years from now, nor ignore how a system in place three years from now will impact the development of the market we would like to have in place ten years from now. Particularly where utility entry and ownership into nascent markets is at issue, as is the case here, our concern with anticompetitive effects must focus on the impacts PG&E's entry and ownership will have on the nascent market as well as the market we hope to develop.

In the context of the nascent EV charging market, the Settling Parties' second argument appears to conflate improved competition and reduced market concentration with less anticompetitive behavior. Notably, while reduced market concentration and improved competition may weigh heavily where the

[61] PG&E Opening Brief at 28, citing Exh. 3 at 24- 25, Table 7.

market contains equally desirable (or profitable) potential locations, such has not been shown to be the case for EV charging in PG&E's territory. This future-cast glosses over, or at a minimum downplays, the impacts of PG&E ownership on the nascent EV charging market.

Here, where we seek to support the development of a now nascent market, our inquiry into the anticompetitive effects of utility ownership must take into account both actual and potential effects. Among other things, we must examine the opportunity costs of utility ownership and in particular, the potential impacts of utility ownership on the development of the market and the potential for utility ownership to displace or preempt market competitors that occupy those areas of the market that have lower barriers to entry and/or are more profitable.

In this context, we initially note that the Settlement Agreement provides for PG&E's entry into the competitive market for EV equipment sales and services in northern California.[62] This very specific geographic market in northern California is the relevant market. ChargePoint and TechNet speak directly to the potential impacts PG&E's entry and ownership will have on the nascent and developing market in this area.[63] Among other things, ChargePoint and/or TechNet assert:

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[62] In contrast, PG&E's testimony erroneously identifies the relevant geographic market as "at least national and probably global." *See* Exh. 62 at 29.

[63] In contrast, the "quantitative market concentration analysis" upon which the Settling Parties substantially rely appears based on the national market. (*See* Settling Parties' Reply Brief at 18-19.)

- "PG&E's entry into the market will push out competitors that cannot compete or adapt to PG&E's takeover of a large sector of the workplace, commercial, public and MUD market sectors."[64]
- "Competition would likely cease within PG&E's target geographical and target product markets, and competitive firms with marketing and technological expertise and an appetite to innovate and compete would be pushed aside or simply not enter PG&E's exclusive market area."[65]
- "Barriers to entry will form within the relevant geographical and product markets because no competitive business could enter and compete against PG&E's zero priced EV charging stations, which come with subsidized or freely provided "make ready" facilities at hosts' sites."[66]
- "PG&E's proposal will affect market forces that would otherwise support innovation and market entry."[67]

Notably, neither D.16-01-023 nor D.16-01-045 conclude that there are no anticompetitive impacts associated with utility ownership of EVSE and charging services. Rather, D.16-01-045 concluded that, after various subsequent modifications, utility "ownership would be in the ratepayers' interests and outweigh the disadvantages that could result from a lack of competition."[68] Based on the record now before us, consistent with D.16-01-045 and

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[64] ChargePoint Opening Brief at 23, citing Exh. 63 at 33-34.

[65] ChargePoint Opening Brief at 24, citing Exh. 63 at 35-36. See also Exh. 21 at 3:3 – 3:5.

[66] *Id.*

[67] TechNet Opening Brief at 10; ChargePoint Opening Brief at 24.

[68] D.16-01-045, Conclusion of Law 15.

D.14-12-079,[69] and our earlier finding that development of the EVSE and EV charging services market is in ratepayers' interest, we find that there are potential anticompetitive impacts associated with the Settlement Agreement.

4.3. The Settlement Agreement is Contested

On April 5, 2015, ORA, TURN, EVCA, TechNet, ChargePoint, Inc., JMP and Vote Solar (collectively, the Non-Settling Parties) filed a response to the motion for adoption of the Settlement Agreement. Among other things, the Non-Settling Parties argue that the Settlement Agreement cannot be considered reasonable, consistent with law, and in the public interest both because it does not resolve significant contested issues in this case, and because the Settlement Agreement's recommended disposition of disputed issues does not reflect a compromise between opposing parties or arms-length negotiations.

In this regard, the Non-Settling Parties first note that PG&E's claim that NRDC, Greenlining Institute, CUE, and Plug-In America did not unqualifiedly support the Enhanced Proposal misrepresents these parties' statements.[70] The Non-Settling Parties point out that with one very limited exception the Settling Parties supported the Enhanced Proposal.[71] The Non-Settling Parties further

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[69] D.14-12-079 at 8.

[70] Rather than criticize the Enhanced Proposal these parties stated that they would support a larger version of the Enhanced Proposal.

[71] According to the Non-Settling Parties, MCE was the only one of the 14 Settling Parties that submitted testimony contesting any aspect of earlier PG&E proposal. MCE recommends the Commission to direct PG&E to provide greater details on its treatment of Community Choice Aggregators (CCAs) and jurisdictions actively pursuing CCAs during its deployment and recommended that the Commission direct PG&E to revise its full utility ownership model of EVSEs to a make-ready model that is similar to the SCE Phase 1 Settlement in order to minimize the risks imposed on ratepayer funds. Notably, PG&E's December 21, 2015 rebuttal testimony clarified its position that customers operating and maintain charging stations may choose

Footnote continued on next page

note that five of the Settling Parties (Alliance of Auto Manufacturers, Greenlots, Sierra Club, Center for Sustainable Energy, and Sonoma Clean Energy) did not file any intervenor testimony, while the seven members of the Settling Parties (American Honda Motor Co., CUE, General Motors LLC, The Greenlining Institute, Marin Clean Energy, NRDC, and Plug In America) that did file intervenor testimony merely urged the Commission to act expeditiously on PG&E's "EV Infrastructure and Education Program" application.[72] The Non-Settling Parties claim that rather than resolve disputed issues, the Settlement Agreement represents a consolidation of comparable interests and positions, and is not the result of arms-length negotiations. In this regard, the Non-Settling Parties assert the following:

> PG&E's proposed Settlement in this case does not meet this foundational [arms-length] requirement, because the Settlement's recommended disposition of disputed issues does not reflect negotiation or compromise between opposing parties. PG&E's so-called negotiated agreement between itself and parties that have supported its application throughout this proceeding is not at "arms-length," and for that matter cannot be called a "negotiated agreement" except with respect to that part of the Settlement involving MCE.[73]

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service from "eligible suppliers" including CCAs, and agreed with MCE that PG&E should collaborate with CCAs in marketing, education and outreach.

[72] Response of the Non-Settling Parties to the Motion for Adoption of Settlement Agreement at 8, citing NRDC/CCUE/Greenlining/Plug In America Testimony at 21, and Honda/GM Testimony at 3.

[73] Response of the Non-Settling Parties to the Motion for Adoption of Settlement Agreement at 14 (citation omitted).

The Non-Settling Parties next allege that the Settlement Agreement fails to resolve the significant issues previously identified in the proceeding.[74] The Non-Settling Parties identify the following unresolved issues:

- Cost and size of program;
- Number of DCFC proposed;
- Competitive impact of PG&E ownership of Charging Stations;
- Ratepayer funding for charging stations and proposed utility ownership model;
- Amount & Structure of participation payment;
- Exclusion of Level 1 Chargers from program design
- The "Bridge" funding mechanism;
- Program duration;
- Limits on-site host control over choice of EVSE, services, and pricing;
- Potential impacts on innovation;
- Finally, the Non-Settling Parties note that the Settlement; and
- Agreement is not endorsed by any governmental or ratepayer advocacy group.

While we encourage parties to pursue settlement as a potential alternative to protracted disputes, we find that the outcome of this settlement process did not produce a genuine resolution of the issues. Rather than being the product of an arms-length process, the Settlement Agreement appears to represent a consensus among like-minded thinkers. Indeed, we are hard pressed

[74] Many of these issues were raised in regard to the Enhanced Proposal and are carried over into the Settlement Agreement with little modification or resolution.

to find any concessions given up in exchange for the settlement terms by any signatory to the agreement. This is particularly problematic where, as is the case here, the Settlement Agreement sponsors do not represent all affected interests, and the Settlement Agreement lacks the support of any of the parties that are ratepayer advocates. We therefore conclude that the Settlement Agreement does not meet the standard for contested settlements set forth in D.09-12-045.

4.4. Conclusion

Consistent with Rule 12.4 we can and will treat the Settlement Agreement as joint testimony.[75] In subsequent sections we will review the parties' contentions as they relate to the terms of the Settlement Agreement and prior PG&E proposals and in particular, the Enhanced Proposal. We will adopt those terms that are necessary and appropriate to establish an EV Program that are consistent with the proceeding record and the public interest.

5. Review of Necessary Program Elements

5.1. Market Segment Targets

The Settlement Agreement provides for PG&E to deploy 20 percent of the charging infrastructure to serve MUDs (with a non-binding target of 50 percent for MUDs),[76] and for PG&E to increase the targeted share of charging stations deployed in Disadvantaged Communities to 15 percent (with a stretch goal of

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[75] In relevant part, Rule 12.4 provides that: The Commission may reject a proposed settlement whenever it determines that the settlement is not in the public interest. Upon rejection of the settlement, the Commission may take various steps, including the following: (a) hold hearings on the underlying issues, in which case the parties to the settlement may either withdraw it or offer it as joint testimony, (b) allow the parties time to renegotiate the settlement, (c) propose alternative terms to the parties to the settlement which are acceptable to the Commission and allow the parties reasonable time within which to elect to accept such terms or to request other relief.

[76] *See* Joint Motion for Adoption of Settlement, § 5, at 9.

20 percent for disadvantaged and low-income communities).[77] While several of the Non-Settling Parties argue for substantially greater deployment targets in these segments, we find little in the proceeding record to support this argument. We will adopt the deployment targets provided for these segments as proposed in the Settlement Agreement.[78]

5.2. Utility Ownership

The express terms of the Settlement Agreement provide for PG&E's "ownership of EV Facilities and EVSE."[79] Thus, aside from target goals for the MUD and DAC segments, the terms of the Settlement Agreement provide PG&E unfettered authority to own EV supply infrastructure (i.e., the make-ready infrastructure) and the EVSE anywhere in its territory.[80]

A fundamental concern among most parties that object to PG&E's ownership of EVSE is the possibility, if not likelihood that the utility will locate its facilities in areas where private parties are already competing to provide EVSE and EVSE services. JMP captures this line of thinking where they note:

> [T]argeting market segments where there is already demand will only supplant existing third-party providers who could have met that demand. It makes more sense to target the underserved segments that would adopt greater number of EVs, but for the availability of inexpensive EVSE.

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[77] *See* Joint Motion for Adoption of Settlement, § 1, at 3.

[78] The Settlement Agreement provides an expanded definition of DACs which includes communities with high concentrations of California Alternate Rates for Energy (CARE) households for the purposes of the 20% DAC stretch goal. We will approve this expansion in this specific and non-binding goal.

[79] Joint Motion to Adopt Settlement Agreement, § 4, at 4.

[80] The Settlement Agreement provides for a specific segment target goal of 20 percent for MUDs, with a 50 percent stretch goal.

On claims that "[t]here is no need to test a utility-ownership model for EV chargers in this pilot because that approach has already been approved and will be tested in SDG&E's similar EV pilot,"[81] GPI and other parties argue against utility ownership in general. Vote Solar captures this line of thinking where it argues:

> [A]pproving the Settlement Agreement would give PG&E an unfair advantage by allowing it to cherry-pick the most profitable charging opportunities within its region, all while being backed by ratepayer recovery options that are not available to private competitors.[82]

We find this logic compelling and share this concern.

While we share the concerns expressed by many parties regarding utility ownership of charging equipment in the PG&E territory, we decline to adopt the approach of prohibiting all PG&E ownership, as it is at odds with our earlier determination that potential anticompetitive impacts associated with the Settlement Agreement can be prevented or adequately mitigated through the exercise of existing rules and subject to certain conditions and modifications. However, we agree that unrestricted ownership of EVSE by PG&E will likely have anti-competitive effects. We will therefore limit PG&E's EVSE ownership as set forth below.

Some of the Non-Settling Parties contend that utility ownership of the EV supply infrastructure and EVSE should be limited to the MUD and DAC segments. For example, JMP argues that the EV program in the PG&E territory should focus on the underserved customer segments of MUDs and

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[81] GPI Opening Brief at 4.

[82] Vote Solar, Opening Brief at 9.

disadvantaged communities.[83] Similarly, Vote Solar concedes that "[i]f the Commission deems utility ownership of EVSE is necessary, then it should be limited to the underserved markets of MUDs and low-income communities."[84]

Citing D.16-01-045, the Settling Parties counter that "the Commission already has rejected requests to restrict workplace charging, and should do so here."[85] The Settling Parties go on to assert that the Commission in the other EV proceedings has found as a matter of fact that workplace charging needs are underserved and therefore utility EV programs should target workplaces.[86] This argument misrepresents both our prior decision and the issue at hand. As an initial matter, rather than addressing limits on utility ownership, the provisions of D.16-01-045 identified by the Settling Parties discuss the appropriate level of the participation payments and requests to increase education and outreach funding to encourage property owners of MUDs and workplaces to sign up for the utility program. Second, contrary to the Settling Parties' intimations, there is nothing in the record of this proceeding which suggests that limiting utility ownership to MUDs and DACs will adversely impact EV adoption in workplaces.

Certain market segments have proven more difficult for private sector providers to penetrate. As noted by JMP, the MUD market segment is the most

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[83] *See* ChargePoint Opening Brief at 13, 65- 70; ORA Opening Brief at 9, 27- 28; TURN Opening Brief at 11, 54- 59; and JMP Reply Brief at 5.

[84] Vote Solar Opening Brief at 6.

[85] Settling Parties Reply Brief at 32, citing D.16-01-045 at 133.

[86] *Id.*

difficult for EVSE and EV service providers to penetrate.[87] This contention was validated by the Settling Parties during hearings where, among other things, it was stated:

- The MUD market is not very well served with EVSE equipment right now, because there are tenant/landlord issues that make it extremely difficult to bring charging infrastructure to those marketplaces.[88]
- The difficulties associated with deploying MUDs are well known and well documented.[89]
- Residential charging is a virtual necessity. You can't buy a plug-in car if you can't plug in at home... customers that live in MUDs are effectively blocked out of the market.[90]

JMP and other Non-Settling party members identify DACs as another hard to reach market where utility ownership is more appropriate.[91] According to ChargePoint, "PG&E can and should help address obstacles currently preventing wider deployment of EV charging infrastructure, especially at MUD locations and disadvantaged communities."[92]

We find merit in the Non-Settling Parties arguments and will adopt limits on PG&E's ownership as a means to both avoid anticompetitive market impacts and to facilitate penetration of charging infrastructure in the more difficult MUD

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[87] JMP Opening Brief at 24.

[88] Corey, Tr. 2:36:14-19.

[89] Tr. 2:37:7-8.

[90] Tr. 2:123:10-16.

[91] JMP Opening Brief at 10.

[92] ChargePoint Opening Brief at 27, citing Exh. 64 at 6-8.

and DAC markets. Specifically, for non-MUD/non-DAC segments we limit PG&E's ownership to the make-ready infrastructure only.

In the DAC and MUD market segments which have traditionally proven more difficult to penetrate, we wish to ensure that PG&E has both the program latitude and incentives to achieve success. With this in mind, we will approve a program that allows PG&E to own EVSE only in the MUD or DAC segments. PG&E may own up to 35 percent of total EVSE ports projected to be installed through the pilot. PG&E will own up to and including the make-ready infrastructure regardless of who owns the EVSE. For sites where PG&E owns the make-ready infrastructure and EVSE, the site host shall pay a participation payment as described below. For the remainder of the sites, where PG&E owns only the make-ready, the site host will purchase and own the EVSE and receive a rebate as described below. PG&E must present all site hosts with the option to own the EVSE. To clarify, only where the site host chooses not to own the EVSE, is PG&E allowed ownership and only then, up to 35 percent of the total projected deployment of EVSE ports. Furthermore, site hosts should not be prohibited from allowing third-party ownership of the EVSE on their property, and passing through the rebate to that third party, as further described later in this decision. PG&E shall track EVSE ownership and rebates in its quarterly reports as specified in this decision.

5.3. Customer of Record

The term "Customer of Record" is described in § 6 of the Settlement Agreement.[93] § 6 of the Settlement Agreement provides:

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[93] Settlement Agreement, Section 6, at 9-10.

> **The EVSP will be served** at an applicable, commercial, time-of-use rate, such as Schedule A-6 (if less than 75 kilowatt), Schedule A-10 or Schedule E-19 (voluntary service), **as PG&E's customer of record. The Provider** will then deliver energy to drivers at the price per kWh reflected in the selected rate at that time. (Emphasis added.)

Though frequently mentioned in the document, EVSP is not defined anywhere in the Settlement Agreement. However, in as much as § 3 of the Settlement Agreement provides that "Provider" means a third-party EV services or equipment provider, § 3 arguably suggest that a third-party EV services or equipment provider, could be served as PG&E's customer of record for electricity service. PG&E has not provided sufficient justification for why a third-party service provider should become the PG&E customer of record on the site host's property. As ChargePoint notes, one particularly concerning result of this approach is that the site host will not have any control of the EVSE on their property.[94] This limits the site host's ability to create an effective load management strategy, since they would not receive the price signal or be responsible for the electricity usage. With this in mind, we will adopt the simpler rule that in all instances the site host shall be PG&E's customer of record.

5.4. Scale of EV Deployment

As noted above, both the number and type of EVSE and EVSE ports provided for in the various proposals varies significantly. At the low end we have the Compliant Proposal and Non-Settling Parties recommendations which provide for a total of 2,510 EVSE. In terms of charger numbers, these two proposals can be distinguished by the ratio of Level 2 to DCFCs they provide for

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[94] ChargePoint Opening Brief at 41.

(2,460/50 versus 2,500/10, respectively), and the fact that the Non-Settling Parties generally specify that all Level 2 chargers should be dual port chargers.[95] At the high end we have the Enhanced Proposal and Settlement Agreement which call for 7,430 and 7,500 Level 2 charging ports respectively. Both proposals call for 100 DCFCs.

5.4.1. Level 2 Chargers

No party contends that the number of Level 2 chargers provided for at the lower end (2460-2500) is excessive.[96] Rather, the dispute among the parties goes to whether the higher number of EVSE ports called for in the Enhanced Proposal and Settlement Agreement is necessary and appropriate. Arguments against the higher numbers of EVSE ports called for in the Enhanced Proposal and Settlement Agreement are primarily procedural.[97] Parties including TURN, ChargePoint, ORA, and others assert that it is improper for the Commission to consider the Enhanced Proposal as PG&E was specifically directed to submit a smaller proposal. For example, citing the Scoping Ruling ChargePoint argues:

> The Commission clearly instructed PG&E to file a Phase 1 program that is 'limited to a maximum of 10 percent of the total originally-proposed number of charging stations, to be deployed over no more than 24 months.' Since PG&E's "originally-proposed number of charging stations" was 25,000 Level 2 EVSE and 100 DCFC, a compliant Phase 1 proposal

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[95] Among the Non-Settling Parties, TURN and JMP suggest the chargers may be Level 1 or Level 2, and GPI suggests that up to 300 DCFCs be provided for.

[96] As previously noted, PG&E does assert that the 2460 chargers provided for in the Compliant Proposal is not sufficient to allow it to reach its share of the 1.5 million ZEVs called for by the Governor by 2025.

[97] Substantive arguments going to the potential anticompetitive impacts associated with the larger number of EVSE called for in the Enhanced Proposal and Settlement Agreement are addressed above and need no further consideration here.

> would permit PG&E to deploy only 2,500 Level 2 charging stations and 10 DC fast chargers over a 24-month period.[98]

ORA addresses this same issue where it contends that the larger number of PG&E-owned EVSE provided for in the Enhanced Proposal was not considered in the Scoping Ruling and asserts that the Commission may not consider issues beyond those set forth in the scoping memo.[99] We disagree with the contention that the Enhanced Proposal is beyond the scope of the proceeding.

Rather than the broad interpretation ORA provides, *Southern California Edison v. P.U.C.*, stands for the more limited proposition that the Commission is constrained in its ability to bring issues into a proceeding by the due process requirement that parties be provided adequate time to prepare responses to such issues.[100] In contrast to *Southern California Edison v. P.U.C.*, where the court concluded that parties had less than two weeks to prepare a response to multiple issues spanning hundreds of pages of testimony, the parties here had time to conduct additional discovery, provide written responses, and conduct cross-examination related to the Enhanced Proposal. Keeping in mind that parties have also had time to conduct additional discovery, provide written responses, and conduct cross-examination on the Settlement Agreement, no party has identified a Commission rule that prohibits our consideration of the number of EVSE ports called for in the Settlement Agreement. Ultimately, the fact that we are lawfully considering the Settlement Agreement's request for up

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[98] ChargePoint Opening Brief at 15, citing Scoping Ruling at 7.

[99] *Southern California Edison v. P.U.C.* (2006) 140 Cal.App.4th 1085, 2006 Cal. PUC LEXIS 948.

[100] *Southern California Edison v. P.U.C.* (2006) 140 Cal.App.4th 1085, 2006 Cal. PUC LEXIS 948.

to 7,500 Level 2 chargers, renders challenges to our consideration of the 7,430 Level 2 chargers called for in the Enhanced Proposal moot.

While we have expressed concerns about how PG&E's ownership of EVSE may limit competition, the modifications made herein to the level of utility ownership, establishment of the customer of record, and other provisions of the Settlement Agreement, address many of the anti-competitive concerns and make the proposed deployment scale of chargers requested by the Settling Parties reasonable. Therefore, we will allow PG&E to deploy and own make-ready infrastructure to support up to 7,500 Level 2 charging ports and to own up to 35 percent of the total EVSE ports proposed for deployment in this pilot, but limited to the MUD and DAC market segments under the conditions set forth in this decision.

5.4.2. Number of DC Fast Charging Stations

Where the Enhanced Proposal and Settlement Agreement provide for PG&E to be allowed to own 100 DCFC, the Compliant Proposal calls for half as many (50), and the Non-Settling Parties argue that PG&E should only be allowed to own ten. Arguments going to the appropriate number and type of charger are three-fold. First parties such as EVCA argue that DCFCs have more limited utility and, in particular, provide little if any advantages at locations where cars are typically parked for longer periods of time, such as MUDs.[101] Second, and relatedly, some parties note that the benefits of DCFC are overly speculative in nature.[102] In addition to the claims of limited usefulness made above, these

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[101] EVCA Opening Brief at 9-10.

[102] For example, parties question whether DCFC is beneficial in MUD locations where individuals routinely park for long periods of time and often overnight.

arguments call into question both the need for utility ownership of faster charging provided by DCFC, and the likelihood that DCFC will soon be replaced by a faster and/or more innovative approach to charging.[103] Finally, parties such as JMP argue that DCFC is overly costly compared to Level 1 and 2 chargers. According to JMP:

> DC Fast Chargers make up a significant portion of the costs of PG&E's proposals, and on a per unit basis cost over 10 times as much as Level 2 chargers. In the compliant proposal, the requested 50 DCFC account for $12.4 million in capital and expense costs, which comes to 14 percent of the overall budget, and $248,000 per charger.[104]

Parties advocating a low number of DCFCs cite the above data and recommend that PG&E ownership of DCFCs should be limited as it carries a greater risk of significant stranded costs.[105]

According to the Settling Parties, reducing the number of DCFCs PG&E can own as urged by TURN and other parties "is not only inconsistent with the precedent set by the SDG&E decision, but also would result in a program that is simply too small for PG&E's vast service territory and too small to meaningfully contribute toward the goals established by the Commission, Governor Brown, and the California Legislature."[106] This argument misunderstands the purpose of these pilot programs as claims of binding precedent are, in general, antithetical to pilot programs and our use of pilot programs here reflects our interest in innovation rather than replication. Indeed, contrary to the Settling Parties claim

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[103] *See* EVCA Opening Brief at 9-10.

[104] JMP Opening Brief at 15, citing Exh. 3 at 9.

[105] *See* TURN Opening Brief at 28 for additional factors that may lead to stranded costs.

[106] Settling Parties Reply Brief at 8.

that "[c]apping the deployment of DCFC to a mere 10 stations would render that portion of the program almost meaningless and contradicts the Commission's goal to test different models in different service territories,"[107] we note that it is neither necessary nor practical to adopt every element in a proposed pilot program based on the fact that the element is currently not being tested in another pilot program.

The Settling Parties take issue with the cost arguments made by TURN and other parties. While the Settling Parties persuasively argue that DCFC cost in the Settlement Agreement compare favorably to those found in benchmarks such as the California Energy Commission's grants for DCFCs,[108] they do little to address the contention that DCFC costs are high compared to Level 1 or Level 2 Chargers as ChargePoint, TURN, and others allege.

Finally, the Settling Parties challenge claims that the DCFCs called for in the Settlement Agreement carry a significant risk of stranded assets, and assert that the following four features offset the likelihood of stranded costs:

- The size and duration of Charge Smart and Save have been reduced significantly from PG&E's original proposal, with a more specific focus on leveraging PG&E's utility and community skill sets to reach market segments (MUDs, workplaces and Disadvantaged Communities) that are underserved and most likely to be able to make use of new EV infrastructure and accelerate EV adoption.
- The duration of Charge Smart and Save is only three years, which provides a "hard stop" on siting and installation of

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[107] Settling Parties Reply Brief at 12, citing Tr.Vol.4, April 27, 2016, 459:14 (Honda/Harty).

[108] Settling Parties Reply Brief, at 23.

EV infrastructure until the Commission has an opportunity to review and evaluate the initial results.

- Unlike the "make ready" model Charge Smart and Save provides that EV infrastructure, including charging stations, is subject to utility easements or licenses that allow successor site hosts and EV drivers to access EV charging facilities even if the original site host and/or EV drivers/tenants change, making it less likely that changes in site ownership or site hosts will lead to premature stranding of useful, operable EV assets.
- Unlike the "make ready" model, Charge Smart and Save requires the utility, under the direct regulation and oversight of the Commission, to maintain and keep the EV charging facilities operable and available, in accordance with utility safety and O&M standards.

These arguments go to the general structure of the overall program and have little to do with stranded costs associated with just DCFC. Furthermore, settling parties provided no specific estimates of the ratepayer value from DCFC deployment. Nor did they provide detailed discussion on the siting criteria for DCFC and how this may differ from Level 2 charging. Finally, PG&E and settling parties did not thoroughly address the market concentration for DCFC specifically and the specific limits on competition for this type of technology compared to Level 2 charging. Only somewhat persuasive is the Settling Parties' contention that the potential for stranded costs will be further reduced because, rather than proprietary DCFC, the Settlement Agreement provides for "open source" equipment that will be capable of serving any DCFC-capable vehicle on the market.

In addition to questions that persist related to the higher costs of DCFC and its limited utility in MUDs, we decline to allow PG&E to own DCFC in its

service territory as part of this pilot. That said, we are not prejudging future applications if PG&E or another utility can present a more compelling proposal for utility involvement in the DCFC market.

5.4.3. Single versus Multi-Port Chargers

TURN recommends the use of multi-port rather than single port chargers in all instances where Level 2 chargers are installed as a cost saving/efficiency measure. As noted by TURN, the Settlement Agreement "achieves the significant cost reductions by providing for the use of multi-port [Level] L2 and DC chargers."[109] In reply, the Settling Parties note that after considering this approach they determined:

> [I]n many commercial and MUD locations, there may not be sufficient space or demand at a site. To address this mix of customer and EV driver needs, it is more realistic to assume a mix of multi-port and single port stations.

While we acknowledge that not all sites will be able to physically accommodate multi-port chargers, PG&E's claim that there may not be sufficient demand at a site lacks detail and seems counter to our underlying objectives. We will therefore direct PG&E to provide for dual ports or multi-ports on its Level 2 chargers wherever space is not a limitation and giving due deference to the site hosts' preferences.

5.5. Participation Payment

The Settlement Agreement provides for all DCFC customers, all customers within disadvantaged communities, and all customers at "sites owned or leased by school districts, government agencies or non-profit entities" to receive 100 percent subsidized make-ready infrastructure, EVSE, services, and

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[109] TURN Opening Brief at 19.

maintenance. For MUDs not located in disadvantaged communities, a participation payment of 10 percent of the base cost of the EVSE would be charged by PG&E and paid by the site host, and private for-profit entities would be charged a participation payment of 20 percent of the base cost of the EVSE. The Non-Settling Parties generally call for DACs and MUDs in DACs to receive a full payment waiver. Unlike the proposals put forth by the Settling and Non-Settling Parties, the Original, Compliant, and Enhanced proposals do not provide for participation payments by site hosts.

Parties opposing the participation payment provisions in the Settlement Agreement challenge both the scope of the waivers provided, and amount of the participation payment required.

5.5.1. Scope of Exemptions from Participation Payment

TURN, ORA, and ChargePoint maintain that the waiver categories are overly broad, asserting that the Settlement Agreement provides for participation payment waivers beyond sites located in disadvantaged communities. After noting that in addition to DACs, the Settlement Agreement provides waiver exemptions for all non-profit organizations, government agencies, and sites owned or leased by school districts, such that these entities would pay nothing for charging stations installed at their properties, TURN asserts that because these categories are broadly defined, ratepayers are likely to end up subsidizing 100 percent of profitable private entities' costs. By way of example, TURN notes that the National Football League and Kaiser Permanente are non-profit entities (with revenues of $7 billion and $25 billion respectively), that would qualify for exemptions to the participation payment requirement under the Settlement

Agreement.[110] Additionally, TURN notes that PG&E has no idea how many sites in its territory will qualify for the waiver and that it is possible that the entire program could be comprised of site hosts who do not contribute anything to participate in the program. TURN also questions the appropriateness of ratepayers subsidizing government agencies. Finally, TURN notes that neither D.16-01-023 nor D.16-01-045, which approved utility EV charging infrastructure programs for SCE and SDG&E, included a participation payment waiver for sites beyond DACs. In this regard, TURN notes that D.16-01-045 "does not include a single mention of waiving the participation payment for any location besides those in DACs and Finding of Fact #20 provides clear direction that the participation payment waiver only applies to sites in DACs."[111]

ORA and JMP agree with TURN that the Settlement Agreement can lead to problematic outcomes. Where JMP suggests alternatives to address this problem such as basing waiver eligibility on energy consumption, ORA suggests that disadvantaged communities should be defined as the top quartile of "Disadvantaged Communities" identified by CalEnviroScreen 2.0 on a PG&E service territory basis and, for locations within eligible disadvantaged communities, only MUD should be provided a full waiver of customer contribution to costs.

Finally, several of the Non-Settling Parties take issue with Settlement Agreement provisions that waive participation fees for DCFC across all market segments. For example, ChargePoint asserts that the Settlement Agreement approach is unreasonable in this regard because customers are willing to

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[110] TURN Opening Brief at 47, citing Tr. Vol. 2, 6:1-28.
[111] TURN Opening Brief at 48.

contribute a portion of the cost in exchange for receiving a subsidy for installing DCFC.[112] Both EVCA and ORA agree with ChargePoint's argument in this regard.[113] Indeed, even in the context of the smaller Compliant Proposal, JMP suggests the Commission address waivers for DCFC "by simply striking the entire portion of the compliant proposal that deals with DCFC, and reduce the overall budget by the $12.4 million forecasted cost."[114]

In contrast, the Settling Parties do little to explain the scope of the participation payment exemptions they provide. For example, while the Settling Parties acknowledge that under the Settlement Agreement well-funded nonprofit entities outside of DACs will qualify for exemptions from the participation payment,[115] they fail to explain why this feature is essential to their proposal or of value to ratepayers.[116]

The Settling Parties also fail to explain the basis for their extension of the participation payment exemption to schools, government entities, and DCFC installations. As the Settling Parties fail to provide a justification for these exemptions, they should be denied. We will instead adopt ORA's suggestion and direct that the exemption only be applied to the top quartile of "Disadvantaged Communities" as identified by CalEnviroScreen 2.0 on a PG&E service territory basis, for Level 2 charging locations, and only MUDs in these communities will be provided a waiver of the participation payment.

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[112] ChargePoint Opening Brief at 45.

[113] EVCA Opening Brief at 10; ORA Opening Brief at 18.

[114] JMP Opening Brief at 15, citing Exh. 3 at 9.

[115] TURN Opening Brief at 47, citing Tr. Vol. 2, 6:1-28.

[116] Such an explanation would seem to be in order if only to avoid the appearance of self-dealing as some signatories will likely qualify for the exemption provided.

5.5.2. Amount of Participation Payment

As noted above, the Settlement Agreement provides for all DCFC customers, all customers within disadvantaged communities, and all customers at "sites owned or leased by school districts, government agencies or non-profit entities" to receive a 100 percent subsidized make-ready, EVSE, services, and maintenance, MUDs (not located in disadvantaged communities) would pay a participation payment of 10 percent of the base cost of the EVSE, and private for-profit entities would be charged a participation payment of 20 percent of the base cost of the EVSE. As a general matter, the Non-Settling Parties favor a more substantial participation payment for segments other than DACs and view the participation payments called for in the Settlement Agreement as both nominal and unlikely to produce any of the intended benefits.

Where several of the Non-Settling Parties generally argue that a more substantial participation payment is necessary,[117] TURN provides a detailed analysis of this issue. Citing testimony by the Settling Parties, TURN first notes that the participation payment is based on the cost of the EV charger only (exclusive of the supporting infrastructure), and then apportioned by 10 percent or 20 percent.[118] Based on filings and calculations performed on the substantially similar SDG&E proposal, TURN estimates that the 10 percent and 20 percent participation payments will amount to only $180 and $360 (respectively) in per charger port costs. While it acknowledges that the actual costs will vary slightly, TURN asserts that its estimate demonstrates that "site hosts will pay

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[117] *See* e.g., ChargePoint Opening Brief at 45; EVCA Opening Brief at10; and ORA Opening Brief at 18.

[118] TURN Opening Brief at 45, citing Exh. 1 at 10-11.

virtually nothing in monetary terms and as a percentage of the total costs of installation under the Settlement Agreement."[119] TURN argues that a more substantial participation payment can help allocate investment where it is most likely to influence EV adoption and mitigate "free-ridership" and concludes that a meaningful participation payment is especially important for the workplace market segment because PG&E does not have a strategy for distinguishing between site hosts who would have installed the charging stations regardless of participation in the program.

The Settling Parties identify participation payments as an issue of continuing debate in all three utility EV proceedings, but urge that the question of whether site-host participation payments are too low or too high to help avoid stranded costs and off-set potential anticompetitive consequences of utility ownership be resolved in favor of the interests of program design. According to the Settling Parties:

> The goal of utility EV infrastructure programs is to promote and implement EV infrastructure where needed to incent and support EVs and clean transportation electrification in parallel with other non-utility programs.[120]

The Settling Parties argue that the higher participation payments urged by TURN and others, are not consistent with the overall purpose of utility EV programs. While the Settling Parties acknowledge that participation payments can play a role in ensuring that site hosts are committed to the goals of

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[119] TURN Opening Brief at 46. TURN goes on to argue that the costs that PG&E earns a rate of return on will not be reduced by the participation payment (since the Settlement Agreement provides for revenue from the participation to be credited against O&M costs rather than used to offset ratebase), so ratepayers will receive even less value.

[120] Settling Parties Reply Brief at 27-28.

the EV program, i.e. "have skin in the game,"[121] they contend that such payments are not primarily intended to offset the costs of the programs or to discriminate against site hosts based on ability to pay.[122]

While we agree that site host participation payments should strike a reasonable balance between site host "skin in the game," and avoiding unnecessarily high payments that damage the program design and deter site-host participation, we do not agree that the approach to participation payments provided for in the Settlement Agreement achieves this balance just because it is "virtually identical" to that approved in D.16-01-045. Among other things, rather than adopt the specific numbers now advocated by the Settling Parties (or any other particular numbers), D.16-01-045 largely deferred this determination to the program advisory council established therein. That SDG&E subsequently filed an Advice Letter seeking approval of participant payment numbers comparable to those now proffered by the Settling Parties cannot be construed as equivalent to prior Commission approval especially since Advice Letter 2886-E that was filed is the subject of protest by one or more parties to D.16-01-045. [123]

Given the barriers to adoption we have identified in DACs, MUDs in DACs in which PG&E owns the EVSE will have a minimal participation

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[121] The Settling Parties further contend that the site hosts will already be making a significant contribution to the success of the program by voluntarily providing their in-kind support – which will be substantial – for siting of EV infrastructure and an ongoing partnership with the utility and the EVSE providers for promotion and education on the benefits of EV use.

[122] Settling Parties Reply Brief at 27-28.

[123] Based on the protest to the Advice Letter filed by this advisory board, it appears the parties to D.16-01-045 continue to disagree about the appropriate participation payment.

payment. MUD site hosts in DACs will pay only the differential in price between the actual cost of the EVSE they selected for their site and the EVSE base cost. In the case the site host chooses an EVSE model whose price is equal to the base cost, the participation payment will be $0. For MUDs located outside of DACs and workplaces located in DACs, the participation payment will be 50% of the EVSE base cost plus the differential in price between the actual cost of the EVSE they selected for their site and the EVSE base cost.[124] We include in the calculations the price differential between the chosen EVSE model and the base cost in order to make the participation payment equivalent to a rebate in terms of a site host's out-of-pocket costs.

The participation payment does not apply to workplaces and other locations that are not in DACs, as the site host will always own the EVSE in this case. Table B summarizes the participation payment information.

5.6. EVSE Rebate

Because it proposed full PG&E ownership of all equipment and infrastructure, the Settlement Agreement did not contemplate a rebate. As detailed above, we will only allow the utility to own up to 35 percent of the total EVSE ports deployed in the program and only in the MUD and DAC market segments. At sites where PG&E is only installing and owning the make-ready infrastructure, we will direct PG&E to provide a rebate to the site host for the base costs of the EVSE. In these instances, in conjunction with the Program Advisory Council, PG&E shall conduct a Request for Proposals (RFP) to determine the base costs which will be used to determine the rebate amounts.

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[124] In formula form this equates to .5 (base cost) + differential.

The base cost for the Level 2 EVSE should be based on the price of the lowest cost EVSE model qualified through the RFP process.

For MUDs located in DACs (defined as the top quartile of "Disadvantaged Communities" as identified by CalEnviroScreen 2.0 on a PG&E service territory basis) the rebate should be 100% of the EVSE base cost. In MUDs that are not in DACs and workplaces that are in DACs, the rebate should be 50% of the EVSE base cost. In workplaces that are not in DACs, the rebate should be 25% of the base cost.

Table B below shows the rebate level for each market segment in comparison to the participation payment for the same segment.

Table B: **Summary of Participation Payment and Rebates**

Segment	EVSE Ownership	Participation Payment by Customer	Rebate to Customer
MUD located in DAC	PG&E	differential between actual cost of EVSE selected by customer and base cost	
	Site Host		100% of EVSE base cost
MUD located outside of DAC and Workplace located in DAC	PG&E	50% of EVSE base cost plus differential between actual cost of EVSE selected by customer and base cost	
	Site Host		50% of EVSE base cost
Workplace located outside of DAC	Site Host		25% of EVSE base cost

Also, to better support innovative business models and provide increased levels of customer choice, we make clear that site hosts may enter into

agreements with outside parties that allow for ownership, maintenance, and/or operation of EVSE where PG&E does not own the EVSE. Just as a utility may be able to simplify the EVSE installation process for customers, we believe that third parties can develop products and services to fill this role as well. A third party may also complete PG&E's program application on behalf of the site host, and may be designated to receive the rebate if the site host so chooses.

PG&E has stated that it "will be responsible for the operations and maintenance of the charging equipment, through contracts with equipment and service providers as partners in the program delivery and ongoing operations." However, because we allow PG&E to own EVSE at some, but not all locations, clarification of operations and maintenance (O&M) costs is in order. While PG&E should be responsible for all O&M of equipment it owns, site hosts that own the EVSE under the PG&E program should be responsible for the O&M of their EVSE. PG&E will select O&M vendors through the RFP Process as described below. PG&E shall make this list of approved O&M vendors available to all site hosts. For site hosts where PG&E owns the EVSE, PG&E will choose the O&M vendor and pay the O&M costs. For site hosts that own their EVSE, the site host will choose the O&M vendor from PG&E's approved vendor list and be responsible for the O&M costs.

5.7. TOU Rates and Load Management

Under the Settlement Agreement, where the program site host opts to receive the TOU Rate (i.e., the Rate-to-Host pricing plan), the site host, or its selected vendor, will be required to submit to PG&E the load management tactics it will implement at its EV charging station, including the prices or fees that it intends to levy on EV drivers, and any communication methods to be used to implement the load management tactics. However, the Settlement Agreement

also provides that, "[s]ite hosts that do not submit load management plans consistent with the Guiding Principles will be asked by PG&E to revise accordingly and will be ineligible to participate in the Program until PG&E determines that the load management plan is consistent with the Guiding Principles."[125]

While TURN finds value in exploring the question of whether the Settlement Agreement's TOU pricing option will result in system benefits, TURN argues that:

> [T]here is absolutely no basis to conclude *a priori* that the "TOU Rate-to-Driver" will promote the twin goals of 1) encouraging EV adoption, and 2) promoting beneficial rather than harmful charging patterns.[126]

According to TURN, whether the TOU tariff called for in the Settlement Agreement provides a benefit for reliability or costs depends on its influence both on EV adoption and charging behavior.[127]

In contrast, ChargePoint takes issue with the approach to load management provided for in the Settlement Agreement and argues that "it is a waste of time and a waste of ratepayer money to implement a Phase 1 program design that replaces site host control over pricing using load management capabilities of the EVSE with a flat TOU rate pass through."[128] In addition to

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[125] Joint Motion for Adoption of Settlement at 10.

[126] TURN Opening Brief at 50.

[127] TURN asserts that there are at least two dimensions to the problem of "less costly service" due to EV charging and concludes that ensuring that EV charging occurs "off-peak" would not necessarily result in net ratepayer benefits, if such a rate negatively impacts the demand for EVs or EVSEs. TURN Opening Brief at 51.

[128] ChargePoint Opening Brief at 10.

arguing that the Settlement Agreement provision allowing for the review and revision of load management plans is overly vague and provides PG&E carte blanche review, such that site hosts only have the illusion of load management choice,[129] ChargePoint argues that the approach in the Settlement Agreement approach lacks sufficient definition. According to ChargePoint, among other things, the Settlement Agreement fails to explain:

- Which customer segments would be on which TOU rates. PG&E offered no information regarding the applicable TOU periods;
- How the TOU time periods relate to the times that drivers are likely to charge EVs within different customer segments (MUD, commercial, workplace, DCFC, public buildings, etc.);
- What the average driver at these various locations would pay for a typical charging event, or how the TOU rates would affect drivers that are only able to access the EVSE during peak hours;
- How demand charges (which are calculated monthly, retroactively) can be reflected in rates to drivers;
- How demand charges and other non-volumetric charges would influence the TOU pricing signal; and
- How driver cost under the mandatory TOU rates compares to what drivers at various types of location typically pay when site hosts control pricing.

ChargePoint goes on to argue that the PG&E Phase 1 program should "allow each site host to take advantage of all of the functionality of smart EVSE and network services – for the benefit of the site host, the driver and the

[129] ChargePoint Opening Brief at 50-51.

grid – rather than dictating the default pass through of TOU rates and control of the EVSE by a third-party "customer of record."[130] Specifically, ChargePoint recommends that:

- The Commission allow site hosts to determine whether and how to charge drivers for EV charging, as long as the site host follows a reasonable load management plan;[131]
- The Commission require each site host to participate directly or through a third-party aggregator in available DR programs; and
- Every participating site host be required to provide a load management plan.

While ChargePoint makes valid arguments, we believe there is confusion on what is being proposed under the Settlement Agreement. The Settlement Agreement states that under the TOU Rate-to-Driver option, "PG&E will serve electricity to service providers who will then pass the TOU price signals directly to EV drivers to ensure that drivers who charge in a manner that supports the grid Principles."[132] As stated earlier in this decision, the customer of record under the program shall be the site host, not the service provider. Therefore, in the program we adopt, when the site host prefers the TOU Rate-to-Driver option,

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[130] ChargePoint Opening Brief at 47. ChargePoint also correctly notes that the settlement states that PG&E will, at some undefined point in the future, "evaluate potential DCFC load management strategies," but does not explain what these "potential" strategies might be, or how or when they would be "evaluated." (ChargePoint Opening Brief at 49.)

[131] In as much as it fails to define what constitutes a "reasonable load management plan," ChargePoint's proposal suffers from the same flaw of vagueness that ChargePoint attributed to PG&E's approach.

[132] Joint Motion to Adopt Settlement Agreement, Attachment 1, at 6.

PG&E should work with the site host to determine the appropriate mechanism to directly bill the EV drivers.

However, under the TOU Rate-to-Host option, the Settlement Agreement is clear that "Site Hosts will receive the TOU price signals, and will be able to propose alternative pricing and load management tactics consistent with Program Guiding Principles."[133] This is a reasonable approach to allowing the site host flexibility to receive the offered rate from the utility and make a decision, based on their unique site, as to whether or how to pass that rate onto drivers or to modify the rate to drivers in a way that best meets their site's energy management plan. PG&E should ensure that the load management plans include reasonable driver pricing options to ensure there is sufficient customer uptake and charging is not cost-prohibitive.

5.8. Program Costs

Our efforts to promote EVs and EV charging infrastructure must be balanced with the statutory requirement that rates be just and reasonable. We focus on the cost of the Settlement and the Non-Settling Parties proposals because, as bookends to the program we adopt herein they provide useful insight into our cost considerations. Where the Settling Parties agree that the cost of Charge Smart and Save should be substantially reduced from PG&E's $222 million "Enhanced Proposal," to a cost cap of no more than $160 million, the Non-Settling Parties argue that the total budget should not exceed the $87.4 million cost of PG&E's Compliant Proposal, and some parties suggest that specific cost disallowances could reduce this amount even more. While much of the difference between the two cost estimates can be attributed to size differences

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[133] *Ibid.*

between the two proposals and the modifications adopted herein, utility ownership and capital costs must also be considered when determining the appropriate funding for the proposal we adopt today.

5.8.1. Potential Cost Savings Based Adopted Program

We adopt a program that provides for a total of 7,500 Level 2 EVSE ports, the use of multi-port chargers where appropriate, a more substantial participation payment, and the potential ownership by PG&E of EVSE in MUDs and DACs only. Several of the adopted features can be expected to reduce program costs compared to other proposals. Among other things, denying deployment of DCFC in the program may reduce costs by more than $25 million,[134] and the appropriate use of dual port chargers may reduce program cost by as much as $15 million.[135] We anticipate additional program costs reductions as a result of the reduced ownership role we provide PG&E. As TURN notes, PG&E's proposed ownership of all of the equipment is a significant cost since the utility proposes to ratebase all capital expenditures and earn an 8.06 percent rate of return over the life of the equipment.[136]

5.8.2. Other Potential Savings

TURN identifies several other provisions of the Settlement Agreement where it believes costs reductions may be possible. Among other things, TURN notes that contingencies account for 10 percent of the Settlement Agreement's total costs. In particular, according to TURN, PG&E assumes a capital "contingency" of $9.7 million for Level 2 Chargers, a capital "contingency" of

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[134] *See* JMP Opening Brief at 16-17.

[135] *See* JMP Opening Brief at 15.

[136] TURN Opening Brief at 43, citing Exh. 58, at 1-4.

and $4.8 million for DCFC, and an expense "contingency" of $2.1 million for Level 2 and DCFC combined. While we note that a 10 percent contingency is not itself excessive,[137] we expect reductions in the contingency amounts associated with DCFC; this reduction is included in the $25 million DCFC cost reduction described in the preceding section.

TURN also notes that the Settlement Agreement budgets $1.2 million in capital costs to build an "EV Cost of Ownership Tool" and $1 million in capital costs to build a "Site Host Online Application Portal." TURN questions the more than $1.1 million in capital contingency costs and almost $2 million in expenses and O&M contingency costs provided for this aspect of the proposal. We agree with TURN that, at 50 percent and near 100 percent (respectively), these capital contingency and O&M costs are excessive, and will reduce them to 10 percent and 50 percent (respectively) for a cost reduction of almost $2 million. Finally, we note our agreement with TURN's assertion that PG&E's assumption that all Level 2 charging occurs "on-peak" is unrealistic and has likely inflated PG&E's estimates for transformer upgrades and other cost inputs.

Section 15 of the Settlement Agreement provides a $5 million set-aside for equity programs supporting Disadvantaged Communities. The Settlement Agreement states that PG&E will "consult with the Program Advisory Council to identify priority areas" and "advance strategies to increase access to EVs in low and moderate income communities." We find this proposal overly broad; it has no stated objectives or specifications of program requirements. Given this

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[137] In D.16-01-023, SCE included a 35 percent contingency adder in its cost estimates. *See* Finding of Fact 17, at 47.

limited record, we are not able to assess whether the set aside would yield any ratepayer benefits. We reject the $5 million set-aside for equity programs.

5.8.3. Conclusion

While we anticipate substantial savings as a result of the features of the adopted program, we acknowledge that we are unlikely to see 100 percent of these savings. Because any remaining funds can be used as bridge funding and to support Phase 2 of this program, if a Phase 2 program is warranted and proposed, we will err on the side of more rather than less funding of the Phase 1 program. Consistent with this approach, we adopt a budget that reflects the proposed Settlement Agreement budget of $160 million less $25 million for DCFC capital and expenses and less the $5 million set aside for equity programs. The adopted budget is $130 million, which includes forecast capital and expense costs, forecasts education and outreach costs, forecast administrative costs, rebate expenses and other implementation costs.

5.9. Cost Recovery

In general, a utility's ratebase represents the value of its property that is used and useful in rendering utility public service. Because ratebase is the foundation upon which the company's earnings, or rate of return, is based, elements included in the ratebase are of special concern in the ratemaking process and subject to additional scrutiny by regulatory authorities. Including only utility property prudently incurred and devoted to providing utility service ensures that present utility customers pay only for the costs associated with the benefits received and prevents current ratepayers from subsidizing service to future customers. Operating expenses are generally the ordinary non-capital expenses that are reasonable and necessary for the utility's operation.

PG&E proposed in its initial application the creation of a new one-way balancing account, the Electric Vehicle Program Balancing Account, to recover the revenue requirement associated with the new pilot. The program costs recorded in the balancing account are proposed to be "incremental capital and expenses related to distribution investments and the associated operations and maintenance (O&M) costs, program management organization (PMO) costs, as well as EV Program education and outreach costs."[138] PG&E's initial application also proposed that starting with PG&E's 2020 General Rate Case (GRC), "PG&E would request that ongoing O&M costs relating to EV capital infrastructure installed or forecast to be installed prior to 2020 be recovered in the 2020 GRC authorized electric distribution revenue requirements."[139] The initial application proposes including in distribution rates the forecast revenue requirement associated with this new balancing account.[140] On an annual basis, the revenue requirement recorded in the new balancing account would be trued-up by transferring its balance to the Distribution Revenue Adjustment Mechanism as part of the Annual Electric True-up process at the end of the year for rates effective January 1 of the following year.[141] PG&E's initial application requests that actual costs recorded in the balancing account be found reasonable as long as they are below the pilot program cost cap.

The Settlement Agreement states that the "costs of Charge Smart and Save will be recovered in accordance with the cost recovery and rate design proposal

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[138] Application at 7.

[139] Application at 7.

[140] Application at 8.

[141] PG&E February 9, 2015, Testimony at 7-3 to 7-4.

in Chapter 7 of PG&E's February 9, 2015, prepared testimony,"[142] which is summarized above. Additionally, the revenue collected from the participation payments will be credited against O&M costs, consistent with D.16-01-045.

No parties take issue with PG&E's creation of a balancing account or inclusion of incremental costs related to electric distribution infrastructure and make-ready infrastructure in the balancing account. We therefore authorize PG&E to establish a one-way balancing account as proposed in the Settlement Agreement, with the clarifications described below. PG&E should file an advice letter within 60 days of this decision to create the new program balancing account.

The majority of the Non-Settling Parties suggest that PG&E should be able to ratebase infrastructure up to the make ready, but not the EVSE.[143] However, these parties do not provide any justification as to why PG&E-owned EVSE should not be included in PG&E's ratebase. We find it appropriate for PG&E to include the EVSE it owns in its ratebase, because it will be utility property that is used and useful in rendering utility service.

Because the Settlement Agreement did not contemplate an EVSE rebate, parties did not provide specific suggestions of how the rebates should be treated for ratemaking purposes. Therefore, we will adopt a ratemaking treatment consistent with SCE's Charge Ready Program in which all site hosts own the

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[142] Settlement Agreement Section 4 at 9.

[143] ChargePoint Opening Brief at 14, EVCA Opening Brief at 7, JMP Opening Brief at 11, ORA Opening Brief at 10, TechNet Opening Brief at 7, TURN Opening Brief at 12, and Vote Solar Opening Brief at 6.

EVSE and receive a rebate from SCE.[144] PG&E should treat the rebates as expenses in accordance with Generally Accepted Accounting Principles, the costs of which are recovered from customers in the year the expense is incurred. The costs of the rebates should not be treated as a regulatory asset that is included in ratebase. In comments on the Proposed Decision the Settling Parties suggest that the rebate costs would be recovered independent of the established cost cap. We clarify that the authorized funding of $130 million includes the cost of rebates.

As TURN identifies, under the Settlement Agreement, any participation payments would be credited against O&M costs, rather than offsetting capital costs that are included in ratebase. TURN is concerned that this treatment of the participation payment provides less value for ratepayers because it does not reduce the portion of pilot costs on which PG&E earns a rate of return.[145] While we share TURN's concern, we want to ensure comparable treatment of the rebate expense and participation payment. Therefore, consistent with the ratemaking treatment prescribed in the SDG&E Power Your Drive Program,[146] PG&E should use the participation payments it receives from the pilot program to offset the O&M costs incurred. PG&E should file a Tier 1 advice letter within 60 days of this decision to track its O&M costs, and apply the participation payments it receives from the site host, as an offset to the O&M costs.

5.10. Program Advisory Council

Other than the Original Proposal submitted by PG&E, each of the proposals submitted in this proceeding provide for the establishment of a

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[144] D.16-01-023 at 18-20, Findings of Fact 15-16, and Conclusion of Law 12.

[145] TURN Opening Brief at 46.

[146] D.16-01-045 at 128, 148, Conclusion of Law 32.

Program Advisory Council. The Program Advisory Council provided for in Settlement Agreement is similar to the Program Advisory Councils provided for in D.16-01-023 and D.16-01-045 in that it provides:

- PG&E's procurement of EV charging equipment and services to be subject to advisory review by non-market participant members of the Program Advisory Council. (Joint Motion to Adopt Settlement, at 14.)
- PG&E to solicit the participation of a broad and diverse stakeholder advisory group in planning and implementing the Charge Smart and Save Program, including reviewing progress reports by PG&E on actual costs and deployment under Charge Smart and Save, and opportunities to improve the cost effectiveness of the program and increase access to EV charging.[147]
- PG&E, after consulting with the Program Advisory Council, to use Tier 2 advice letters for mid-course program modifications that require Commission authorization.[148]
- PG&E, after consultation with the Program Advisory Council, to be able to file for modification of the participation payment by way of a Tier 2 advice letter, subject to protest by any party.[149]
- The Program Advisory Council to monitor and provide recommendations to contractors or subcontractors associated with the increase of hiring from Disadvantaged

[147] Joint Motion to Adopt Settlement at 6.

[148] Joint Motion to Adopt Settlement at 6.

[149] Joint Motion to Adopt Settlement at 6.

> Communities, including best practices for hiring in Disadvantaged Communities.[150]

More generally, the Settlement Agreement calls for PG&E to solicit, form, and support a Program Advisory Council under the same terms, conditions and responsibilities as adopted by the Commission for the SDG&E Program Advisory Council in D.16-01-045, Attachment 2, Appendix A.[151]

While several of the Non-Settling Parties support the proposal to create the Program Advisory Council, most of these parties find fault with the specific proposal. For example, ChargePoint supports the creation of a Program Advisory Council but argues that, in addition to representatives from the Commission Energy Division, CCAs should be allowed to serve on the Program Advisory Council.[152] ChargePoint also takes issue with PG&E's formation of a Non-Market subgroup on claims that PG&E has made clear who would be excluded from the group.[153] ORA appears to share this concern where it questions provisions establishing that the "procurement of EV charging equipment and services will be subject to advisory review by non-market participant members of the Charge/Save proposal Advisory Council."[154]

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[150] Joint Motion to Adopt Settlement at 13.

[151] Joint Motion to Adopt Settlement at 6.

[152] *See* ChargePoint Opening Brief at 73, and Settling Parties Reply Brief, at 26 wherein the Settling Parties challenge ChargePoint's request that EVSE vendors like itself take part in the review and evaluation of EVSE procurement process.

[153] ChargePoint makes additional arguments in this regard but in doing so goes beyond the page limitation established for Opening Briefs. In fairness to the other parties, these additional arguments will not be considered.

[154] ORA Opening Brief at 10.

Also, on claims that the Settlement Agreement does not provide site selection criteria, ORA expresses concern about using the Program Advisory Council to develop siting criteria. With this in mind, we establish the following baseline criteria[155] for site selection and direct PG&E to finalize site selection criteria with the Program Advisory Council:

- Date of indicated interest (first-in-line priority);
- Current and expected volume of EV drivers;
- Number of charging stations desired;
- Segment (MUD, workplace, disadvantaged community);
- Nearby transformer available capacity;
- Distance between transformer and new service point;
- Site conditions related to construction feasibility (i.e., trenching surface, EVSE mounting surface, condition of facility);
- Land and property ownership;
- If leasing, term and conditions of lease;
- Existing/available Americans with Disabilities Act accessible parking and compliance; and
- Distribution Resources Plan Integration Capacity Analysis.

Additionally, recognizing that CalEnviroScreen 2.0 is not a perfect tool to identify a disadvantaged community or site, PG&E should identify sites that not only meet the CalEnviroScreen 2.0 definition of "disadvantaged," but are also in the spirit of the definition.

ORA also expresses the more general concern that "[t]oo many important elements of the Charge/Save proposal have been left to an undefined Program

[155] These site selection criteria are based upon those approved for SDG&E's VGI Pilot in D.16-01-045.

Advisory Council to determine"[156] TURN's endorsement of the Program Advisory Council idea is more guarded. According to TURN, "[t]he proposed Program Advisory Council lacks any real oversight authority and is not a sufficient substitute for a phased approach." In particular, TURN notes that the stated role and purpose of the Program Advisory Council will be to "provide input to PG&E for programmatic changes as needed during the course of the PG&E Program" as evidence that: 1) "the [Program Advisory Council] PAC does not have formal decision-making authority," and 2) the Program Advisory Council lacks the ability to suggest program modifications directly to the Commission.[157]

While we find merit in the Non-Settling Parties concerns, particularly those expressed by TURN, we note that rather than substitute for a phased approach, the Program Advisory Council at issue here is the first part of the phased approach we have demanded. To the extent that parties and/or Program Advisory Council members subsequently find that the Program Advisory Council lacks the expertise to address certain issues or is unable to bring ideas before the Commission, they should develop proposals that address these issues for consideration as part of our Phase 2 preparations.

For the time being, we will adopt the Program Advisory Council proposal submitted by the Settling Parties, with the following modifications. First, the Program Advisory Council shall provide input on criteria to assess the load management plans of site hosts; however PG&E shall be responsible for approving load management plans. Second, the Program Advisory Council may

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[156] ORA Opening Brief at 8.

[157] TURN Opening Brief at 62.

request that PG&E modify its data collection parameters as it sees reasonable. In the event that PG&E in any way fails to timely comply with such a request, PG&E will forward the request and a statement of the rationale for its refusal to timely comply with the request to the Program Advisory Council and the Commission's Energy Division. Third, the Program Advisory Council should meet at least quarterly instead of semi-annually during the first year and two of the meetings should be held in person in San Francisco.

5.11. Education and Outreach

Settling parties are proposing around $15 million for "Site Acquisition Support and Market Education and Outreach" which includes roughly $5 million for an equity program in DACs.[158] In addition to arguing that the education and outreach (E&O) program provided for in the Settlement Agreement is exorbitantly priced, TURN notes that many of the activities and tools provided for in the program appear to be duplicative of existing statewide, regional, and federal EV E&O efforts. For its part, ChargePoint urges the Commission to ensure that all E&O) activities conform to the guidelines established in D.11-07-029, and add a "market neutral customer engagement" requirement to the guiding principles. While we believe E&O has the potential to significantly advance the program objectives and EV adoption in general, we also believe the concerns identified above to be valid. Unfortunately, the proceeding record related to the proposed E&O activities is insufficient to allow us to meaningfully assess the proposed program costs. We therefore direct PG&E to make outreach proposals to the Program Advisory Council and, based on Program Advisory

[158] Joint Motion to Adopt Settlement Agreement, Charge Smart and Save Settlement Agreement at 25.

Council feedback, to file a new E&O proposal via Tier 1 Advice Letter with specific cost line items, within six months of the issuance of this decision. Costs for E&O should not exceed $10 million, which is in line with the original budget of $15 million, minus the DAC equity program which is not authorized in this decision (see section 5.8.2), and are included as part of the total authorized program budget of $130 million. However, given the change in ownership structure of the program, we would expect the E&O expenses to change accordingly.

Additionally, PG&E should develop a geographical information system (GIS) tool to track the locations of infrastructure installations, consistent with requirements adopted in the SDG&E and SCE infrastructure pilots.

5.12. Reporting

The Settlement Agreement provides for PG&E to file quarterly progress reports with the Commission, and the Program Advisory Council, and to serve the reports on all parties to D.16-01-023 and D.16-01-045.[159] The Settlement Agreement also states that the PAC will be able to determine if additional data collection and reporting is necessary. Like ChargePoint, we see no need for PG&E to file these reports on parties to the two prior decisions but will otherwise adopt the Settlement Agreement approach. In addition to the data collection and metrics included in Appendix B to the Settlement Agreement, we require the following additional reporting metrics:

[159] Exh. 01, Settlement at 14.

- Comparison between actual and projected installation and infrastructure costs, and an explanation for any significant differences.
- A list of issues PG&E has encountered in pilot implementation, and a resolution or lesson learned for each issue.
- Progress or status on vendor qualification.

5.13. Pilot Program Duration

As noted above, where the Compliant Proposal and Non-Settling Parties call for the duration of the approved pilot program to be limited to two years after initial construction, the Enhanced Proposal and Settlement Agreement provide for the approved pilot program to have a three-year duration. Keeping in mind that parties that urged the shorter time-frame did so in conjunction with their advocating for a substantially smaller program, given the record before us and the terms we adopt above, we approve a pilot program with a three-year duration.

5.14. Program Bridge Funding

The Settlement Agreement states that PG&E will enroll customers for three years from the beginning of construction, and any remaining funds after the three-year period can be used to extend the site host and EVSE supplier sign up periods. The Settling Parties contend that bridge funding is necessary to "prevent economic harm to contractors and disruption to program implementation."[160] We agree. However, given the program adopted above, it is reasonable to anticipate that some of the savings projected by the Non-Settling Parties will occur. Several parties opine about how these savings should be

[160] Exh. 01 at 16-17.

handled. For example, the Settling Parties provide that any cost savings on site-specific deployment costs will be used for additional deployment not to exceed the cost cap. The Settlement Agreement also states that if PG&E has not received a decision on Phase 2 of the pilot, it will file a Tier 2 Advice Letter to authorize bridge funding to extend the program. TURN cautions that this Tier 2 Advice Letter filing is a "back door," and PG&E needs to stop implementing at some point to allow the Commission and parties to assess the success of Phase 1.

In general, the Non-Settling Parties, such as ChargePoint, TechNet, and ORA suggest "PG&E may use any cost savings (budget remaining after deployment of the maximum number of EVSE) for additional deployment consistent with these recommendations and, if relevant, for continued deployment during the transition period."[161] TURN and JMP appear to echo this sentiment and suggest cost savings be put toward the bridge period and reinvested in future phases.[162] As the additional deployment provided for by the Non-Settling Parties was in reference to a total deployment of 2,500 chargers, rather than the 7,500 chargers we authorize today, it is not reasonable to conclude that these parties would now agree that cost savings should be used to fund deployment of chargers beyond those provided for herein. We therefore adopt the more limited recommendation that cost savings associated with this first phase of deployment may be used to fund the bridge period (if one is necessary). If PG&E chooses to file an application for a second phase of deployment of this program, subject to the 7,500 cap above, PG&E may continue

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[161] *See* ChargePoint Opening Brief at 13; TechNet Opening Brief at 7; VoteSolar Opening Brief at 8; and ORA Opening Brief at 9-10.

[162] *See* TURN Opening Brief at 11; and JMP Opening Brief at 15.

expending any remaining Phase 1 funds while the Commission is considering Phase 2, until its authorized Phase 1 budget has been expended. If PG&E does not file for a second phase, it shall file an Advice Letter specifying the ratemaking treatment of any unspent funds.

5.15. Data Collection

On October 12, 2015, PG&E served its supplemental testimony and responses to the questions in the Scoping Ruling stating that PG&E's compliant proposal would include 18 months of data collection and PG&E's enhanced proposal would collect and report 30 full months of information from deployed EV stations. Appendix B of the Settlement Agreement specifies "the collection and reporting of data and metrics comparable to the data and metrics required by the Commission for the SDG&E [D.16-01-023] and SCE [D.16-01-045] programs."

While TURN considers the directives in Appendix B of the Settlement Agreement to be a good start, it voices two significant concerns. First, according to TURN, the Settlement Agreement neglects "two critical areas of data: 1) EV Adoption attributable to PG&E's program, and 2) the impact of the program on the private market and EV infrastructure development outside of the program." Second, while Appendix B of the Settlement Agreement states that "The [Program Advisory Council] PAC will have the flexibility to determine if additional data collection and reporting objectives are of interest and will help to inform Commission policy" TURN strongly urges the Commission be as specific as possible regarding data collection requirements because, the Program Advisory Council as proposed, will have no formal authority to make revisions

to PG&E's data collection efforts.[163] As we have addressed these concerns above, we need take no further action here and will adopt the Settlement Agreement's data collection provisions.

6. Safety Considerations

The safety-related considerations for the program we adopt are ensuring that the EV site installation and the associated EVSE infrastructure are installed safely and in accordance with applicable codes and regulations, and that the electricity dispensed from the EV charging stations is safely delivered.

These safety-related considerations are addressed in the Settlement Agreement, and should be incorporated into the adopted program terms. In particular, contractors who construct, install, and maintain the EV site installations and charging stations will be required to have Electric Vehicle Infrastructure Training Program (EVITP) certification.[164] The EVITP provides training and certification to licensed electricians who plan to install EVSE.

In addition, the Settlement Agreement provides that:

> PG&E will require that all construction, installation and maintenance of EV Facilities that is not performed by employees of PG&E shall be performed by contractors signatory to the IBEW who hold a valid C-10 contractor's license, as defined in the governing labor agreement between PG&E and the IBEW.[165]

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[163] TURN Opening Brief at 61, citing Exh. 01, at 21.

[164] Joint Motion for Adoption of Settlement, Attachment 1, at 6 and 12.

[165] According to the Contractors State License Board of the California Department of Consumer Affairs, a C-10 contractor's license allows an electrical contractor to place, install, erect or connect any electrical wires, fixtures, appliances, apparatus, raceways, conduits, solar photovoltaic cells or any part thereof, which generate, transmit, transform or utilize electrical energy in any form or for any purpose.

Also, as part of its planning for each EV site installation, we will require PG&E to prepare an engineering design and electrical load calculations, and submit that to the local permitting agencies to obtain the necessary permits. Lastly, as part of the RFI and RFP processes, PG&E needs to consider and ensure that the metering data, and other data, transmitted from the EVSE is secure.

7. Comments on Proposed Decision

The proposed decision of ALJ Darwin E. Farrar in this matter was mailed to the parties in accordance with Section 311 of the Public Utilities Code and comments were allowed under Rule 14.3 of the Commission's Rules of Practice and Procedure. Comments were filed on December 2, 2016 by PG&E and Settling Parties, ORA, TURN, Consumer Federation of California, JMP, Coalition of Energy Users, TechNet, ChargePoint, EVCA, GPI, and Vote Solar. Reply comments were filed on December 12, 2016 by PG&E and Settling Parties, ORA, TURN, JMP, ChargePoint, EVCA, and GPI.

8. Assignment of Proceeding

Carla J. Peterman is the assigned Commissioner and Darwin E. Farrar is the assigned ALJ in this proceeding.

Findings of Fact

1. Executive Order B-16-2012 directed the Commission and other state agencies to establish benchmarks to help achieve the build-out of ZEV infrastructure capable of supporting up to one million vehicles, and to integrate PEV charging into the state's electricity grid, by 2020 and 1.5 million ZEVs by 2025.

2. On February 9, 2015, PG&E filed A.15-02-009, seeking approval of its proposed Electric Vehicle Infrastructure and Education Program.

3. On September 4, 2015, the assigned Commissioner and assigned Administrative Law Judge issued a Scoping Ruling requiring PG&E to submit a program at 10 percent the size of the original application, but did not state that would be the upper limit of a program authorized by the Commission.

4. On October 12, 2015, PG&E served supplemental testimony and responses to the questions in the Scoping Ruling and included both a "Compliant Proposal" and an "Enhanced Proposal."

5. A Joint Motion for Adoption of the Settlement Agreement was filed on March 21, 2016.

6. The Settlement Agreement constitutes the Applicant's final program proposal, and is preferred by the Applicant and other Settling Parties to the Original, Compliant, and Enhanced Proposals.

7. On April 25-28, 2016, parties participated in hearings on the Settlement Agreement, the Compliant Proposal, and the Enhanced Proposal.

8. The Opening Briefs filed by JMP, ORA, TURN, ChargePoint, Vote Solar, EVCA, TechNet, and GPI contain several common proposed modifications to the PG&E Compliant Proposal.

9. The Settlement Agreement represents a consolidation of comparable interests and positions, lacks the support of any ratepayer advocates, does not represent all affected interests, is contested, and is not the result of arms-length negotiations.

10. The express terms of the Settlement Agreement provide for PG&E to own EV supply infrastructure and EVSE.

11. The Settlement Agreement provides for PG&E to commit to deploying 20% of the approved charging infrastructure to serve MUDs and provides a non-binding target of 50 percent for MUDs.

12. The Settlement Agreement provides for PG&E to increase the targeted share of charging stations deployed in Disadvantaged Communities to 15 percent and provides a stretch goal of 20 percent for disadvantaged and low-income communities.

13. The Settlement Agreement does not provide a fully-detailed RFP process to identify O&M vendors or determine the price of the lowest cost EVSE model.

14. Aside from target goals for the MUD and DAC segments, the terms of the Settlement Agreement provide PG&E authority to own EV supply infrastructure and EVSE anywhere in its territory.

15. The Settlement Agreement significantly differs from the program adopted in D.16-01-045 for SDG&E.

16. There are potential significant anticompetitive impacts associated with PG&E's ownership of EV supply infrastructure and EVSE.

17. The Settlement Agreement would allow PG&E to pick the most profitable charging opportunities within its region.

18. There is nothing in the record of this proceeding which suggests that limiting utility ownership to MUDs and DACs will adversely impact EV adoption in workplaces.

19. D.16-01-045 determined that certain factors (i.e. market saturation rates, allowing site host a choice among EVSE and providers, and rate options) are important factors that can reduce anticompetitive impacts.

20. There is nothing in D.16-01-045 suggesting that factors such as market saturation rates, site host choice among EVSE and EV charging services providers, and/or rate options obviate the need for anti-competitive mitigation measures.

21. Where PG&E owns only the make-ready infrastructure, the site host will receive a rebate for its purchase of EVSE.

22. The DAC and MUD market segments have traditionally proven more difficult for electric vehicle charging to penetrate.

23. For the purposes of this proceeding, "Disadvantaged Communities" are those communities in PG&E's service territory with scores among the top quartile of areas identified by CalEnviroScreen 2.0.

24. Neither D.16-01-023 nor D.16-01-045, which approved utility EV charging infrastructure programs for SCE and SDG&E, included a full participation payment waiver for sites outside of DACs.

25. Third-party ownership of EVSE where PG&E does not own the EVSE could support innovative business models and provides increased levels of customer choice.

26. Our limitation on the level of utility ownership, determination of the customer of record, and modifications to other provisions of the Settlement Agreement, make the proposed deployment scale of electric vehicle charging stations requested by the Settling Parties reasonable.

27. Adopting pilot programs reflects our interest in innovation rather than replication.

28. DCFCs make up a significant portion of the costs of the Settlement Agreement.

29. DCFC unit costs are high compared to Level 2 Chargers.

30. Including DCFCs in the PG&E pilot is inappropriate at this time.

31. Participation payments can play a role in ensuring that site hosts are committed to the goals of the EV program.

32. Site host participation payments should strike a reasonable balance between site host having a stake in the program, and avoiding unnecessarily high payments that damage the program design and deter site-host participation.

33. The Settling Parties fail to explain the basis for their extension of the participation payment exemption to schools, government entities, and DCFC installations.

34. Reducing the number of DCFCs in the program may reduce costs by approximately $25 million.

35. The appropriate use of dual port chargers may reduce program cost by as much as $15 million.

36. PG&E assumes a capital contingency of $9.7 million for Level 2 Chargers, a capital "contingency" of $4.8 million for DCFC, and an expense "contingency" of $2.1 million for Level 2 and DCFC combined.

37. The contingency budget will decrease as a result of the reduced use of DCFC and Level 2 Chargers adopted herein.

38. The Settlement Agreement's $5 million set aside for equity programs supporting Disadvantaged Communities is overly broad, with no stated objectives or specifications of program requirements.

39. The Program Advisory Council provided for in the Settlement Agreement is similar to the Program Advisory Councils adopted in D.16-01-023 and D.16-01-045.

40. Bridge funding can provide predictability and stability to prevent economic harm to contractors and avoid program disruption.

41. PG&E's assumption that all Level 2 charging occurs "on-peak" is unrealistic and has likely inflated PG&E's estimates for transformer upgrades and other cost inputs.

42. The requirements in Attachment 1 of the Joint Motion of Adoption of the Settlement Agreement, will ensure that the construction, installation, and operation of the EV site installations and charging stations comply with all applicable safety regulations and codes.

Conclusions of Law

1. PG&E has the burden of proving that it is entitled to the relief sought in this proceeding, and affirmatively establishing the reasonableness of all aspects of its application.

2. PG&E is obliged to affirmatively establish that its proposal meets all of the requirements set forth in Pub. Util. Code §§ 740.3 and 740.8.

3. Proponents of utility ownership of EV charging infrastructure must affirmatively establish that the benefits of utility ownership of EV charging infrastructure are balanced against the competitive limitation that may result from that ownership.

4. Where a settlement affecting all PG&E customers is proffered, the factors used by the courts in approving class action settlements provide the appropriate criteria.

5. Rule 12.4 allows settlement proposals to be treated as joint testimony.

6. The Commission encourages parties to pursue settlement as a potential alternative to protracted disputes.

7. Neither D.16-01-023 nor D.16-01-045 conclude that utility ownership of EVSE is without anticompetitive impacts.

8. The Settlement Agreement provides benefits that are in the public interest.

9. The potential anticompetitive impacts associated with PG&E's ownership of EV infrastructure and EVSE can be prevented or adequately mitigated through

the exercise of existing rules and the imposition of certain conditions and modifications.

10. Parties to this proceeding have had ample time to conduct additional discovery, provide and review written responses, and conduct cross-examination on the Settlement Agreement.

11. The Scoping Ruling in no way prohibited PG&E from filing additional proposals that did not comply with the requirement to file a smaller program, thus the Enhanced Proposal is not beyond the scope of the proceeding.

12. Claims of binding precedent are, in general, antithetical to the purpose of pilot programs.

13. The balancing test set forth in D.11-07-029 (and reaffirmed in D.14-12-079 and subsequent related decisions), establishes that our review of the public interest must include an analysis of the impact of utility ownership on competition where proposals call for utility ownership of PEV charging infrastructure.

14. D.14-12-079 also reaffirmed the balancing test applied in D.11-07-029, which requires the ratepayer benefits of utility ownership of PEV charging infrastructure to be balanced against the competitive limitation(s) that may result from that ownership.

15. The Commission overturned the broad prohibition against utility EV infrastructure ownership in D.14-12-079.

16. The Settlement Agreement does not meet the standard for contested settlements set forth in D.09-12-045.

17. Consistent with Rule 12.4 we can and will treat the Settlement Agreement as joint testimony.

18. A 10 percent contingency is not excessive.

19. Our efforts to promote EVs and EV charging infrastructure must be balanced with the statutory requirement that rates be just and reasonable.

20. The adopted EV Program will reduce the costs of the program as compared to the Settlement Agreement.

21. At more than 50 percent and almost 100 percent (respectively), the $1.1 million in capital contingency costs and almost $2 million in expenses and O&M costs provided in the Settlement are excessive. Given the adopted features of the PG&E EV program, it is reasonable to anticipate that some of the savings projected by the Non-Settling Parties will occur.

22. PG&E should establish a one-way balancing account.

23. PG&E should file a Tier 1 advice letter within 60 days of this decision to track its O&M costs, and apply the participation payments it receives from the site host, as an offset to the program costs.

24. Hearings were required in this proceeding.

25. This proceeding should be closed.

O R D E R

IT IS ORDERED that:

1. Pacific Gas and Electric Company (PG&E) shall implement a three-year Electric Vehicle Pilot Program that contains the following features:

- PG&E may deploy the service connection and supply infrastructure (make-ready infrastructure) to support up to 7,500 Electric Vehicle Level 2 charging ports;
- Total program cost shall not exceed $130 million;
- PG&E may own up to 35 percent of total Electric Vehicle Supply Equipment (EVSE) ports projected to be installed through the pilot;

- PG&E shall not own EVSEs installed in workplaces in the non-Disadvantaged Communities segments;
- Where PG&E owns the make-ready infrastructure and EVSE, the site host shall pay a participation payment as described below;
- PG&E shall own the make-ready infrastructure regardless of who owns the EVSE; and
- PG&E shall present all customers with the option to own the EVSE.

2. Pacific Gas and Electric Company must work with the Program Advisory Council to establish the "base cost" for the Level 2 Electric Vehicle Supply Equipment, based on the price of the lowest cost Electric Vehicle Supply Equipment model qualified through the Request for Proposal process and the resultant base cost must be used to determine rebate and participation payment amounts.

3. Consistent with the Southern California Edison Company Charge Ready Program, Pacific Gas and Electric Company must treat the program rebates as expenses within the authorized revenue requirement, the costs of which are recovered from customers in the year the expense is incurred.

4. Pacific Gas and Electric Company is authorized to recover the revenue requirements associated with up to $130 million of capital, operations and maintenance, rebate, and education and outreach expenditures for implementation of Phase 1 of its Charge Smart and Save Program.

5. Pacific Gas and Electric Company must qualify vendors and Electric Vehicle Supply Equipment models through a rolling qualification process at least quarterly and make the list of qualified vendors and models available to all site hosts.

6. Pacific Gas and Electric Company must select Operations and Maintenance vendors through the Request for Proposal process in conjunction with the Program Advisory Group, and make the list of approved Operations and Maintenance vendors available to all site hosts.

7. For site hosts where Pacific Gas and Electric Company (PG&E) owns the Electric Vehicle Supply Equipment, PG&E will choose the Operations and Maintenance vendor, and PG&E will pay the Operations and Maintenance costs.

8. For site hosts that own their Electric Vehicle Supply Equipment, the site host will choose the Operations and Maintenance vendor and pay the Operations and Maintenance costs.

9. In all instances, the site host must be Pacific Gas and Electric Company's customer of record and not the service provider.

10. Pacific Gas and Electric Company shall provide for dual ports on its Level 2 chargers wherever feasible.

11. Pacific Gas and Electric Company (PG&E) will provide a 50 percent rebate to the site host for the base costs of the Electric Vehicle Supply Equipment (EVSE) at Multiple Unit Dwelling sites that are not in Disadvantaged Communities and workplaces that are in Disadvantaged Communities where PG&E is installing and owning the make-ready infrastructure but does not own the EVSE.

12. Pacific Gas and Electric Company (PG&E) will provide a 100 percent rebate to the site host for the base costs of the Electric Vehicle Supply Equipment (EVSE) at Multiple Unit Dwelling sites that are Disadvantaged Communities where PG&E is installing and owning the make-ready infrastructure but does not own the EVSE.

13. Pacific Gas and Electric Company (PG&E) will provide a 25 percent rebate to the site host for the base costs of the Electric Vehicle Supply Equipment at Workplace sites that are not in Disadvantaged Communities where PG&E is installing and owning the make-ready infrastructure but does not own the EVSE.

14. Pacific Gas and Electric (PG&E) shall offer site hosts a choice between the Time of Use (TOU) Rate-to-Host option as well as the TOU Rate-to-Driver option:

- Under the "TOU Rate-to-Driver" option, PG&E will serve electricity to the site host or their service provider who will then pass the TOU price signals directly to Electric Vehicle drivers to ensure that drivers who charge in a manner that supports the Program Guiding Principles.
- Under the "TOU Rate-to-Host" option, the Site Hosts will receive the TOU signals and will be able to propose alternative pricing and load management tactics consistent with Program Guiding Principles.

15. Pacific Gas and Electric Company must file a Tier 1 advice letter within 60 days of the effective date of this decision to track its Operation and Maintenance costs, and apply the participation payments it receives from the site host as an offset to the Operation and Maintenance costs, and to establish a one-way balancing account.

16. The Program Advisory Council provided for in the Settlement Agreement shall develop planning standards and reasonableness reviews for site host energy management plans.

17. The Program Advisory Council proposal submitted by the Settling Parties is adopted with the following modifications:

- The Program Advisory Council may suggest criteria by which to assess the load management plans of site hosts,

but the responsibility to approve the load management plans remains with Pacific Gas and Electric Company (PG&E).

- The Program Advisory Council may request that PG&E modify its data collection parameters as it sees reasonable.
- The Program Advisory Council's role shall include consulting with PG&E on the development of site selection criteria (based on the site selection criteria developed for San Diego Gas & Electric Company in D.16-01-045.
- In the first program year, the Program Advisory Council shall meet at least quarterly and at least two of the Program Advisory Council quarterly meetings shall be in person in San Francisco, others may be by telephone and/or in alternate locations.

18. Within 6 months of the effective date of this decision Pacific Gas and Electric Company must file a Tier 1 Advice Letter that:

- Sets forth a new Education and Outreach proposal with specific cost line items and a $10 million cap;
- Sets forth provisions for a geographic information system map to track the development of infrastructure, consistent with California Public Utilities Code section 740.2 and Decision 16-01-045; and

19. Within 60 days of the effective date of this decision, Pacific Gas and Electric Company must file a Tier 1 Advice Letter that:

- Summarizes the approved program, in the same level of detail as in the Settlement Agreement, but incorporates all aspects of the program as modified and approved in the decision.
- Details the rate options that will be provided to site hosts under the hybrid EVSE ownership program established by this Decision.

20. Pacific Gas and Electric Company must file and serve quarterly reports with the Commission, the Program Advisory Council, and the service list for Application 15-02-009 documenting progress on all aspects of the program approved herein.

21. Cost savings associated with Phase 1 shall be used to fund the bridge period (if necessary) and reinvested in future phases.

22. Data and metrics shall be collected and reported by Pacific Gas and Electric Company in the manner set forth in Appendix B to the Settlement filed on March 21, 2016.

23. All previous rulings are affirmed and all motions not previously granted are deemed denied.

24. Application 15-02-009 is closed.

This order is effective today.

Dated _____, at San Francisco, California.

ELECTRIC SCHEDULE EV Sheet 1

RESIDENTIAL TIME-OF-USE
SERVICE FOR PLUG-IN ELECTRIC VEHICLE CUSTOMERS

APPLICABILITY: This optional experimental schedule applies to electric service to customers for whom Schedule E-1 applies and who have a currently registered Motor Vehicle, as defined by the California Motor Vehicle Code, which is a battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV) recharged via a recharging outlet at the customer's premises. This schedule is not available to customers with a conventional, charge sustaining (battery recharged solely from the vehicle's on-board generator) hybrid electric vehicle (HEV). Low speed electric vehicles and electrically powered motorcycles or bicycles, as defined by the California Motor Vehicle Code, are not eligible for this rate option. This rate schedule is subject to an enrollment cap of 60,000. Service under this schedule is provided at the sole option of PG&E and based upon the availability of metering equipment and customer infrastructure improvements necessary for charging.

The provisions of Schedule S—Standby Service Special Conditions 1 through 6 shall also apply to customers whose premises are regularly supplied in part (but not in whole) by electric energy from a nonutility source of supply. These customers will pay monthly reservation charges as specified under Section 1 of Schedule S, in addition to all applicable Schedule EV charges. See Special Condition 6 of this rate schedule for exemptions to standby charges.

Depending on the manner in which customers will fuel their vehicle, one of the following rates will apply:

Rate A: Applies to all applicable customers unless they qualify for and choose Rate B.

Rate B: Applies to all applicable customers with a separately metered BEV or PHEV recharging outlet.

TERRITORY: This rate schedule applies everywhere PG&E provides electric service.

RATES: Total bundled service charges are calculated using the total rates below. Customers on this schedule are subject to the delivery minimum bill amount shown below applied to the delivery portion of the bill (i.e. to all rate components other than the generation rate). In addition, total bundled charges will include applicable generation charges per kWh for all kWh usage.

Direct Access (DA) and Community Choice Aggregation (CCA) charges shall be calculated in accordance with the paragraph in this rate schedule titled Billing.

TOTAL RATES

Rate A

Total Energy Rates ($ per kWh)	PEAK	PART-PEAK	OFF-PEAK
Summer Usage	$0.45389 (I)	$0.24986 (I)	$0.12225 (I)
Winter Usage	$0.32018 (I)	$0.19794 (I)	$0.12503 (I)

Delivery Minimum Bill Amount ($ per meter per day)	$0.32854
California Climate Credit (per household, per semi-annual payment occurring in the April and October bill cycles)	($17.40)

(Continued)

ELECTRIC SCHEDULE EV Sheet 2
RESIDENTIAL TIME-OF-USE
SERVICE FOR PLUG-IN ELECTRIC VEHICLE CUSTOMERS

RATES:(Cont'd.)

Total bundled service charges shown on a customer's bills are unbundled according to the component rates shown below. Where the delivery minimum bill amount applies, the customer's bill will equal the sum of (1) the delivery minimum bill amount plus (2) for bundled service, the generation rate times the number of kWh used. For revenue accounting purposes, the revenues from the delivery minimum bill amount will be assigned to the Transmission, Transmission Rate Adjustments, Reliability Services, Public Purpose Programs, Nuclear Decommissioning, Competition Transition Charges, Energy Cost Recovery Amount, DWR Bond, and New System Generation Charges[1] based on kWh usage times the corresponding unbundled rate component per kWh, with any residual revenue assigned to Distribution.***

UNBUNDLING OF TOTAL RATES

Energy Rates by Component ($ per kWh)	PEAK	PART-PEAK	OFF-PEAK
Generation:			
Summer Usage	$0.23092	$0.11128	$0.05593
Winter Usage	$0.08629	$0.05391	$0.05792
Distribution:**			
Summer Usage	$0.16880 (I)	$0.08441 (I)	$0.01215
Winter Usage	$0.17972 (I)	$0.08986 (I)	$0.01294
Transmission* (all usage)	$0.02536 (I)	$0.02536 (I)	$0.02536 (I)
Transmission Rate Adjustments* (all usage)	$0.00231 (R)	$0.00231 (R)	$0.00231 (R)
Reliability Services* (all usage)	$0.00000	$0.00000	$0.00000
Public Purpose Programs (all usage)	$0.01501	$0.01501	$0.01501
Nuclear Decommissioning (all usage)	$0.00149	$0.00149	$0.00149
Competition Transition Charges (all usage)	$0.00130	$0.00130	$0.00130
Energy Cost Recovery Amount (all usage)	($0.00001)	($0.00001)	($0.00001)
DWR Bond (all usage)	$0.00549	$0.00549	$0.00549
New System Generation Charge (all usage)**	$0.00322	$0.00322	$0.00322

* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and New System Generation Charges are combined for presentation on customer bills.
*** This same assignment of revenues applies to direct access and community choice aggregation customers.
[1] Per Decision 11-12-031, New System Generation Charges are effective 1/1/2012.

(Continued)

ELECTRIC SCHEDULE EV Sheet 3
RESIDENTIAL TIME-OF-USE
SERVICE FOR PLUG-IN ELECTRIC VEHICLE CUSTOMERS

RATES: (Cont'd.)

TOTAL RATES

Rate B

Total Energy Rates ($ per kWh)	PEAK	PART-PEAK	OFF-PEAK
Summer Usage	$0.44738 (I)	$0.24660 (I)	$0.12179 (I)
Winter Usage	$0.31325 (I)	$0.19447 (I)	$0.12453 (I)
Total Meter Charge Per Day	$0.04928		

Total bundled service charges shown on customer's bills are unbundled according to the component rates shown below.

UNBUNDLING OF TOTAL RATES

Meter Charge Rate: Meter charge rate provided in the Total Rate section above are assigned entirely to the unbundled distribution component.

Energy Rates by Component ($ per kWh)	PEAK	PART-PEAK	OFF-PEAK
Generation:			
Summer	$0.23092	$0.11128	$0.05593
Winter	$0.08629	$0.05391	$0.05792
Distribution:**			
Summer	$0.16229 (I)	$0.08115 (I)	$0.01169 (I)
Winter	$0.17279 (I)	$0.08639 (I)	$0.01244
Transmission* (all usage)	$0.02536 (I)	$0.02536 (I)	$0.02536 (I)
Transmission Rate Adjustments* (all usage)	$0.00231 (R)	$0.00231 (R)	$0.00231 (R)
Reliability Services* (all usage)	$0.00000	$0.00000	$0.00000
Public Purpose Programs (all usage)	$0.01501	$0.01501	$0.01501
Nuclear Decommissioning (all usage)	$0.00149	$0.00149	$0.00149
Competition Transition Charges (all usage)	$0.00130	$0.00130	$0.00130
Energy Cost Recovery Amount (all usage)	($0.00001)	($0.00001)	($0.00001)
DWR Bond (all usage)	$0.00549	$0.00549	$0.00549
New System Generation Charge (all usage)**	$0.00322	$0.00322	$0.00322

* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and New System Generation Charges are combined for presentation on customer bills.

(Continued)

ELECTRIC SCHEDULE EV Sheet 4
RESIDENTIAL TIME-OF-USE
SERVICE FOR PLUG-IN ELECTRIC VEHICLE CUSTOMERS

SPECIAL CONDITIONS:

1. TIME PERIODS: Times of the year and times of the day are defined as follows:

All Year:

Peak: 2:00 p.m. to 9:00 p.m. Monday through Friday. 3:00 p.m. to 7:00 p.m. Saturday, Sunday and Holidays.

Partial-Peak: 7:00 a.m. to 2:00 p.m. and 9:00 p.m. to 11:00 p.m. Monday through Friday, except holidays. (T)

Off-Peak: All other hours.

HOLIDAYS: "Holidays" for the purposes of this rate schedule are New Year's Day, President's Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, and Christmas Day. The dates will be those on which the holidays are legally observed. (N) I I (N)

DAYLIGHT SAVING TIME ADJUSTMENT: The time periods shown above will begin and end one hour later for the period between the second Sunday in March and the first Sunday in April, and for the period between the last Sunday in October and the first Sunday in November.

2. SEASONAL CHANGES: The summer season is May 1 through October 31 and the winter season is November 1 through April 30. When billing includes use in both the summer and winter periods, charges will be prorated based upon the number of days in each period.

3. ADDITIONAL METERS: If a residential dwelling unit is served by more than one electric meter, the customer must designate which meter is the primary meter and which is (are) the additional meter(s).

4. BILLING: A customer's bill is calculated based on the option applicable to the customer.

Bundled Service Customers receive supply and delivery services solely from PG&E. The customer's bill is based on the Total Rates set forth above.

Transitional Bundled Service Customers take transitional bundled service as prescribed in Rules 22.1 and 23.1, or take bundled service prior to the end of the six (6) month advance notice period required to elect bundled portfolio service as prescribed in Rules 22.1 and 23.1. These customers shall pay charges for transmission, transmission rate adjustments, reliability services, distribution, nuclear decommissioning, public purpose programs, the new system generation charge, the applicable Cost Responsibility Surcharge (CRS) pursuant to Schedule DA CRS or Schedule CCA CRS, and short-term commodity prices as set forth in Schedule TBCC.

(Continued)

ELECTRIC SCHEDULE EV Sheet 5
RESIDENTIAL TIME-OF-USE
SERVICE FOR PLUG-IN ELECTRIC VEHICLE CUSTOMERS

SPECIAL CONDITIONS: (Cont'd.)

4. BILLING (Cont'd.):

Direct Access (DA) and Community Choice Aggregation (CCA) Customers purchase energy from their non-utility provider and continue receiving delivery services from PG&E. Bills are equal to the sum of charges for transmission, transmission rate adjustments, reliability services, distribution, public purpose programs, nuclear decommissioning, the new system generation charge, the franchise fee surcharge, and the applicable CRS. The CRS is equal to the sum of the individual charges set forth below. Exemptions to the CRS, including exemptions continuous DA service, are set forth in Schedules DA CRS and CCA CRS.

	DA / CCA CRS	
Energy Cost Recovery Amount Charge (per kWh)	($0.00001)	(I)
DWR Bond Charge (per kWh)	$0.00549	(I)
CTC Charge (per kWh)	$0.00130	(R)
Power Charge Indifference Adjustment (per kWh)		
2009 Vintage	$0.02470	(I)
2010 Vintage	$0.02803	(I)
2011 Vintage	$0.02922	(I)
2012 Vintage	$0.03014	(I)
2013 Vintage	$0.03001	(I)
2014 Vintage	$0.02949	(I)
2015 Vintage	$0.02909	(I)
2016 Vintage	$0.02919	(I)
2017 Vintage	$0.02919	(N) (N)

(Continued)

ELECTRIC SCHEDULE EV Sheet 6 (N)
RESIDENTIAL TIME-OF-USE (N)
SERVICE FOR PLUG-IN ELECTRIC VEHICLE CUSTOMERS (N)

SPECIAL CONDITIONS: (Cont'd.)

5. SOLAR GENERATION FACILITIES EXEMPTION: Customers who utilize solar generating facilities which are less than or equal to one megawatt to serve load and who do not sell power or make more than incidental export of power into PG&E's power grid and who have not elected service under Schedule NEM, will be exempt from paying the otherwise applicable standby reservation charges. (N)

6. DISTRIBUTED ENERGY RESOURCES EXEMPTION: Any customer under a time-of-use rate schedule using electric generation technology that meets the criteria as defined in Electric Rule 1 for Distributed Energy Resources is exempt from the otherwise applicable standby reservation charges. Customers qualifying for this exemption shall be subject to the following requirements. Customers qualifying for an exemption from standby charges under Public Utilities (PU) Code Sections 353.1 and 353.3, as described above, must take service on a time-of-use (TOU) schedule in order to receive this exemption until a real-time pricing program, as described in PU Code 353.3, is made available. Once available, customers qualifying for the standby charge exemption must participate in the real-time program referred to above. Qualification for and receipt of this distributed energy resources exemption does not exempt the customer from metering charges applicable to time-of-use (TOU) and real-time pricing, or exempt the customer from reasonable interconnection charges, non-bypassable charges as required in Preliminary Statement BB - *Competition Transition Charge Responsibility for All Customers and CTC Procurement*, or obligations determined by the Commission to result from participation in the purchase of power through the California Department of Water Resources, as provided in PU Code Section 353.7.

7. DWR BOND CHARGE: The Department of Water Resources (DWR) Bond Charge was imposed by California Public Utilities Commission Decision 02-10-063, as modified by Decision 02-12-082, and is property of DWR for all purposes under California law. The Bond Charge applies to all retail sales, excluding CARE sales. The DWR Bond Charge (where applicable) is included in customers' total billed amounts.

(N)

Appendix J

DRAFT TARIFF

RATE SCHEDULE 96 – ELECTRIC VEHICLE CHARGING

APPLICABLE: Available for electric vehicle charging at FortisBC-owned Direct Current Fast Charging stations.

RATE: $9.00 per 30 minute period

The rate is pro-rated based on the time that a vehicle is plugged in.

NOTE: Customers taking service under this Rate Schedule will be billed and make payment at the time of charging.

The rate for electric vehicle charging will be reviewed on a periodic basis.

Appendix K

DRAFT ORDERS

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British Columbia
Utilities Commission

Suite 410, 900 Howe Street
Vancouver, BC Canada V6Z 2N3
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P: 604.660.4700
TF: 1.800.663.1385
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ORDER NUMBER
G-xx-xx

IN THE MATTER OF
the *Utilities Commission Act*, RSBC 1996, Chapter 473

and

FortisBC Inc.
Application for Approval of the Electric Vehicle Charging
Electric Tariff Rate Schedule 96

BEFORE:
Panel Chair/Commissioner
Commissioner
Commissioner

on Date

ORDER

WHEREAS:

A. On December 22, 2017, FortisBC Inc. (FBC) submitted an Application for Approval of the Electric Vehicle (EV) Charging Electric Tariff Rate Schedule 96 to the British Columbia Utilities Commission (Commission) pursuant to section(s) 59-61 and 89 of the *Utilities Commission Act* (UCA) (Application);

B. The Application requests an interim rate for FBC EV Charging stations effective January 12, 2018, pending a final decision on the Application;

C. In the Application, FBC proposes a regulatory timetable for a public written hearing process with one round of information requests, followed by intervener written final argument and FBC written reply argument ;

D. The Commission has reviewed FBC's proposal and considers that approval of the interim rate effective January 12, 2018 and establishment of a regulatory timetable for review of the Application is warranted.

NOW THEREFORE pursuant to section(s) 59-61 of the *Utilities Commission Act*, the British Columbia Utilities Commission orders as follows:

1. FBC's application for approval of EV Charging Electric Tariff Rate Schedule 96 on an interim basis effective January 12, 2018 is approved.

2. A written hearing is established for the review of the Application. The Regulatory Timetable is set out in Appendix A to this order.

3. By no later than January 26, 2018, FBC is to publish the Public Notice, attached as Appendix B to this Order, in such local and community newspapers as to provide adequate notice to those parties who may have an interest in or be affected by the Application.

4. The Application, together with any supporting materials, will be available for inspection at FBC Office, Suite 100, 1975 Springfield Road, Kelowna, BC V1Y 7V7. The Application and supporting materials also will be available on the FortisBC website at www.fortisbc.com and on the Commission website at www.bcuc.com.

5. Interveners who wish to participate in the regulatory proceeding are to register with the Commission by completing a Request to Intervene Form, available on the Commission's website at http://www.bcuc.com/Registration-Intervener-1.aspx by February 2, 2018, and in accordance with the Commission's Rules of Practice and Procedure attached to Order G-1-16.

DATED at the City of Vancouver, in the Province of British Columbia, this (XX) day of [Month Year].

BY ORDER

Original signed by:

(X. X. last name)
Commissioner

Attachments

FortisBC Inc. Application for Approval of the Electric Vehicle Charging
Electric Tariff Rate Schedule 96

REGULATORY TIMETABLE

ACTION	DATE (2018)
FBC publishes Public Notice	Week of January 22
Registration of Interveners	Friday, February 2
Commission and Intervener Information Request (IR) No. 1	Tuesday, February 13
FBC Response to IR No. 1	Friday, March 2
Intervener Written Final Argument	Friday March 16
FBC Written Reply Argument	Wednesday, March 28

bcuc
British Columbia
Utilities Commission

PUBLIC NOTICE

Application for Approval of the Electric Vehicle Charge Electric Tariff Rate

On December 22, 2017, FortisBC Inc. applied to the British Columbia Utilities Commission (Commission), pursuant to section(s) 59-61 of the *Utilities Commission Act,* for approval of a rate for Electric Vehicle (EV) charging at FBC-owned EV Charging stations.

HOW TO PARTICIPATE

There are a number of ways to participate in a matter before the Commission:

- **Submit a letter of comment**
- **Register as an interested party**
- **Request intervener status**

For more information, or to find the forms for any of the options above, please visit our website or contact us at the information below.

www.bcuc.com/RegisterIndex.aspx

All submissions received, including letters of comment, are placed on the public record, posted on the Commission's website and provided to the Panel and all participants in the proceeding.

NEXT STEPS

Intervener registration Persons who are directly or sufficiently affected by the Commission's decision or have relevant information or expertise, and that wish to actively participate in the proceeding can request intervener status by submitting a completed Request to Intervene Form by February 2, 2018.

GET MORE INFORMATION

All documents filed on the public record are available on the "Current Proceedings" page of the Commission's website at www.bcuc.com.

If you would like to review the material in hard copy, or if you have any other inquiries, please contact Laurel Ross, Acting Commission Secretary, at the following contact information.

British Columbia Utilities Commission
Sixth Floor, 900 Howe Street
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Utilities Commission

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P: 604.660.4700
TF: 1.800.663.1385
F: 604.660.1102

ORDER NUMBER
G-xx-xx

IN THE MATTER OF
the *Utilities Commission Act*, RSBC 1996, Chapter 473

and

FortisBC Inc. Application for Approval of the Electric Vehicle Charging
Electric Tariff Rate Schedule 96

BEFORE:
[Panel Chair]
Commissioner
Commissioner

on Date

ORDER

WHEREAS:

A. On December 22, 2017, FortisBC Inc. (FBC) submitted an Application for Approval of the Electric Vehicle (EV) Charging Electric Tariff Rate Schedule 96 to the British Columbia Utilities Commission (Commission) pursuant to section(s) 59-61 of the *Utilities Commission Act* (UCA) (Application);

B. The Application requests approval of a new Rate Schedule 96 for EV Charging at FBC-owned EV charging stations;

C. The Application also requests approval of the establishment of an Emissions Regulation deferral account to capture net revenue from the monetization of carbon credits;

D. The Commission has reviewed and considered the Application and determines that the requested approvals are necessary and in the public interest.

NOW THEREFORE the Commission orders as follows:

1. Electric Tariff Rate Schedule 96 for EV charging is approved as permanent.
2. The establishment of the Emissions Regulation deferral account attracting FBC's short term interest rate is approved.

DATED at the City of Vancouver, in the Province of British Columbia, this (XX) day of (Month Year).

BY ORDER

(X. X. last name)
Commissioner

Appendix 4

MOGILE TECHNOLOGIES INC.
SUMMARY OF EV CHARGING SERVICES AND RATES IN BC AND ACROSS CANADA

Appendix D – Mogile Report

Table 1: Level 2 and DCFC Ports by Province

Province	Level 2	DCFC
AB	156	34
BC	1,142	120
MB	39	3
NB	91	18
NL	45	0
NS	51	3
ON	1,331	386
PE	33	0
QC	2,849	270
SK	45	0

Note: These numbers represent the number of ports available in Canada. One port could have more than one connector (ex: One CHAdeMO and one SAE Combo) but it can only charge one vehicle at a time.

Table 2: Level 2 Pricing by Province

Province	Free	Per Session $1 - $3, $2.5 being the most common	Per Session >$3, $5 being the most common	Per Hour $0.15-$3, $1/hr and $2/hr being the most common	Per Hour >$3, $6 being the most common	Per kWh $0.15-$0.35	Other or unsure
AB	138	0	4	0	0	0	14
BC	1,020	2	0	33	1	1	85
MB	39	0	0	0	0	0	0
NB	53	36	0	0	0	0	2
NL	45	0	0	0	0	0	0
NS	48	0	2	1	0	0	0
ON	855	31	14	132	15	2	282
PE	33	0	0	0	0	0	0
QC	984	331	1	1,403	0	0	130
SK	45	0	0	0	0	0	0

Table 3: DCFC Pricing by Province

Province	Free	Per Session $4.95 - $15, $15 being the most common	Per Hour $10-$21, $10/hr and $12/hr being the most common	Per kWh $0.18-$0.35	Tesla-Specific	Other or unsure
AB	1	0	1	0	32	0
BC	10	0	5	25	78	3
MB	1	0	0	0	0	1
NB	0	0	18	0	0	0
NL	0	0	0	0	0	0
NS	0	1	0	0	0	2
ON	61	11	111	3	200	0
PE	0	0	0	0	0	0
QC	27	1	125	0	116	1
SK	0	0	0	0	0	0

Table 4: Station Ownership in BC (% of total ports)

Level 2				
Utility	Municipality	Business	Tesla	Uncertain
1.0%	20.9%	53.2%	17.2%	7.7%
DCFC				
Utility	Municipality	Business	Tesla	Uncertain
31.7%	0.0%	3.3%	65.0%	0.0%

Table 5: Station Ownership in BC (% of total charging locations)

Level 2				
Utility	Municipality	Business	Tesla	Uncertain
0.6%	23.7%	49.3%	19.6%	6.8%
DCFC				
Utility	Municipality	Business	Tesla	Uncertain
74.5%	0.0%	5.9%	19.6%	0.0%

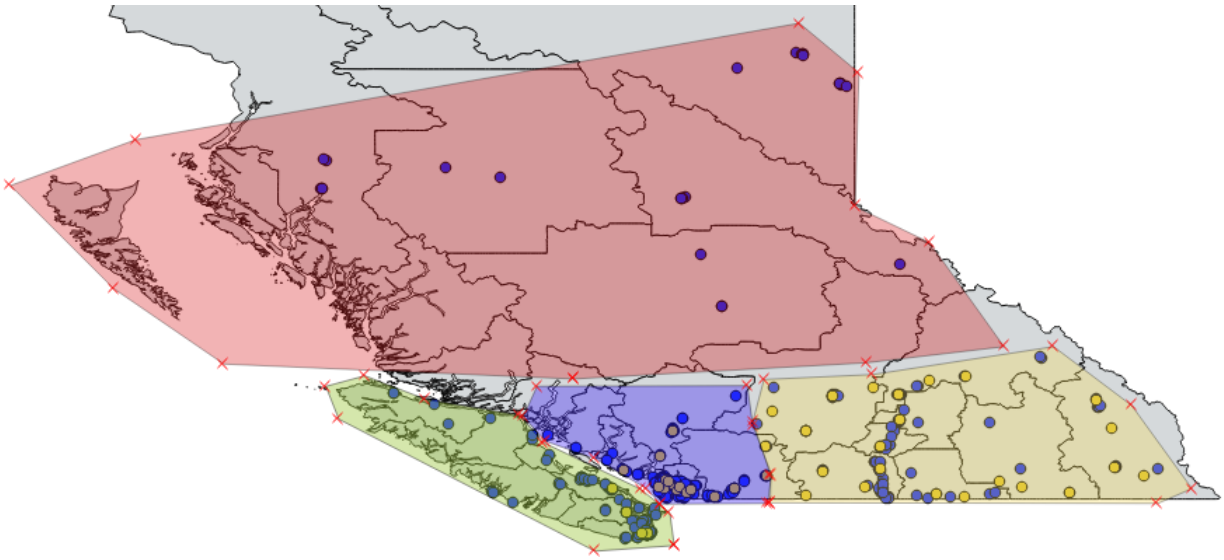
Note: A charging location may have one or more ports available for charging vehicles.

Table 6: Number of Public Charging Ports and Locations

	No. Ports		No. Locations	
Region	**L2**	**DCFC**	**L2**	**DCFC**
Lower Mainland and Sunshine Coast	565	16	278	15
Vancouver Island	220	4	137	4
Southern Interior	124	23	91	23
North	31	0	26	0

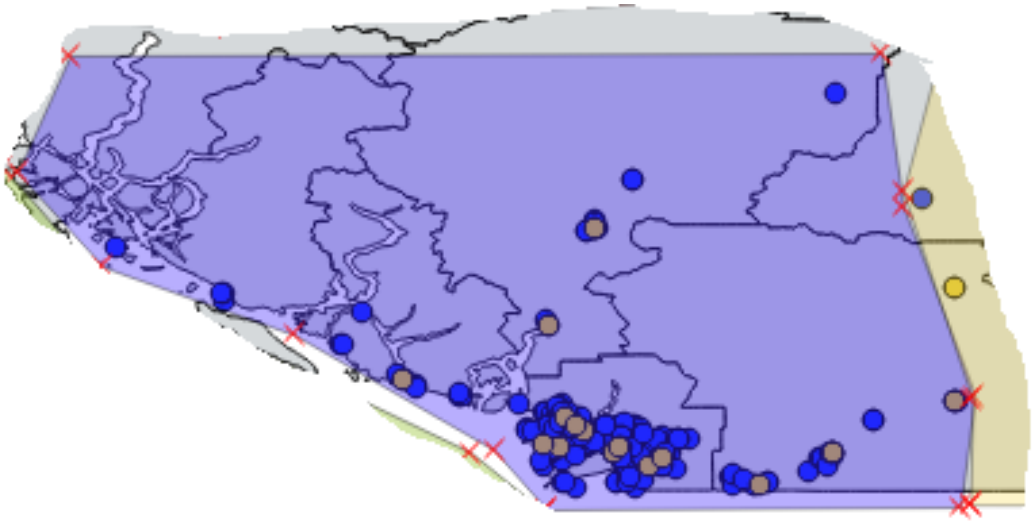
Note: These numbers exclude Tesla charging stations.

Figure 1: Overview of Level 2 and DCFC Charging Locations in BC



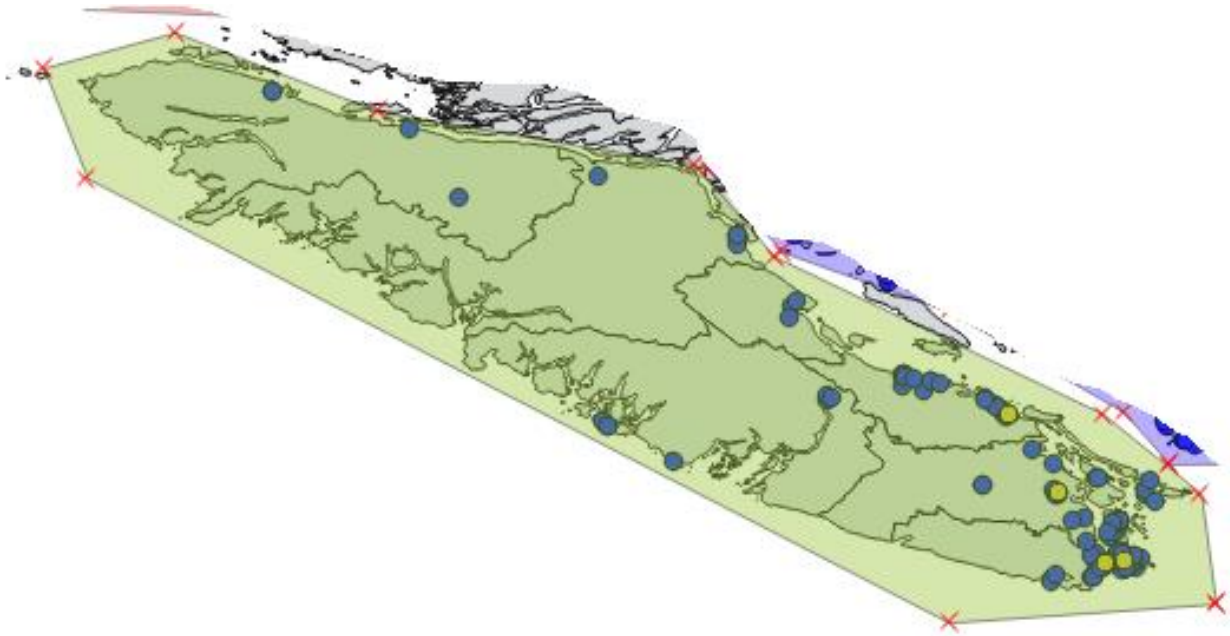
Note: Blue dots represent Level 2 locations, yellow dotes represent DCFC locations.

Figure 2: Overview of Level 2 and DCFC Charging Locations (Lower Mainland and Sunshine Coast)



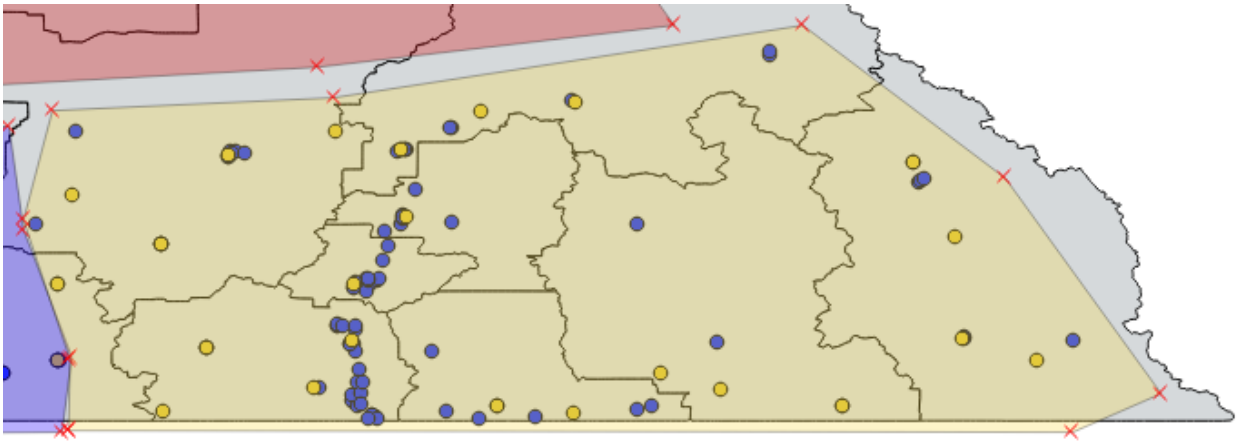
Note: Blue dots represent Level 2 locations, yellow dotes represent DCFC locations.

Figure 3: Overview of Level 2 and DCFC Charging Locations (Vancouver Island)



Note: Blue dots represent Level 2 locations, yellow dotes represent DCFC locations.

Figure 4: Overview of Level 2 and DCFC Charging Locations (Southern Interior)



Appendix 5

CITY OF VANCOUVER USER FEES FOR CITY OWNED AND OPERATED PUBLIC ELECTRIC VEHICLE CHARGING STATIONS REPORT

RR-1(d)

CITY OF VANCOUVER

ADMINISTRATIVE REPORT

Report Date:	June 20, 2017
Contact:	Doug Smith
Contact No.:	604.829.4308
RTS No.:	12009
VanRIMS No.:	08-2000-20
Meeting Date:	June 27, 2017

TO: Vancouver City Council

FROM: General Manager of Planning, Urban Design and Sustainability

SUBJECT: User Fees for City Owned and Operated Public Electric Vehicle Charging Stations

RECOMMENDATION

A. THAT Council approve the charging of user fees at City owned and operated public Electric Vehicle (EV) charging stations as described herein.

B. THAT Council approve, in principle, changes to the Parking Meter By-law No. 2952, as generally outlined in this report and Appendix A, to effect the charging of user fees at City owned and operated public EV charging stations.

C. THAT Council authorize the Director of Legal Services to prepare and bring forward for enactment amendments to the Parking Meter By-law No. 2952 as generally outlined in Appendix B.

REPORT SUMMARY

The City committed to introducing user fees for public electric vehicle ("EV") charging stations as part of the 2016 EV Ecosystem Strategy. The intent of this report is to seek Council approval to charge user fees at City owned and operated public EV charging stations and to amend the Parking Meter By-law to allow implementation and enforcement of these fees.

User fees will be introduced with the intention of increasing turnover at EV charging stations, and encouraging EV drivers with access to home or workplace charging to use those preferentially.

The City consulted with stakeholders and thought leaders on EV infrastructure in early 2017 as part of the development of this program.

COUNCIL AUTHORITY/PREVIOUS DECISIONS

The City has the legal authority to own and operate EV charging stations in the City of Vancouver pursuant to section 145 of the *Vancouver Charter*. As part of the City's authority to operate EV charging stations, the City may charge user fees.

In November 2016, Council unanimously adopted the EV Ecosystem Strategy, providing a five-year strategy on the City's approach to home, workplace and public charging infrastructure; and, defined the City's role as a provider of and a market enabler for electric vehicle charging access as a community amenity to 2021. The introduction of user fees was the Fair Access Quick-Start committed to under the EV Ecosystem Strategy.

In November 2015, Council adopted the *Renewable City Strategy*, committing to derive 100 per cent of all energy used in Vancouver from renewable sources before 2050; and, to reduce greenhouse gas emissions by 80 per cent from 2005 levels before 2050.

In August 2013, Council adopted new minimum requirements for all parking stalls in new one- and two-family homes, 20 per cent of parking stalls in multi-unit residential buildings, and ten per cent of parking stalls in new commercial buildings, such that they be equipped with a "Level 2" charging circuit under the *Vancouver Building By-law*.

In October 2012, Council adopted *Transportation 2040*, which includes actions to support electric vehicle deployment and the provision of charging infrastructure.

In July 2011, Council adopted the *Greenest City Action Plan (GCAP)*. Goal 9 (Clean Air) of GCAP includes encouraging electric vehicle transport. Goal 2 of GCAP includes carbon reduction goals to reduce greenhouse gas emissions by 33 per cent by 2020 over 2007 levels. In 2009, Council adopted requirements in the *Vancouver Building By-law* for electric vehicle charging circuits in new homes and multi-unit residential buildings. These were the first such requirements in North America.

For many years preceding this, Council has directed staff to develop policy and plans that have been built upon in the current Greenest City work including *Clouds of Change*, the *Community Climate Change Action Plan*, EcoDensity and others.

CITY MANAGER'S/GENERAL MANAGER'S COMMENTS

The City Manager recommends approval of the foregoing.

REPORT

Background/Context

The 2016 EV Ecosystem Strategy describes how different approaches to deploying electric vehicle charging infrastructure in the home, workplace, and public settings can create an interdependent network that will support the electrification of light-duty vehicles in Vancouver. The different approaches build on an existing public network of charging stations (currently numbering approximately 250, of which approximately 75 are City owned)), and on a growing number of homes and commercial buildings that have been constructed with EV charging circuits since 2011.

A public survey of over 2,000 Vancouver residents in 2016 indicated that 85% of people planning to buy new cars in the next five years would or would consider buying an electric vehicle, a number greater than total EVs registered in Vancouver at the time.

Challenges

Presently, the City does not require payment for the use of City owned and operated public charging stations, although the standard parking rates for each block or parking lot apply. Use of City owned and operated EV charging stations has more than doubled in the past two years, with over 17,000 charging sessions averaging nearly five hours per day per station, but with some locations having up to approximately 13 hours of use per port, per day. Increasing congestion at many of the City owned and operated public access EV charging stations is reducing their utility to members of the public who rely on them. The significant growth in EV uptake (a 63% increase between 2015 and 2016) is likely to exacerbate this issue under current conditions.

In 2016, City owned and operated public access EV charging stations logged over 17,000 charging sessions. Data shows that approximately half of all time spent at City owned and operated EV charging stations occurs after the battery is full, suggesting a need for greater turnover.

Solutions

If approved, user fees will be introduced and phased in at City owned and operated EV charging stations with the intention of increasing turnover at such stations, and encouraging EV drivers with access to home or workplace charging to use those preferentially.

The City consulted with stakeholders and thought leaders, including BC Hydro, SFU Sustainable Transportation Action Research Team, Metro Vancouver, and the BC Institute of Technology, among others, on EV infrastructure in early 2017 as part of program development.

The user fee program for City owned and operated EV charging stations will be guided by the following principles, in order of importance:

1. Increasing turnover
2. Ease of understanding
3. Encourage home use where possible and use of lowest power infrastructure
4. Eventual return on investment on infrastructure
5. Fairness
6. Rates that encourage the transition to electric vehicles

Roll-out of User Fees to initial City owned and operated EV Chargers

Initially, user fees will be introduced at City owned and operated EV charging stations located at 16 different locations – all of which are City or Park Board jurisdiction sites. For context, EV charging stations presently exist under four different operating models in Vancouver, as described in the table below. User fees proposed in this report will be applied to Groups ‘A’ and ‘D’ initially. The EV charging station in Group D is the only one that is not City owned and operated. That charger is owned by BC Hydro and operated by

the City. EV charging stations that fall within Groups B and C are not under consideration for user fees at this time.

Group	Owner	Operator	City to Apply User Fees	Example(s)
A	City	City	Yes	City Hall Main Library Branch Hillcrest Community Centre Curbside locations
B	City	Third Party Site Host	No	Oakridge Mall Bentall Centre
C	Third Party	Third Party	No	Fairmont Pacific Rim Vancity Credit Union
D	Third Party	City	Yes	Empire Fields (BC Hydro owns station, City operates).

A separate approval process for charging stations at Park Board jurisdiction sites is required by the Park Board and this may be scheduled in the fall of 2017.

Proposed Fees

Fees will be charged hourly instead of per unit of energy, to encourage turnover once batteries are fully charged. Charging hourly is also a more familiar and easily understood method of payment. For more details on the fee models considered please see Appendix A.

User fees are initially proposed as follows:

- Level 2[1]: $2.00/hour plus regular meter rate (as applicable)
- DC Fast Charge[2]: $16/hour plus regular meter rate (as applicable)

[1] Typically provides up to 30km of range per hour plugged in
[2] Typically provides up 200km of range per hour plugged in

The above pricing equates to about $0.46/L and $0.50/L of gasoline equivalent respectively[3]. The City's existing EV infrastructure on those City owned and operated EV chargers that are part of the initial rollout is capable of collecting user fees based on rates set by the City. With the exception of three charging stations at Hillcrest Community Centre, which are being upgraded, no additional changes or upgrades to City EV infrastructure is anticipated to implement the user fee system. The City will also ensure that, before applying a user fee at any particular City owned and operated EV charger, the party that has been hired by the City to electronically process payment at that EV charger complies with the standards established by the Payment Card Industry's PCI Security Standards Council.

For more detail on rates, please refer to Appendix A and page 41 in the EV Ecosystem Strategy.

Strategic Analysis

Pricing will be designed so that residential charging will cost less than public charging, and Level 2 to cost less than Fast Charging. The primary goal of this graded pricing model is to encourage drivers with home or workplace charging options to use them when possible. Because of the large price differential between electricity and liquid fuels in the region, it will be possible to implement charge station pricing that is effective in minimizing abuse while at the same time being far less expensive than gasoline or diesel. Also these rates will help ensure that other modes like walking, biking and transit will remain more attractive financially than driving an EV.

The pricing structure will be developed as an "add-on" to existing parking fees to optimize station utilization. In other words, the Level 2 and DCFC rates that are developed under the above criteria will be in addition to a given parking lot price or fee zone prices.

It should be noted that those City owned and operated EV charging stations that are part of the initial rollout and that are located in parking lots should not require a change in pricing policy by the parking management company. The City will set rates through the EV charging stations that will include the usual parking fee at a given lot and remit the parking fee to the lot operator. The City will agree upon the terms and conditions of such an arrangement with the parking lot operator before applying a user fee to such EV chargers.

Implications/Related Issues/Risk (if applicable)

Financial

Details of financial implications of introducing user fees are provided in Appendix A of this Council Report. The existing thirty (30) Level 2 stations and one (1) DC Fast Charging station will not incur any additional capital costs. Future installations, as approved under the 2016 EV Ecosystem Strategy, will have capital costs that will be funded within the approved 2015-2018 capital plan and expenditures will be managed with existing budget.

[3] Equivalency with gasoline is strictly an estimate, and can vary based on the energy efficiency of vehicles being compared. Typically, an EV can travel approximately nine to ten times further on a unit of energy than a similar internal combustion engine vehicle. Home charging would be closer to $0.20/litre equivalent.

It is estimated that annual revenues from all stations will be $23,500 with annual operating (excluding the investment for capital costs and installation) of approximately $14,500. It is anticipated that the currently proposed user fees will achieve a positive return-on-investment ("ROI") for Level 2 charging stations in approximately 1.25 years. It is anticipated that the currently proposed user fees for DC Fast Charge stations will not achieve a short-term ROI, however, revenues will increase significantly as electric vehicles become more common.
\
It is not presently known how sensitive EV drivers will be to user fees. As more market data is obtained and as the number of EVs on the road increases, it is expected that user fees will be adjusted and that positive ROIs will be achievable during the useful lifetime of the infrastructure.

The framework for rate-setting is described in detail in Appendix A.

Human Resources/Labour Relations

The introduction of user fees for City owned and operated public EV charging stations, and the concurrent inclusion of EV infrastructure within the Parking Meter By-law will generate the need for, and the ability of the City to, enforce the appropriate use of such public charging stations. This in turn will generate training needs for City Parking Enforcement staff and external partners, including parking management companies such as Easypark. Sustainability will support such training prior to the launch of user fees.

The collection of user fees will be via electronic means through existing data network providers that support the City owned and operated public EV charging stations. Human resources implications for this are therefore expected to be minimal and no new resources will be required.

Legal

The City may sell electricity through City owned and operated EV charging stations for a user fee without attracting public utility regulation under the British Columbia *Utilities Commission Act*. The definition of "public utility" under the *Utilities Commission Act* excludes municipalities.

Notwithstanding the above, the sale of electricity by the City through a City owned and operated EV charging station would trigger certain filing requirements under "energy supply contract" section (s. 71) of the *Utilities Commission Act*. This includes the need to file a generic sales contract as well as quarterly and annual sales information.

Public Notifications

City staff will provide public notifications for at least one month prior to implementing new user fees. Notifications will be provided through four modes simultaneously:

1. Messages displayed on EV charging station displays at affected sites.
2. Messages posted online at Vancouver.ca and to EV infrastructure mapping sites like Chargehub.com and plugshare.com outlining new pricing and implementation
3. Signage posted adjacent to EV charging stations at affected locations.

4. Regular social media reminders leading up to implementation.

The City will continue to gather input via 311 and social media to monitor implementation and may convene future user workshops to get input on evolving the program to best suit user's needs.

CONCLUSION

As directed by Council via the EV Ecosystem Strategy, the introduction of user fees at City owned and operated public access EV charging stations will increase turnover and ensure that the infrastructure is used more optimally and make owning an EV easier and more attractive. To implement a user fee system, Sustainability staff will work with Easypark, EV charging station data network providers, and City staff in affected departments and the Park Board. Public notifications will be provided approximately one month before the initiation of user fees, expected during summer 2017.

* * * * *

Financial Plan for COV Owned and Operated Public Electric Vehicle Charging Station Rates

1. Summary

The City committed to introducing user fees for public electric vehicle ("EV") charging stations as part of the 2016 EV Ecosystem Strategy. Sustainability will present an update to City Council on June 27, 2017 that will include proposed rates and changes to the *Parking Meter Bylaw*.

Presently, the City does not charge any fees at any of its public charging stations. Increasing congestion at many of the City's public access EV charging stations is reducing their utility to members of the public who rely on them. The significant growth in EV uptake (a 63% increase between 2015 and 2016) is likely to exacerbate this issue under current policy.

In 2016, City public access EV charging stations logged over 17,000 charging sessions. Data shows that approximately half of all time spent at City-owned EV charging stations occurs after the battery is full, suggesting a need for greater turnover.

The City consulted with stakeholders and thought leaders on EV infrastructure in early 2017 as part of program development.

2. Guiding Principles

User fees will be introduced with the intention of increasing turnover at City owned and operated EV charging stations, and encouraging EV drivers with access to home or workplace charging to use those preferentially.

The user fee program for City owned and operated EV charging stations will be guided by the following principles, in order of importance:

1. Turnover
2. Ease of Understanding
3. Encourage home use, lowest power use infrastructure
4. Return on investment on infrastructure
5. Public perception of fairness
6. Inexpensive compared to fossil fuels (maintain attractiveness of EVs over ICEs)

3. Consultation & Fee Models

Three potential models for fees were considered as part of the program design and consultation. The City plans to implement a time-based ($/hour) model as described below due to its alignment with the program principles as described above. A brief description of the three fee options is below.

Time-based ($ / hour)

Charging fees based on the length of time a station is occupied, and will encourage turnover so that charging stations are used by those who need them for EV charging and not simply as parking spaces, and optimize access through improved availability. Hourly fees are simple to understand, and would mirror existing rate structures for parking meters.

Energy-based ($/ kWh)

An alternate argument suggests that a fee based on energy (per kWh) would be more equitable between different models of vehicles with different on-board charging speeds, since users would only pay for energy received regardless of the length of time to charge. This, however, may hamper the ability for users who may be queuing to use station to determine wait times, and the ability for enforcement staff to manage these systems becomes increasingly complex.

Hybrid rate ($/kWh until battery full, then $/hour)

The third, hybrid option, would ensure equity in terms of pricing of energy delivered, while at the same time ensuring that users continue to pay a rate for staying at a charging station. Some jurisdictions have examined using relatively high hourly rates once a battery is fully charged to more strongly disincentivize “squatting”. However, a hybrid rate is also more difficult for users to understand, and may possibly lead to a less positive user experience. Some jurisdictions have introduced a ‘punitive’ hybrid rate such that the price is dramatically higher after a given time. However, more conventional parking enforcement measures can be employed by the City to prevent drivers staying beyond time limits at a given location.

It should be noted that upper limits on parking / charging times will be imposed, in line with the lot or city block that the charger is located on.

4. Station Usage

The City will only be bringing in user fees at locations where the City owns and operates the EV charging stations. The only exception is the DC Fast Charge Station located at Empire Fields, where BC Hydro owns the charge station and the City operates it. At these locations, the City owns the electrical supply, which is limited to City/Park Board buildings, City parking lots and stations on City ROW.

Such stations are present at 16 locations, as follows:

<u>Level 2 Stations (7kW)</u>

1. Arbutus St. adjacent to Kits Beach tennis courts
2. Britannia Community Centre
3. City Hall
4. Pacific National Exhibition

5. Mainland St. at Nelson
6. 180 Keefer St.
7. Mt. Pleasant Community Centre
8. Laneways at Oak & 49th Ave.
9. Coal Harbour Community Centre
10. Vancouver Aquarium
11. Vancouver Public Library Main Branch
12. Hillcrest Community Centre
13. Beach Ave. at Cardero St.
14. Beach Ave. at Bute St.
15. Beach Ave. at Bidwell St.

<u>DC Fast Charge Station (50kW)</u>

16. Empire Fields

Analysis of usage at 15 Level 2 locations was conducted for the period from January 10, 2016 to January 9, 2017 to determine the variations in usage at each location, and the typical session length and power obtained by users. It should be noted that usage at all locations has been increasing since 2013 when analysis began.

Usage of the Empire Fields location is not presently monitored, but is anecdotally reported to be high.

Analysis determined that the public Level 2 stations are used quite frequently, but not necessarily in a way that provides maximum public benefit. In the period mentioned above, a total of 17,016 charging sessions were recorded across the network.

The Level 2 stations were used on average for approximately three hours per session, consuming an average of approximately 8.2kWh. This suggests that the users of these stations are remaining longer than is necessary: a Level 2 charging station dispenses between 6.7kWh and 7.7kWh, indicating that on average, stations stop dispensing power less than halfway through a session.

The table below provides the breakdown, for illustration purposes, of the usage at Level 2 charging stations on City property.

Table 1 - EV Infrastructure Usage at City Properties

Station Name	Average Session Length	Avg. Energy (kWh/ session)	Total Sessions	Avg. Sessions / Month	Avg Session / per port	Avg Sessions (port/mo)	Average Usage per Day (hh:mm/port/d)
Kits Beach	2:40:18	8.76	1668	139.0	834	70	6:06
Britannia Community Centre	2:31:43	7.58	1910	159.2	955	80	6:36
City Hall	4:01:17	5.65	3035	252.9	759	63	8:21
Hastings Park	3:23:05	10.8	619	51.6	310	26	2:52
Mainland St.	2:53:41	10.8	3253	271.1	1627	136	12:53
Mt. Pleasant Community Centre	2:10:09	7.25	418	34.8	139	12	0:49
Oak St. / W.49th Ave.	1:30:10	5.03	177	14.8	177	15	0:43
Coal Harbour Community Centre	7:50:24	15.3	746	62.2	373	31	8:00
Vancouver Aquarium	1:38:31	5.33	965	80.4	483	40	2:10
VPL Main Branch	5:22:46	9.78	746	62.2	249	21	3:39
Hillcrest Community Centre	1:47:47	6.54	2475	206.3	825	69	4:03
Beach Ave (all)	1:25:19	5.47	1004	83.7	167	14	0:39
180 Keefer St.	1:40:10	5.143	471	39.3	236	20	1:04
Overall Average	**3:06:16**	**8.19**	**1418**	**118.17**	**575**	**48**	**4:44**
Overall Total			**17,016**				

5. Framework for Rate-Setting

The introduction of user fees will follow the City's model set out in the December 2016 *Parking Meter Bylaw* update. This framework is data-driven, and allows for adjustments to pricing based on a pre-determined objective for occupancy / availability. With respect to charging infrastructure, little is known on consumers' sensitivity to pricing, as few jurisdictions have introduced user fees to-date. Vancouver has significantly higher rates of use (and therefore of congestion) compared to many jurisdictions.

Generally, public understanding of energy consumption is quite low. Based on consultation with other local governments and thought leaders in this field, it was determined that a time-based system of user fees was simpler to integrate into existing parking regimes; and, was more likely to be understood by users. Further, pricing by time ensures an incentive for turnover, as public charging stations will continue to accumulate costs to a user's account; an energy-based system would cease to charge fees once a battery became completely charged.

Due to variations between vehicles, some EVs will obtain less energy over a given charging time than others, giving rise to concerns about equity between users. However, this disparity is not dissimilar from conventional fossil-fueled vehicles, whereby vehicles with poorer fuel economy derive less range per dollar spent compared with more fuel efficient models. Access to the infrastructure is arguably the value proposition behind introducing user fees. Therefore, that access, measured over time, appears the simplest method to ensure fairness.

Rates will be set as follows:

- Price per hour continuously while vehicles are connected
    - In some locations, this will likely be accompanied by an enforced upper limit on parking time.
    - For DC Fast Charge stations, this will be presented as a price-per-minute
- Structured as an 'add-on' to parking fees in a given lot or zone
- Correlated roughly to the power provided
- Tiered such that the charging stations providing the most range per hour will be the most expensive, and all public charging locations will be more expensive than residential electricity rates
- Fees for charging (not including the local parking rate) will be significantly lower than the equivalent fossil fuel costs.

6. Introductory Rates

The City will introduce the following rates, with adjustments expected as user sensitivity to pricing is better understood. The following introductory rates are additional to the parking rate at a given location, although the two fees will likely be collected at the charging station.

- AC Level 2: $2.00/hr
- DC Fast Charging (50kW): $16/hr.

7. Profit-Loss Expectations / Cost-Revenue

All public charging stations have both fixed and variable operating costs, as follows:

Fixed costs:

- Equipment lease or interest on capital investment
- Network services

- Utility basic charges
- Rate rider

Variable costs:

- Utility charges (electricity usage)
- Demand charges
- Transaction fees (network charge)

In order to be remotely monitored and collect payments, a fixed network fee is charged by a third-party operator that provides a cellular data connection to the charger. In addition, BC Hydro rates include a fixed daily charge. Operating costs include the cost of electricity, transaction charges from network providers, and demand charges[1]. It is expected that the introduction of user fees will cover the operating costs of EV charging infrastructure. It is also expected that a 5 year return-on-investment is possible even with a modest decrease in utilization. Because few jurisdictions in North America have implemented pricing for the purposes of easing congestion, projections will be challenging prior to implementing the program.

[1] As of April 1, 2017, BC Hydro now includes a demand charge for all medium and large site accounts (previously, only peak consumption over a specific threshold triggered demand charges).

Typical Cost-Revenue for a Level 2 (~7kW) charging station is provided in the table below.

Table 2 - Proposed Initial Profit-Loss Calculations for a Level 2 EVSE

Item	Unit Qty.	Per Session	Monthly
Typical Session Energy (kWh)		**8**	
Installed Capacity (kW)	**6.65**		
# Sessions	**-**	**1**	**125**
Usage Length (regardless of energy consumption) (hours)	**3**	**3**	**375**
Fixed			
Capital cost	**$4,500**		
Labour & Installation	**$2,500**		
Annual Network Fee	**$225**		**$18.75**
Basic Daily Utility Charge	**$0.2429**		**$7.39**
Annual Maintenance	**$200.00**		**$16.67**
Variable			
Electricity Cost ($/kWh)	**0.0880**	**$0.70**	**$88.00**
Demand Charge ($/kW)	**4.92**		**$32.72**
Rate Rider	**5%**		**$6.41**
Swipe Transaction Fee ($/txn)	**0.91**	**0.91**	**$113.75**
Total Variable Costs		**$1.61**	**$240.87**
Total Operating Costs			**$283.68**
User Fees Revenue	**$2.00**	**$6.00**	**$750.00**
Net Revenue over operating			**$466.32**
Annual Revenue over operating			**$5,595.86**
Simple Payback (yrs)			1.251

Overall, revenues for a Level 2 station could be as high as $750 per month, based on current usage rates. However, it is expected that this will be lower in practice. From a consumer perspective, $2.00/hour translates into about $0.30 per kWh, or the approximate equivalent energy as $0.46 per L of gasoline[2].

[2] Estimates of electricity vs. gasoline fuels' price equivalency are highly imprecise due to broad differences in vehicle efficiency between EVs and fossil-fueled vehicles. An EV can go approximately nine times further per unit of energy compared with a similar fossil fueled vehicle. As the two fuels themselves cannot be easily compared (electricity does not have a physical volume to be priced by), comparisons rely on estimated range per dollar of fuel purchased.

Table 3 - Proposed Initial Profit-Loss Calculations for a DC Fast Charging Station

Item	Unit Qty.	Per Session	Monthly
Typical Session Energy (kWh)		**25**	
Installed Capacity (kW)	**50**		
# Sessions	**-**	**1**	**125**
Usage Length (regardless of energy consumption) (hours)	**0.5**	**0.5**	**62.5**
Fixed Costs			
Capital cost	**$40,000**		
Labour & Installation	**$50,000**		
Annual Network Fee	**$225**		**$18.75**
Basic Daily Utility Charge	**$0.2429**		**$7.39**
Annual Maintenance	**$200.00**		**$16.67**
Variable			
Electricity Cost ($/kWh)	**0.0880**	**$2.20**	**$275.00**
Demand Charge ($/kW)	**4.92**		**$246.00**
Rate Rider	**5%**		**$26.42**
Swipe Transaction Fee ($/txn)	**0.91**	**0.91**	**$113.75**
Total Variable Costs		**$3.11**	**$661.17**
Total Operating Costs			**$703.97**
User Fees Revenue	**$16.00**	**$8.00**	**$1,000.00**
Net Revenue over operating			**$296.03**
Annual Revenue over operating			**$3,552.31**
Simple Payback (yrs)			25.336

The above table provides a sample calculation of the costs and revenues from a DC Fast Charging Station. Note that the simple payback period is significant. However, this assumes an initial usage of approximately 125 sessions per month. As EV adoption grows, it is likely that more than 300 sessions per month would occur, significantly reducing the payback period.

As the primary goal of the User Fees program is to create turnover, but also to ensure that electricity remains a significantly less expensive option, an hourly rate of $16.00 is proposed. From a consumer perspective, this translates into an approximately $0.50/L gasoline price.

8. Adjustments

Rate adjustments will be controlled through a similar methodology to the supply and demand based system applied to parking meters under the *Parking Meter Bylaw*. This is a data-driven system that sets rates to maintain a target occupancy/vacancy in a given area. When the number of vacant parking stalls is too low, parking rates are increased to create turnover and availability; when the number of vacant parking stalls is higher than targeted, parking rates are

reduced to increase demand for those stalls. A similar approach can easily be taken with EV charging, since networked stations are able to track their own availability and use.

Parking meter rates are adjusted based on the Peak Daytime Curbside Occupancy Rate over a calendar year, with adjustments occurring in the following calendar year. The Peak Daytime Curbside Occupancy Rate is defined as "the ratio of the number of occupied spaces on a block during the hours of 9:00 am to 6:00 pm to the total number of spaces on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year."

In the case of EV charging infrastructure, different target occupancies and availabilities are proposed initially because the sensitivity of consumers to price changes is unknown, and the relative availability of public infrastructure is quite low compared to that of metered parking stalls. Additionally, rate adjustments are recommended on a semi-annual basis for the first two years following the introduction of user fees.

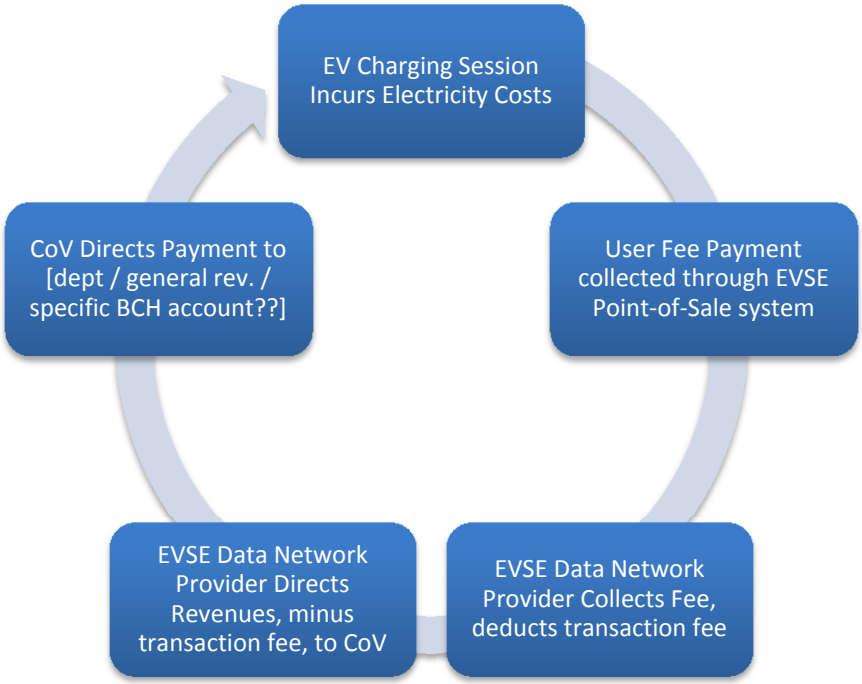
9. Use of Revenues

Two separate arrangements currently exist for electricity costs associated with EV charging stations on City properties.

1. EV infrastructure connected to an electrical panel that supports other loads and is not metered separately from other loads.
2. EV infrastructure is on a separate electrical panel that has a dedicated BC Hydro meter that bills only for EV charging loads.

A project to retrofit all locations captured under 1., above, is presently underway. However, it is anticipated that at some locations, installation of a separate BC Hydro meter may not be possible. In such scenarios, a revenue-grade submeter, as specified by Real Estate and Facilities Management, will be installed to determine the EV infrastructure-specific loads.

Under any of the above scenarios, the intended use of EV infrastructure revenues will be first to ensure cost recovery to the sites or departments responsible for them.



In the case of pay parking lots (i.e. – off-street parking), parking fees will be rolled into fees charged at the charging station, to avoid users needing to pay at multiple locations (i.e. – once at the charger, again at a payment kiosk). In such situations, the portion of revenues from EV charging stations equivalent to the parking rate will be directed back to the parking management company by the City.

10. User Fee Program Responsibilities

Department	Role
Sustainability	• Develop policy for User Fees and Oversee Implementation
Engineering	• Integrate EV Infrastructure User Fees Into Parking Management Policies, Consult with Sustainability on fee adjustments for two years following implementation • Quarterly and annual reporting to BCUC under S.71 of the Utilities Commission Act, supported by SUS • Direct payments to Easypark for portion of revenues equivalent to parking rates.
REFM Energy Management	• Manage Utility bills associated with EV charging
Finance	• Ensure flow of revenues to appropriate departments / accounts
EVSE Network Provider	• Provide monitoring data and remit revenues to CoV
Parking Enforcement (Internal to CoV or Easypark)	• Ensure that time limits at all EV infrastructure are enforced, and the any parking stalls associated with EV infrastructure are used only for that purpose.

A By-Law to amend

Parking Meter By-law No. 2952

regarding electric vehicle charging stations

THE COUNCIL OF THE CITY OF VANCOUVER, in public meeting, enacts as follows:

1. This by-law amends the indicated provisions of the Parking Meter By-law No.2952
2. In Section 2, Council inserts the following definitions in correct alphabetical order:

"Direct Current Fast Charging Station" or "DCFC" is a battery charging station equipment that transfers electric energy (by conductive or inductive means) to a battery or other energy storage device in an electric vehicle, is publicly available and that has a nominal power output of at least 24kW.

"Electric Vehicle" means any vehicle that operates, either partially or exclusively, on electrical energy from an off-board source, that is stored on-board for motive purpose; but, for the purposes of this by-law, does not include vehicles that cannot be licensed by the Insurance Corporation of British Columbia.

"Electric Vehicle Charging Station" means a Direct Current Fast Charging Station or a Level 2 Charging Station.

"Electric Vehicle Parking Space" means any marked parking space that identifies the use to be exclusively for the parking of an electric vehicle. Electric vehicle parking spaces may or may not be situated adjacent to an Electric Vehicle Charging Station.

"Interim Maximum Daytime Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations during the hours of 9:00am and 6:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City over a 30 day period.

"Interim Maximum Evening Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations during the hours of 6:00pm and 10:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City over a 30 day period.

"Interim Maximum Overnight Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations during the hours of 10:00pm and 9:00am to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City over a 30 day period.

"Level 2 Charging Station" is a battery charging station equipment that has as its primary purpose the transfer of electric energy (by conductive or inductive means) to a battery or other energy storage device in an electric vehicle, is publicly owned and publicly available or privately owned and publicly available and that has a nominal power output between 4kW and 15kW.

"Maximum Daytime Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations on a block during the hours of 9:00am and 6:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year.

"Maximum Evening Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations on a block during the hours of 6:00pm and 10:00pm to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year.

"Maximum Overnight Charging Station Occupancy" is the ratio of occupied Electric Vehicle Charging Stations on a block during the hours of 10:00pm and 9:00am to the total number of Electric Vehicle Charging Stations on a block, expressed as a percentage that is calculated based on all data collected by the City throughout the calendar year.

"RFID EV network card" is a card provided by a data network operator of Electric Vehicle Charging Stations on a block that activates an Electric Vehicle Charging station through radio frequency identification technology for the purposes of providing electricity to an electric vehicle and collecting payments.

3. In Section 2, Council strikes the definition of "Parking Meter" and replaces it with:

   "Parking Meter" means a parking meter stand and the single or double parking meter head that it supports or an Electric Vehicle Charging Station.

4. In Section 2, Council adds a new subsection (8) to the definition of a "Metered Space" as follows:

   (8) in the case of an Electric Vehicle Charging Station any lawful parking space on a street between the curb adjacent to the roadway and an imaginary line on the roadway parallel to and 2.5 meters from the curb in an area marked as an Electric Vehicle Parking Space.

5. In Section 5 (1), Council adds the following new subsections:

   (g) in the case of an Electric Vehicle Charging Station designed to accept payments via a network subscription, tap the appropriate RFID EV network card on the appropriate part of the Electric Vehicle Charging Station and connect the electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session;

   (h) in the case of an Electric Vehicle Charging Station designed to accept payments via a smartphone application, use the smartphone application appropriate to the Electric Vehicle Charging Station and connect the electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session;

   (i) in the case of an Electric Vehicle Charging Station designed to accept payments via an RFID-enabled credit card, tap the credit card on the appropriate part of the Electric Vehicle Charging Station and connect the

electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session; or

(j) in the case of an Electric Vehicle Charging Station designed to accept credit card payments by phone, call the phone number printed on the Electric Vehicle Charging Station and provide the appropriate details to initiate a session, and connect the electric vehicle to the Electric Vehicle Charging Station via conductive or inductive means to initiate a charging session.

6. In Section 5(2), Council adds the following new subsection:

(d) the time recorded on the Electric Vehicle Charging Station

7. In Section 5A, Council adds the following new subsections

(13) The initial metered rates for all Level 2 Charging Stations in an existing meter zone shall, prior to adjustment in accordance with this section 5A, be the metered rate for that block plus an additional $2.00 per hour.

(14) The initial metered rates for all Level 2 Charging Stations not in an existing meter zone shall, prior to adjustment in accordance with this section 5A, be $2.00 per hour.

(15) The initial metered rates for all Direct Current Fast Charging Stations in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be the metered rate for that block plus an additional $16.00 per hour.

(16) The initial metered rates for all Direct Current Fast Charging Stations not in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be $16.00 per hour.

(17) The initial metered rates for Direct Current Fast Charging Stations with nominal power outputs greater or less than 50kW in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be the metered rate for that block plus an amount calculated proportionally to the hourly rate of the nearest existing Direct Current Fast Charging Station as follows:

$$(R_{Near}) \times \left(\frac{P_{New}}{P_{Near}}\right) = R_{New}$$

Where

R_{Near} = Hourly Meter Rate of Nearest DCFC ($)

P_{New}= Power Output of New DCFC (kW)

P_{Near} = Power Output of Nearest DCFC (kW)

R_{New} = Hourly Meter Rate of New DCFC ($)

(18) The initial metered rates for Direct Current Fast Charging Stations with nominal power outputs greater or less than 50kW not in an existing meter zone shall, prior to adjustment in accordance with this Section 5A, be an amount calculated in accordance with the formula set out in subsection 5A(17) above without the metered rate.

(19) If the Maximum Daytime Charging Station Occupancy on a block exceeds 75% in a calendar year, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm for the subsequent calendar year shall be increased by $1.00 per hour no later than March 1 of that year.

(20) If the Maximum Daytime Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm for the subsequent calendar year shall be decreased by $1.00 per hour by no later than March 1 of that year provided that the rate shall not be less than the metered rate for that block.

(21) If the Maximum Daytime Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm for the subsequent calendar year shall be decreased by $1.00 per hour by no later than March 1 of that year provided that the rate shall not be less than $1.00 per hour.

(22) If the Maximum Evening Charging Station Occupancy on a block exceeds 75% in a calendar year, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm for the subsequent calendar year shall be increased by $1.00 per hour no later than March 1 of that year.

(23) If the Maximum Evening Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than the metered rate for that block.

(24) If the Maximum Evening Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than $1.00 per hour.

(25) If the Maximum Overnight Charging Station Occupancy on a block exceeds 75% in a calendar year, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am for the subsequent calendar year shall be increased by $1.00 per hour no later than March 1 of that year.

(26) If the Maximum Overnight Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than the metered rate for that block.

(27) If the Maximum Overnight Charging Station Occupancy on a block is less than 40% in a calendar year, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am for the subsequent calendar year shall be decreased by $1.00 per hour no later than March 1 of that year provided that the rate shall not be less than $1.00 per hour.

(28) If the Interim Maximum Daytime Charging Station Occupancy is more than 75%, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm shall be increased by $1.00 per hour.

(29) If the Interim Maximum Daytime Charging Station Occupancy is less than 40%, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm shall be decreased by $1.00 per hour provided that the rate shall not be less than the metered rate for that block.

(30) If the Interim Maximum Daytime Charging Station Occupancy is less than 40%, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 9am and 6pm shall be decreased by $1.00 per hour provided that the rate shall not be less than $1.00 per hour.

(31) If the Interim Maximum Evening Charging Station Occupancy is greater than 75% then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm shall be increased by $1.00 per hour.

(32) If the Interim Maximum Evening Charging Station Occupancy is less than 40%, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm shall be decreased by $1.00 per hour provided that the rate shall not be less than the metered rate for that block.

(33) If the Interim Maximum Evening Charging Station Occupancy is less than 40%, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 6pm and 10pm shall be decreased by $1.00 per hour provided that the rate shall not be less than $1.00 per hour.

(34) If the Interim Maximum Overnight Charging Station Occupancy is greater than 75% then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am shall be increased by $1.00 per hour.

(35) If the Interim Maximum Overnight Charging Station Occupancy is less than 40%, and that block is an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am shall be decreased by $1.00 per hour provided that the rate shall not be less than the metered rate for that block.

(36) If the Interim Maximum Overnight Charging Station Occupancy is less than 40%, and that block is not an existing meter zone, then the metered rate for Electric Vehicle Charging Stations on that block between 10pm and 9am shall be decreased by $1.00 per hour provided that the rate shall not be less than $1.00 per hour.

Appendix 6

2016 MEASUREMENT CANADA INFORMATION BULLETIN

Government of Canada Gouvernement du Canada

Electric vehicle charging stations

Electric vehicle charging stations allow consumers to charge their electric car by buying electricity. Various levels of government and private industry organizations have started to install these stations to invest in clean technologies.

Many of these charging stations use measurement systems that involve new technologies. These new technologies must comply with different federal measurement laws depending on how the electricity is sold.

Electricity sold on the basis of time

Charging stations that are only intended to sell prepaid energy on the basis of time must:

- charge the customer for time within the limits of error set in the Weight and Measures Act
- state the price per unit of time

Electricity sold on the basis of energy

Charging stations that sell electricity on the basis of energy (kWh) or time-related demand (kW) are considered meters. This means that device owners must:

- use defined units of measurement
- make sure the meter type is approved by Measurement Canada
- find an authorized service provider to inspect a new meter before using it and to reinspect the meter periodically
- make sure the meter is sealed properly
- register as a contractor to sell electricity

Date modified:

2017-06-19