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Proceeding name: BCUC Regulation of Electric Vehicle Charging Service Inquiry

Are you currently registered as an intervener or interested party: No

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Comment:
I have a personal interest in electric vehicle adoption and an extensive background in the area over the past 15 years including: CSA Canadian Electric Code Section 86 Electric Vehicles sub-committee member. CSA Canadian Electric Code Part 2 Standard 280-16 EVSE committee member. NRCan ZEV Strategy expert working group member for infrastructure and Codes, standards and Regulations Technical Safety BC working group on EV Energy Management member Sr. EV Specialist AES Engineering Member, past president Vancouver Electric Vehicle Association. EV Owner since 2008 The attached letter / report summarizes my knowledge of the major regulatory obstacles to EV adoption in BC. Without addressing these obstacles, determining a rate or degree of regulation of EV energy provision would be insignificant. The report includes an exploration of a number of regulatory problems, attempted solutions and outstanding issues, and recommendations.

Regulatory Obstacles to EV Adoption

2018-3-31
Don Chandler

Executive Summary

NRCan support for overcoming regulatory obstacles helps to put more EVs on the road. EVs replacing internal combustion engine vehicles significantly reduce GHGs.

This paper describes as a background, many of the regulatory obstacles to EV adoption, how they interrelate, and how they have been addressed to date. Approaches taken for limited speed (electric) vehicles are an example that would facilitate new technology adoption that harmonizes charging infrastructure that may be required by building codes or zoning by-laws, and restricted by utilities, strata, landlord and tenant, measurement, and safety governance, administered by local authorities, and secured by protocols. Regulations, standards, codes, and protocols discussed that relate to electric vehicle infrastructure directly or indirectly include: Vehicle Safety Act and Regulations, Society of Automotive Engineers standard J1772, National Building Code as adopted by provinces, Utilities Commission Act, Strata Property Act, Landlord and Tenant Act, Measurement Canada, Local Government Acts, local zoning by-laws, Safety Act and Canadian Electrical Code, and communications protocols.

In particular the challenges of gaining regulatory acceptance of enabling new technology are the main focus. A small BC start-up has developed and patented Variablegrid; an Electric Vehicle Energy Management System (EVEMS). In addition, associated Electric Vehicle Supply Equipment (EVSE); has also been developed. To comply with the Canadian Electrical Code (CEC) the EVEMS and the EVSE must have an approval or certification label, which requires rigorous testing by an independent recognized laboratory, or it must be acceptable to the Authority Having Jurisdiction (AHJ). As this is innovative and newly developed technology, there are no applicable testing standards in place for either the EVEMS or the management aspects of the EVSE. This report documents the many challenges encountered as a result.

Introduction

The public cannot use an EV if they can't charge it. Corollary: If there were no gas stations there would be no gas powered cars. Charging infrastructure is a prerequisite to EV adoption.

Electric Vehicle Supply Equipment (EVSE) is needed primarily in residential buildings where the vast majority of charging should occur overnight.
The overarching goal is to enable charging in every residential parking stall and along major highways. However to achieve this a number of interdependent regulations, standards and codes need to be changed. These are identified below with a focus on the specific need to overcome the obstacles to develop and certify an Electric Vehicle Energy Management System (EVEMS). A description of events shows how some of these obstacles were overcome.

Background

A number of regulations, codes, and standards are involved to enable EV infrastructure. A history of EV related standards is here: https://etecmc10.vub.ac.be/publications/2008VandenBossche237.pdf . The discussion that follows is organized primarily around these but overlap is involved also. Most of these interact and ultimately have an impact on product design and certification. An overview of EV related codes and standards is here: http://www.energy.ca.gov/papers/98-09-23_KATELEY.PDF , but not other important restrictive regulations is: CSA_Group_Electric_Vehicle_White_Paper_NA_PrV.pdf

Transport Canada Vehicle Safety Act (TCVSA)

TCVSA governs cars while driving, but not while parked and charging. Changes to the Motor Vehicle Safety Act in 2000 enabled Limited Speed Vehicles that were electric to be sold in Canada. Provincial Acts were also modified to permit them on specific roads and local government by-laws were modified to permit them on specific streets. As these charged on 120V 15A regular shared outlets, no further infrastructure was needed.

At the same time, individuals were modifying approved vehicles by converting them to EVs. Although Transport Canada did not have provision to allow these, provinces did have regulations for modified vehicles with an inspection process in place. This allowed individuals to build conversions and develop technology which would eventually influence the major OEMs. An example of this approach is AC Propulsion who acquired technology from Aerovironment and modified a Toyota to create the eBox conversion which they marketed in limited quantities. Tesla acquired this technology and eventually developed a conversion of the Lotus as their first product (the Tesla Roadster), borrowing the same eBox technology. Azure Dynamics in BC also modified Ford vehicles as a small start-up company. Electric Auto Sports (http://www.easpower.com) converted a number of vehicles to electric before shifting to battery importing and distribution which was more lucrative. They have recently returned to conversions working on electric bus designs for two Canadian companies. Having failed to gain government support, these conversions are being funded privately.

Canadian Electric Vehicles (eee.CANev.com) started out by building a number of conversions and providing kits of parts to individuals. They now have a very successful business building small tractors and tugs, airport support vehicles and other similar LSVs. Other LSV companies also started up including Dynasty (IT), ZENN, and Corbin (Sparrow) (eventually sold to Myers).

Since 2011 OEMs have built EVs with mostly level 2 40A chargers on board and one of 3 DCFC ports. The worldwide SAE J1772 standard for Level 1 and 2 charge ports has been a great help in facilitating EV adoption.

For an EV’s battery pack and electrical interface, no such worldwide standard has yet been defined.

Direct Current Fast Charger (DCFC)

The Society of Automotive Engineers (SAE) defines AC Level 1, AC Level 2, and AC Level 3 (unused as yet) charging rates and connectors. It also defines DC Level 1 (not used in North America), DC Level 2 (DCFC), and DC Level 3 (Superchargers). SAE, Japan Automobile Research Institute (JARI), and Tesla are each promoting different DCFC standards. A Part 2 standard for DCFC is under development and SAE J1772 has been updated to include DC charging. While a number of American and International manufacturers have DCFCs available, only one Canadian company (Flo) has developed a DCFC station.

An CSA standard for inductive charging has been developed, with the committee chaired by UBC staff.

National Building Code (NBC)

The NRC model National Building Code and National Energy Code for Buildings scope is limited to safety, health, structure, energy and accessibility, but does not include policy. Therefore, mandating EV infrastructure in the building code is inappropriate and the NBC does not help address the primary goal of enabling charging. (https://www.scribd.com/document/367955704/A-Comparison-of-the-Use-of-Building-Zoning-Codes-to-Regulate-EV-Infrast-2017-Update) Provinces that adopt the National Building Code may modify it as Ontario has done recently. (http://www.mah.gov.on.ca/Page18687.aspx?DateTime=636493708200000000&PageMode=View see also CodeNews Issue 260 that updates the objectives March 8, 2018) BC has provided a bulletin indicating that the building code has no interest in EV infrastructure, enabling municipalities to introduce by-laws to govern EV infrastructure if other Acts do not restrict it. (https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/bulletins/ba_information_bulletin_ba16-01.pdf) The city of Vancouver, under the Vancouver Charter, developed a building by-law in 2008 and 2009 for EV infrastructure which has set an example that other jurisdictions have attempted to use for EV policy.

Utilities Commission Act (UCA)
The UCA governs reselling of electricity. Municipalities and tenants are exempted and special exemptions are also possible.
Utilities normally deliver power to properties at the meter located near the property line, not to cars directly. Rate applications for EV loads are now under consideration.

Strata Property Act (SPA)
The SPA requires super majority approval to make a significant change to the appearance of common property such as to upgrade a building for EVSEs. As such, early adopters are very challenged to get the support of their neighbours to install EV infrastructure in shared property. Individuals do not have the right to charge a car and many (non EV-owning) condominium dwellers are resistant, often due to cost concerns. Some jurisdictions in the US have implemented right to charge legislation (Hawaii, California, Colorado), but the costs are still prohibitive for early adopters. There are no code or standard requirements to encourage efficient designs of wiring for the charging of EVs in Multi Unit Residential Buildings (MURBs).

Landlord and Tenant Act (LTA)

The LTA governs relationships, not policy over non-essential services. Plumbing (connection to a sewage system if the local government has one and a potable water source) is considered an essential services for health reasons, but EV infrastructure is not. Landlords are not required to provide non-essential services.

Measurement Canada (MC)

MC governs measurement of electricity for sale but it is not a means for policy. Meters used for the sale of electricity must be certified as revenue grade.

Local Government Act (LGA)

The **LGA** does not specifically delegate EV charging to local governments through zoning and parking standards.   In BC, parking stall size, surfacing, and electrical lighting is legislated along with accessibility requirements, but EVs are not mentioned. A standard for parking is available from CSA but it addresses structural issues, not electric vehicle infrastructure.

Zoning

Zoning by-laws and parking standards are appropriate instruments of policy but they do not include EV infrastructure, nor are they permitted to by all Local Government Acts. Although zoning is an appropriate law to govern EV infrastructure policy, zoning normally permits only specific attributes of parking to be delegated. (ref: Jim Hindson
https://www.scribd.com/document/367956137/The-Readiness-of-North-American-Jurisdictions-for-EV-Infrast-Regs-2017
https://www.scribd.com/document/367955704/A-Comparison-of-the-Use-of-Building-Zoning-Codes-to-Regulate-EV-Infrast-2017-Update)

Canadian Electrical Code (CEC)

Electric Vehicle Supply Equipment (EVSEs) and Electric Vehicle Energy Management Systems (EVEMSs) cannot be installed unless they meet the electrical code. The CEC is adopted in each province with modifications at the discretion of each province. The model code requires that all electrical equipment be acceptable to the Authority Having Jurisdiction (AHJ) which is normally determined by testing to an appropriate standard as indicated by a label. Where standards exist in Part 2 of the electrical code, they are used. If they are not available, then inspectors may accept custom equipment as a deviation under special permission. (CEC Rule 2-030)

Electrical Code Parts 1, 2, and 3 are all involved but very separate. They govern the safety of how to install wiring, but do not mandate it. Part 1 applies to building wiring. Part 2 applies to electrical equipment and appliances. Part 3 applies to Utilities who are concerned with grid loads and sizing transformers appropriately without undue cost given rate restrictions. EVEMSs are electrical equipment that manage EV loads within a building, but not at the grid level, yet they may impact the grid. Until now, Part 1 of the electric code permitted only dedicated or switched circuits (CEC Rule 86-300 (2), not load management. With the 2018 code, load management is permitted, but a Part 2 standard for EVEMSs is still lacking.
An overview of all EV related codes and standards is available in a white paper from CSA: CSA_Group_Electric_Vehicle_White_Paper_NA_PrV.pdf

Current CEC language

The 2015 code now in effect in BC allows for switching loads on a branch circuit in Section 86-300 (2). Only one load may draw power at any one time.

“ 86-300 Branch circuits (see Appendix B)

(1) Electric vehicle supply equipment shall be supplied by a separate branch circuit that supplies no other loads except ventilation equipment intended for use with the electric vehicle supply equipment.

(2) Notwithstanding Sub-rule (1), electric vehicle supply equipment shall be permitted to be supplied from a branch circuit supplying another load(s), provided that control equipment prevents simultaneous operation of the electric vehicle supply equipment with other circuit loads such that the calculated demand of the circuit is not exceeded.

(3) For the purposes of Sub-rule (2), the calculated demand shall be determined in accordance with Section 8. ”

Proposed CEC language
The 2018 code changes for EV infrastructure are published in the 2018 Canadian Electrical Code. The main relevant text includes the following:
“ 86-300 Branch circuits (see Appendix B)

1) Electric vehicle supply equipment shall be supplied by a separate branch circuit that supplies no other loads except ventilation equipment intended for use with the electric vehicle supply equipment.
2) Notwithstanding Sub-rule 1), electric vehicle supply equipment shall be permitted to be supplied from a branch circuit supplying another load(s), provided that an electric vehicle energy management system is installed in accordance with Sub-rule 8-106 10) or 11).
3) For the purposes of Sub-rule 2), the calculated demand shall be determined in accordance with Section 8. ”

8-106 Use of demand factors...

10) Where electric vehicle supply equipment loads are controlled by an electric vehicle energy management system, the demand load for the electric vehicle supply equipment shall be equal to the maximum load allowed by the electric vehicle energy management system.

11) For the purposes of Rules 8-200 1) a) vi), 8-202 3) d), 8-204 1) d), 8-206 1) d), 8-208 1) d), and 8-210 c), where an electric vehicle energy management system as described in Sub-rule 10) monitors the consumer’s service and feeders and controls the electric vehicle supply equipment loads in accordance with Rule 8-500, the demand load for the electric vehicle supply equipment shall not be required to be considered in the determination of the calculated load.

8-200 1) a)

vi) except as permitted by Rule 8-106 11), any electric vehicle supply equipment loads with a demand factor of 100%; plus “

“8-500 Electric vehicle energy management systems

1) Electric vehicle energy management systems shall be permitted to monitor electrical loads and to control electric vehicle supply equipment loads.

2) An electric vehicle energy management system shall not cause the load of a branch circuit, feeder, or service to exceed the requirements of Rule 8-104 5) or 6).

3) An electric vehicle energy management system shall be permitted to control electrical power by remote means. "

An explanation of these changes is the subject of a separate document included in Appendix A

Technical Safety BC (TSBC)

Although the change to Part 1 permits EVEMSs to be installed, they first must be acceptable to the AHJ. (Rule 2-024) As there is not an appropriate standard for testing EVEMS it is up to the AHJs to determine what is relevant and to check for it. To that end TSBC convened a working group to develop a bulletin to describe a process for approving EVEMSs in BC.

Communication (COM)

The Open Charge Point Protocol (OCPP) provides for communications between a network operator and EVEMSs and EVSEs but is voluntary. It can be used to relay critical peak load signals to influence loads on the grid and for gathering usage data for billing purposes or authentication signals for access.

Communications standards for EVSEs are still undergoing significant revisions and not adopted in Canada. Version 2.0 may be released in March 2018. OCPP is used throughout Europe and much of the US. Various versions of Zigbee protocols are used to communicate with meters. Other protocols such as OpenADR are used to communicate to EVEMSs in some products (Flo).

Problems

Problems arising from the situations described in the background above are discussed here.

Transport Canada Vehicle Safety Act (TCVSA)

As major OEMs were not developing EVs circa 2000, a few small companies were trying to enter the market with their own EVs. The certification and crash testing requirements for these were overwhelming and costly for small innovative companies. Attempts to develop EVs with ground up designs were made by Toronto Hydro, Future Vehicles, and Azure Dynamics. Dynasty was sold to a Pakistani company (https://en.wikipedia.org/wiki/Dynasty_IT), ZENN failed. (https://en.wikipedia.org/wiki/ZENN) (http://www.hybridcars.com/closure-of-service-support-for-zenn-vehicles/) The last ZENN EV in Canada was used in the testing lab of a battery management technology company (a spinoff of Ballard) which sold to Chinese interests that benefited from government support: the EV was recently crushed.

The certification and crash testing requirements for highway capable EVs were overwhelming and costly for a small innovative company. Attempts to develop EVs using ground-up designs were made by Toronto Electric (http://www.torontoelectric.com/innovation/toronto-electric-innovation/), Future Vehicles (https://fvtresearch.com), and Azure Dynamics (https://en.wikipedia.org/wiki/Azure_Dynamics). All of these attempts were thwarted in part by certification challenges. The dearth of support, such as the lack of funding for conversions and minimum funding limits, for early innovation by small start-up companies has led to many entrepreneurial failures. NRCan funding has high entry costs that require matching funding beyond the capability of many start-ups. Only the SR&ED Tax Credit program supports the very early concept stages of development prior to FEED stages.

Battery standards for interchangeability have not been developed which prevents a 'universal' battery pack to be developed or sold by non-OEM aftermarket suppliers. As battery technology is still evolving rapidly it may be too early to standardize. However, an eventual standard for both electrical and form factor would permit aftermarket suppliers to develop a more universal battery module to reduce costs and facilitate battery swapping.

Three phase supply for AC charging, if standardized, might also address power quality concerns resulting from significant load phase imbalances in larger vehicles such as trucks and buses.

Direct Current Fast Charger (DCFC)

Three standards, three levels, different supply voltages and power creates problems.
Tesla, and some provinces have installed Level 2 DCFC stations with three different standards in some locations, but not sufficient numbers to enable travel on all roads that ICE cars can travel. Hence this remains an obstacle. Level 3 DCFC (superchargers) are now emerging which requires yet another different connector. Unfortunately DCFC designers have not settled on a uniform standard, and this is impeding adoption. When one standard for fast charging evolves, stranded assets of the alternates will result and both DCFC stations and EVs that use losing standards will become obsolete. Three standards for one of the three levels for different supply voltages and power create an obstacle to

adoption and this needs to be harmonized.

National Building Code (NBC)

The NBC as modified and adopted is used in some unique leading jurisdictions, but the national model code is out of scope. Although building codes may not restrict EV infrastructure from being governed by local governments, other Acts may. In particular, the Local Government Act of BC does not specifically pass jurisdiction to local governments for EV infrastructure.

However, the City of Vancouver has special jurisdictional powers grandfathered in the Vancouver Charter. This has enabled it to lead in EV infrastructure policy and use it's Building by-law to do so. This early example is leading to other jurisdictions attempting to use the Building Code or local building by-laws to copy Vancouver. Ontario's Building Code Act defines the purpose as: "to establish standards for public health and safety, fire protection, structural sufficiency, conservation, including, without limitation, energy and water conservation, and environmental integrity, and to establish barrier-free requirements, with respect to buildings; so it has implemented some EV policy there by extending the GHG Objective and Functional Statement as reported in CodeNews 260 (not yet published). This sets an example that is out of scope of the National Building Code so inappropriate for other jurisdictions without making similar changes to the purpose of the building code. It does however address harmonization by mandating uniform requirements across all local governments. Many of the problems of using the building code for EV policy are described in a paper by Jim Hindson. (https://www.scribd.com/document/367956137/The-Readiness-of-North-American-Jurisdictions-for-EV-Infrast-Regs-2017) Of note is the building code, unlike the electrical code does not include the premises, so outdoor parking spaces are not included. Also the building code does not consider the land use so a retail mall and an office building which would have different charging needs would be treated the same.

Some leading jurisdictions including Vancouver, have set policies requiring just 20% of stalls in new buildings be provided with EV infrastructure. MURB funding programs in BC are also focused on supporting a few early adopters. (https://pluginbc.ca/charging-program/charging-solutions-incentives/) As a result, very inefficient electrical designs which use up available power and do not require outlets to be distributed throughout a parkade are being implemented in a way which precludes scalability beyond 20% of stalls. If these buildings are to evolve to support all parking stalls, the initial infrastructure will likely have to be removed or modified and a complete new design developed and implemented. Much of the initial wiring and equipment will become stranded.

A letter outlining the many problems with the pioneering by-laws was sent to the city of Vancouver from the Vancouver Electric Vehicle Association (VEVA). A presentation based on this was given to a Canadian Standards Association (CSA) / Natural Resources Canada (NRCan) working group on EV codes and standards in 2015 and also presented to both the cities of Vancouver and Richmond in the spring of 2016.

The early by-laws omitted requirements for metering, and as such some buildings with infrastructure installed are not being used due to the lack of ability to meter and bill for energy used.

Cost is a major obstacle to EV adoption. In particular, the requirements for Level 2 40A dedicated circuits led to expensive installations that were not scalable. They also precluded the use of emerging load management technologies. The early by-laws omitted any performance standard by specifying a 40A installation, which is higher than needed. Future installations that use load management will need to have a minimum performance established to prevent too little power being supplied.

Utilities Commission Act (UCA)

The inability to resell power prevents private investment in EV infrastructure.

The requirement for revenue grade meters is clear, but building wiring design is more efficient with a single common meter and a means to allocate the costs. EVSE standards do not require meters, though many include them, but not of revenue grade certification due to the cost and requirements to have consumption visible to the end user. Phone apps may not be permitted to meet the visibility requirement, and this is a big obstacle to enabling EVs. EVEMSs that include metering and billing are helpful, but there are not standards to require this.

Selling to a condominium association composed of members may be interpreted as re-selling electricity rather than allocation to members. This would be a problem for EV adoption in condominiums.

Rate applications for EV loads may lead to utilities moving the boundary from the property line to the car connector. This would monopolize the EVSE industry by moving it from the private sector to the electrical utilities.

For a utility to provide or require building wiring and equipment such that a meter can be installed at every EVSE is complicated as they might only do so when an end user requires it. Very costly and inefficient designs would result from one-at-a-time installations and ultimately increase utility rates.

Strata Property Act (SPA)

Developers and condominium associations will not install EV infrastructure unless it is cost competitive, or unless a law or by-law requires it. Cities and provinces are unwilling to pass laws that require expensive additions to houses, which now have affordability issues, for EVs which are not yet dominant in sales. Price reductions depend on technology advances and on volume.

There is interplay between Strata rules, property regulations on fixtures and chattels and EVSE mounting and connecting designs and certifications. Ownership of the equipment is regulated, thus restricting some business models as common property cannot be mortgaged.

Load management designs and communication standards limit equipment suppliers to use compatible equipment within a building, thus limiting product selection by individuals. Upgrading products to evolving standards requires re-certification at significant cost. Products that include metering that is used for billing and for load management may require recertification to update billing aspects of integrated software. The integrated designs could evolve with evolving business models or end user requirements, but the costs to re-certify would be prohibitive. An example would be re-allocation of power to those who pay more. Allocation of power is a load management issue and that software would need to be certified. Nevertheless, it is also possible with the use of more sophisticated processing to separate billing and control functions to avoid re-certification when only billing/reporting functions are changed.

The Strata Property Act in BC requires a super-majority of 75% approval for changes to common property and this limits early adopters. Some jurisdictions have addressed this problem with right to charge legislation, but this violates the basic principles of shared property.

Landlord and Tenant Act (LTA)

Until EVs are prevalent, few landlords will proactively install EV infrastructure and this is an obstacle to adoption. It is similar to the challenge of strata properties that require a super majority vote to install EV infrastructure. Although electricity in BC can be re-sold to tenants, there is little motivation for a landlord to provide it. A few stalls might be wired by forward thinking landlords, but in future all stalls will need to be wired and one-at-a-time implementation becomes prohibitively expensive. EVSE networks are not always easily scalable and there are no standards to encourage this.

Measurement Canada (MC)

Electrical standards do not require meters for EVSEs EVSEs do not normally have revenue grade meters. Some have billing options but these would not necessarily meet Measurement Canada regulations. Some EVSE installations have been refused for a lack of metering options that support usage statistics required by BC Government funding programs. Applying for an exemption for each EVSE is onerous, as is certification for the metering in the EVSE. Upgrading an EVSE for billing based on revenue grade metering would also require the consumption to be visible, which is a design change requiring recertification.

Local Government Act (LGA)

It's unclear in BC if the Local Government Act permits local governments to set policies for EV infrastructure in off-street parking. This is explained in a paper by Jim Hindson. (https://www.scribd.com/document/367956137/The-Readiness-of-North-American-Jurisdictions-for-EV-Infrast-Regs-2017) The performance requirements in colder climate zones would be higher than warmer areas of a province. Wiring design is based on performance needs so unharmonized laws would be more flexible, but harmonization would need to allow for different performance standards. This would impact the electrical installation, design and possibly also the selection of EVSEs and load ratings.

Zoning

Local government by-laws are not harmonized. The lack of guidance on EV policy to smaller local governments is limiting EV development in those communities as they do not have the staff expertise and budget to develop policy without guidance. Regulations tend to drive product designs so knowing what will be required is helpful before certification of a uniform product.

Performance minimums need to be established to be sure everyone gets fully charged overnight without wasting money on excessive infrastructure.

Canadian Electrical Code (CEC)

1 The electrical code governs safety, not policy. There are only one or two instances in the electrical code where a specific receptacle is mandated. This is for a GFCI in a bathroom, and for a block heater receptacle in a driveway in the Manitoba code. Mandating outlets for EVs in the electrical code is considered out of scope. As such, this code cannot be used to achieve the goal of residential EV infrastructure.

2 Residential EV infrastructure and EV adoption is cost sensitive. The only way to reduce the cost of EV infrastructure in condominiums is to use smarter technology that makes better utilization of the electrical installation. To address this, an EVEMS and subsequently an integrated EVSE was designed in 2010 and redeveloped over a number of years to a final form in 2017. The design involves the sensing and monitoring of upstream current to control downstream equipment.

3 This approach involves components that go beyond what is normally in an uncontrolled EVSE. Due to the integration with the electrical infrastructure for control, a significant amount of testing is needed. A major portion can be done in the lab.

4 Testing and demonstration of prototype EVSEs depends on installation and connection to the grid. This requires acceptance by the AHJ which looks for approval from a test lab. This requires testing to standards which are inadequate, and often inappropriate standards are suggested which leads to unnecessary testing. This is a newly developed technology for which there are no applicable standards, so trying to find or adapt existing standards becomes very challenging, but there are no alternatives. Even acquiring the various standards to determine which to apply is a challenge. They are not available in any public libraries or even at CSA offices. To purchase all the potential standards to review them is very expensive. Such standards testing is very time consuming and expensive, often beyond the abilities of a small innovative company. This presents a major obstacle to bringing a new product from the prototype stage to full production.

5 The other aspect of developing a product is that it cannot be tested in a real-world environment without some form of certification or approval. This is not always possible as many test labs will not offer field testing when a standard exists. There is no clear path to enable the testing of prototypes in field trials for safety regulated equipment. In particular, equipment that employs functional safety components for personal protection in software that is integrated with energy management equipment has even higher costs and depends on safety hazard analysis that only the culture of large companies can afford. Using special inspections to approve early designs allows for field testing and design improvements before committing to a fixed design for production and certification.

6 In some cases equipment may be tested to a related standard that does not address the safety concerns of EV charging. Although a test lab may label such equipment, it may not be appropriate. As EVs are new technology, test labs are generally unfamiliar with the equipment or how it works. Inspectors are generally not familiar with all the hundreds of Part 2 equipment standards and as such are not in a position to evaluate the applicability of a label. Often inspectors may accept an installation with an inappropriate label. This is a safety risk which if encountered would lead to reduced EV adoption.

7 While it’s far beyond the scope of the project, the underlying problem, and a significant obstacle to enabling new innovative technology, is this: How to test a new product for which there are no applicable testing standards?

8 There is little co-ordination between electrical systems that span different parts of the Electrical Code. This is particularly evident with EV loads that are large and normally occur in conjunction with building peak loads. When a utility (Part 3) attempts to control EV loads it may compete with an EVEMS (Part 1) that is also controlling EVSE loads (Part 2) at the building level by signalling EVs (SAE) that respond to managed changes in demand load limits. An EV may also be programmed to avoid charging on grid peak load times. This conflict in triple sources of load control without coordination leads to inefficiency and higher costs.

9 A further obstacle to certification lies in the fact that the EVSE connects the grid to an otherwise ungrounded car that is not approved to safety standards. This raises the need for personal protection in the EVSE. The tests for personal protection are expensive and approved equipment is not available for installation in the EVSE as no other products require it. It is also practical to share parts (CTs) for both personal protection functions and load management and metering to reduce equipment costs but this increases testing costs. The use of software in personal protection or safety related functions such as load control adds more testing cost.

10 Standards for software are process based rather than test based. Quality assurance processes are the purview of large engineering organizations such as the military, space and government contractors and are normally not introduced to companies of less than 100 staff. The process standards developed for these systems are overwhelming for a small start-up company. Although they assure improving quality they do not necessarily guarantee a safely functioning system. Testing is still required. Cost is an obstacle for small start-up companies that cannot afford a full manufacturer site certification test program, nor do they have the culture to develop and apply process standards often used for software.

11 The above specific certification challenges were discovered through a detailed series of events which are logged separately..

12 Standards for unmanaged dedicated EVSEs exist (CSA 22.2 280.16) but it does not address inputs that dynamically reduce the maximum current based on external events, a feature that is needed for load management. As such, this function is untested and the standard is not adequate for approval of EVSEs that use that feature for load management.

13 EVSE standards need to be expanded to cover testing that works with EVEMSs as a cohesive system. Communication is a two-way street: EVSEs and EVEMSs both need standards for communications reliability and fail-safe conditions.

14 Although recent changes to the electric code allow for EVEMSs to be installed there are no EVEMS test standards that are acceptable to the Authority Having Jurisdiction (AHJ). EVEMS standards need development based on processes now being defined by Technical Safety BC such as communications failures and commissioning issues.

15 The biggest obstacle to innovation is the cost of certification and without government support, innovation is unlikely to succeed. Much innovation occurs in small start-up companies that cannot afford certification costs. Most government funding programs do not apply to the early stages of development from concept to alpha prototypes.

Technical Safety BC (TSBC)

As a member of the Technical Safety BC working group I provided the following input to TSBC on safety issues Dec 5, 2017 prior to the first meeting:

"Inspection Issues for Electric Vehicle Energy Management Systems (EVEMS)

Energy Management for EVs involves oversubscription of branch circuits or feeders, or supply or any combination of these. Simple systems share two EVSEs on a circuit, typically 40A. This goes beyond the interpretation of a dedicated circuit for the EVSE as the internals of the EVSE is not tested for load sharing under C22.2 280-16, Where a single input cord is provided to a unit and the load control is internal a circuit breaker internal to the unit will protect it. 280-16 does not require this, so inspection should confirm that Rule 8-104 (5) and 8-104(6) are addressed with an external circuit breaker.

Where two or more EVSEs share a circuit the same issue arises, except that more than one input supply may be used. These would require communications between the units with separate input supply. C22.2 280-16 does not test communications on the input so they would not be approved for load sharing or load management installations. Where this configuration is installed communications failure should result in a fail safe condition. Some EVSEs will fail safe to an 8 Amp draw which limits the number that can be configured on the circuit. A minimum operating level of 6 Amps is established by SAE J1772. If the fail safe condition exceeds the circuit capacity than the fail safe should result in reducing the load to zero. This is not tested for in 280-16 so the installation should be inspected with this check in mind. Simply interrupting the communications and observing the load change should demonstrate this issue is addressed.

When a panel is overloaded the energy management system will limit the number of EVSEs that are enabled or limit the load permitted to each one. Again, if communications to the EVEMS, which may be managed remotely, fails, then a fail safe condition should be evident. The same principles as above apply.

Communications may be remote and use wireless means. The EVEMS may also be distributed, partially in the EVSE and partially in another extra low voltage (ELV) device or in the cloud. Any possible communications failures should be checked.

A supply may also be overloaded with multiple panels. Communications in this case is the same and failures must result in a fail safe condition. This can be observed at installation when it is inspected.

When an EVEMS is commissioned it is important to identify which EVSE is operating on each circuit and panel. As circuits and panels do not communicate an EVEMS cannot determine dynamically which EVSE is on which circuit or panel. As such the assignment is established when it is installed. If an EVSE were to be moved or on a different circuit than established at installation the management would consider it to be operating on the wrong circuit and manage the load according. This could overload a circuit causing the breaker to trip and violate Rules 8-104 (5) and 8-104(6). The assignment of EVSE to circuit and panel should be labelled on each panel and each outlet or EVSE and checked when installed. Similarly an assignment between the EVSE and the owner should be established for billing purposes consistent with the utility policy and the Utilities Commission Act and Measurement Canada and the Strata Property Act or Landlord and Tenant Act. Apportioning of costs from a single revenue meter such that they do not exceed the revenue meter reported usage is appropriate.

Commissioning requires access to the EVEMS by a trained person. This is typically done by the manufacturer or the installer who is trained by the manufacturer and follows the manufacturers installation instructions. Often the EVEMS will be password protected. This password should not be accessible to an untrained person such as a property manager or end user.

Where the EVEMS monitors the supply, feeder, or circuit and controls the EVSE loads accordingly, the rating for the equipment is established during commissioning. A maximum limit that does not exceed the demand load for the circuit or feeder or the calculated load for the installation may be considered to be zero. However, it may add a rating to the calculated load if the installation has the capacity and this would be identified at installation. This rating should be reviewed at the time of inspection for consistency with the calculated or actual load and the main circuit breaker rating.

Where the EVEMS limits the maximum load by spreading the demand over a longer time, the peak load for the installation will impact the demand rating used by the utility. Even if the calculated load is not increased, if the continuous demand may exceed 60% of the maximum peak the utility should be informed to ensure the transformer is sized appropriately."

Part 2 standards are based on individual equipment and no systems standards exist that would cover Part 1, 2, 3, SAE J1772, and EVs.

Communication (COM)

There are concerns about stranded assets in an emerging technology field given one early technical leader (BLINK) failed as a company and when they closed their doors the 12450 stations were unsupported. (https://www.greentechmedia.com/articles/read/ecotality-bankruptcy-blink-ev-charging-network-changes-hands-but-not-bad-r#gs.KrVo2mc). This drove a desire for open standards that allow competing products to be controlled by alternative networks and equipment. The consequences of this failure highlight the improved lifetime of equipment that does not rely on centralized cloud communications for support. It is possible to develop control/billing equipment that is completely local to the installation and has no effect on other installations.

For technical reasons of optimizing the cost of developing and installing EV infrastructure, and the lack of open standards maturity, each manufacturer of EVEMSs has chosen to use different communication protocols. This limits the manner in which products on the market can be controlled through an open standard.

As different utilities use different versions of protocols such as Zigbee it is challenging to design, develop and certify a product to a multitude of protocols. As the communications are used for transmitting load signals and revenue, they are subject to certification.

An open protocol like OpenADR enables a utility to send pricing signals via an OCPP network server to a group of EVSE during peak load times to reduce the load and support a more efficient grid. It may also negotiate with negawatt generators for a price incentive. This can reduce the daily operational costs to the end users. However, this also reduces the time available to charge at a maximum rate, such that more infrastructure is needed to charge during the reduced time. An EVEMS can do an excellent job of managing EV loads in a building and presenting a flat load profile back to the grid which helps to support a more efficient grid. It also optimizes the use of a minimal building infrastructure. However, if the utility attempts to send out Time of Use price signals in an attempt to manage the grid load, users wishing to take advantage of lower energy costs would have to build bigger and more expensive infrastructure so they could later on charge in a shorter time. This higher up-front cost is an obstacle and somewhat unnecessary as an EVEMS can present a flat load profile to the grid eliminating the need for grid level management. The trade-off is between higher infrastructure costs and operational incentives (or lower infrastructure costs and no operational benefits). A blend of these two approaches is also possible and the optimal solution is likely dependent on the specific building's electrical infrastructure and operational use patterns.

Solutions

The following descriptions outline the experience that has been acquired and the achievements and obstacles encountered along the way, while attempting solutions These events have culminated in many obstacles being removed or partially addressed, some with government support, some by volunteer effort only, yet they still leave some overwhelming obstacles for which further government support is needed.

Transport Canada Vehicle Safety Act (TCVSA)

Limited Speed Vehicle (LSV) regulations were introduced in 2000 and implemented provincially is some provinces and municipalities. These EVs had reduced safety requirements with the intent of allowing small companies to enter the market with emerging products and avoid the expensive challenges of full crash testing and other safety measures such as air bags. Three Canadian companies were established using these regulations to sell LSVs in Canada: CanEV, Dynasty, and ZENN. CanEV survives today and has sold well over 100 LSVs. With recent rebates being extended to special purpose vehicles in BC their business is flourishing.

This experience is an example that could serve as a model for EVSE and EVEMS manufacturers entering the market.

More recently Electrameccanica in BC (electrameccanica.com) bought the assets of Myers (previously Corbin Sparrow) LSVs and used it as a mule to develop a highway capable EV. With a more extensive auto racing background and private funding they achieved full crash tested certification for the production version, the 3 wheeled single-occupant SOLO. This consumed significant resources of the owner without government assistance. They now have many pre-orders and are starting offshore production. (https://www.design-engineering.com/features/solo-peoples-ev/)

Recently Transport Canada has initiated a ZEV Strategy Planning activity that is hoping to identify many of the obstacles to EV adoption and address them.

Direct Current Fast Charger (DCFC)

BC has piloted and tested a number of DCFC stations at Powertech Labs and BCIT, AddEnergie developed DCFC stations in Canada.
J1772 has been updated to 48A maximum; DC charging is now integrated into the standard.
Wireless charging safety standards (C22.2 No.317 and CAN/CSA-E61980-1 are undergoing development and prototype products are at UBC. SAE J2750 is also undergoing development.
60 DCFC stations are in place or under construction. In order to gain acceptance of the product, UBC researchers chaired the committee to write the standard for CSA.

BC is now considering extending public charging on all transportation corridors – a map has been developed by VEVA member Kelly Carmichael who developed the EVInfrastructure tool on his own with minimal remuneration from government users. It was Beta tested by volunteer Don Chandler, creating example maps for needed infrastructure on corridors. It is now being used by more planning projects with minor reimbursement. Federal funding for DCFC infrastructure on corridors would benefit from supporting the use of this tool.

More urban DCFC stations are being installed which allows for residents to 'top up' locally and allows for a lower performance charging policy in residential parking. Even public Level 2 stations at community centres and commercial staff parking locations reduce the demand on residential designs enabling a more cost-effective performance standard in local regions that also have publicly available DCFC stations installed.

The Canadian company Flo has developed a DCFC with significant government and utility support for both development and demonstration projects. They are flourishing. Smaller entrepreneurial EVSE manufacturer start-ups are struggling.

National Building Code (NBC)

The building code was used in leading jurisdictions including the City of Vancouver (CoV), Ontario and Quebec , but out of scope nationally. Ontario has placed some policy requirements in their building code and others to be permitted in zoning by-laws.

The CoV building by-law for EVs is now being moved to the Parking by-law and includes 100% of residential parking. This was approved by council on March 14, 2018 and now posted in the meeting agenda and reports.

Utilities Commission Act (UCA)

Under the Utilities Commission Act (with a few exceptions) only a public utility can sell electricity and this is an obstacle to private investment in EVSE installation. However, it is acknowledged by the Utilities Commission that it will not stop stratas from implementing EV infrastructure and BC Hydro has indicated they will consent if no profit is made in the allocating of electricity costs to strata members. A legal opinion on the validity of this is needed, which will affect future designs for EVSEs in shared parking spaces. Further, this will clarify the need for revenue grade metering in EVSEs and the associated need for certification. The PlugInBC.com website provides some example strata by-laws that allocate electricity costs to owners.

A Fortis rate application has triggered a broader investigation of EV Infrastructure needs by the Utilities Commission.

Strata Property Act (SPA)

A study by the Municipality of Richmond is developing example by-laws for stratas. They need to address the ownership of installed equipment (is it chattel or fixture?), billing authority, and other issues, all of which impact EVSE design and ultimately certification. Right to charge legislation and the design of the MURB funding programs has a significant influence on EVSE installation design. A pioneering installation example by Variablegrid has piloted an approach that is optimally cost effective for shared parking lots. Field testing allowed this to happen and the cooperation of TSBC was also instrumental. Early test results of certification testing now underway gave confidence to TSBC in accepting the installation. It has also led to feedback which will contribute to the development of standards for EVEMSs. In this case the Strata Board was relatively unsupportive and as such, helped to identify obstacles that condominium residents face. Installation costs were optimized with designs by AES Engineering and installation by Cielo Electric. BC Government MURB funding was also supportive and flexible while understanding the many technical obstacles and resulting delays throughout the process.

Landlord and Tenant Act (LTA)

Under the Utilities Commission Act, Landlords are permitted to re-sell electricity to their tenant(s), but only if the tenancy is for a period of less than 5 years. A longer term exemption would facilitate installation of EVSEs in apartments and rental condo units. No action has been taken on this issue to date. It is unlikely to affect EVSE designs, but apartment owners will gravitate to load managed solutions which are less expensive. Support of the Variablegrid technology will help to address this market and a couple of apartment building owners have already expressed interest in this system..

Measurement Canada (MC)

Certifying a meter to Revenue Grade is a significant cost for the relatively small amount of electricity to be sold.
Although some EVSE manufacturers may certify with integral revenue grade metering (such as Chargepoint), others will not. Current transformers used to meter electrical consumption are also used for load management and personnel protection in the EVSE. Therefore any changes in these rules could result in the need for re-design and re-certification. BC Utilities Commission has indicated that estimates based on EVSE internal measurements are acceptable provided the total does not exceed the utility bill. This has not been tested legally so the uncertainty still presents a risk.

Local Government Act (LGA)

The Local Government Act is unclear in BC as to whether or not local governments have the jurisdiction to mandate EV infrastructure in buildings or off-street parking spaces. Some municipalities are proceeding based on independent legal advice, but they may be challenged in future. The province has indicated support for EVs and will not challenge them. As some municipalities have waded into electrical specification requirements in their policies, these can impact EVSE designs and the enabling of load managed technologies. The City of Vancouver still requires a 40A supply, though the requirement for a dedicated circuit (which precludes load management) has been removed and updates are expected in March of 2018.

Zoning

The rationale for managing EVSE adoption through zoning by-laws is supported in papers and examples by Jim Hindson (https://www.scribd.com/document/367988386/Model-Zoning-Bylaw-for-EV-Infrastructure-Generic-December-15-2017-pdf).

The City of Richmond has implemented a Zoning by-law requiring EV infrastructure in all residential parking spaces. They sponsored a costing study on load managed EVSE technology which supported their new by-law.

The City of Port Coquitlam has implemented a Zoning by-law requiring partial EV infrastructure in all residential parking spaces and a single utility meter in shared parking.

The City of Richmond are now sponsoring a further study by AES Engineering to address many of the remaining obstacles to EV Infrastructure in condos. It is anticipated that this will provide guidance to other municipalities in an effort to address harmonization. A leading example copies much of the by-law by the City of Richmond with elements from a similar by-law by the City of Port Coquitlam. An example by-law that would be ideal for most municipalities and addresses all concerns identified is in Appendix B.

The new CoV proposed zoning by-law accommodates infrastructure designs for premises with indoor and/or detached outdoor parking, which leads to a better electrical design that permits both simple EVSEs and load managed systems.

Burnaby, Surrey and South Saanich are currently working on similar zoning by-laws. The municipality of West Vancouver has expressed interest.

Canadian Electrical Code (CEC)

This section discusses what actions we took to address the problems above. A map to the problems above is in Appendix D.

In order to comply with the CEC, an EVSE must be approved by field testing or certified through a much more rigorous process to manufacturing site certification. After having approached four testing labs without success, a fifth lab, QAI, was approached which agreed to complete field testing under SPE1000 to approve the EVSE. CSA had previously visually inspected the EVSE and suggested minor revisions, and once made in the subsequent production version, passing the SPE1000 tests was relatively straight forward, despite not having access to a copy of the standard. Variablegrid's EVSEs were approved on a unit-by-unit basis and installations may proceed with an external GFCI under special permission of the Electrical Inspectors.

However the Inspectors were concerned with the fact that the EVSEs were effectively controlled by a non-approved EVEMS. This led to TSBC getting involved and initiating a working group to address EVEMSs. This is discussed in the section below.

Although installation of field test units is underway, approval by TSBC is pending completion of the working group activity to develop a bulletin to guide inspectors in the testing of EVEMSs.

Technical Safety BC (TSBC)

Technical Safety BC working group discussions led to a proposed requirement for a bulletin including an Operator's Permit to reduce the risk. This and other requirements were necessary to bridge the gap until testing standards are developed for EVEMSs. A bulletin is still under development taking into account other inputs from the working group. When published, it will provide guidance to AHJs inspecting installations which share and manage loads using an EVEMS. In the mean time, early systems are being installed and inspected with knowledge from and involvement by working group members. TSBC and the City of Vancouver have agreed to accept applications for special permission under CEC Rule 2-034 that are consistent with the 2018 code and address the issues being identified by the working group. Without this coordination and support from TSBC this technology would continue to face insurmountable obstacles. Some teething problems have been identified and resolved through this process. Minor modifications have been made to the Variablegrid EVEMS password protection in order to separate commissioning and user billing access, thus complying with safety issues which have been identified. Other products tested and approved to inappropriate standards have identified safety issues including configuration access and fail-safe condition, that will need to be addressed to the satisfaction of the AHJ.

TSBC have been connected to CSA to recommend the development of a Technical Information Letter (TIL) and standard based on this bulletin for testing, approval, and acceptance of EVEMSs.

COM

If utilities could offer the same or better pricing to systems that manage building loads in a way that prevents higher peaks, then an optimal solution could work. Rather than implementing time of use billing, simply applying incremental peak load penalties to residential buildings and EVSE combined accounts, it would encourage the adoption of load management technologies, flattening peaks on the building and thus prevent overloads on the grid. This is done in Medium Service Commercial Accounts by BCHydro. If a blended approach is used then OCPP 1.6J or newer with smart charging profile should be used.

Open protocols and their challenges are immature and the resulting problems could be solved with more development and analysis.

Recommendations

A number of regulatory obstacles to EV adoption are mentioned in this report which need to be addressed. Although codes and standards changes may enable the technology and overcome those obstacles, it is far from enough and other regulatory hurdles would prevent the adoption of the enabling technologies and EVs.

Transport Canada Vehicle Safety Act (TCVSA)

It is recommended that funding be extended to address the early stages of development of small start-ups that have innovation and skills, but lack the financial support needed to reach early production.

It is recommended that a path for field testing of early prototypes with reduced costs be sought. The development of standards for Limited Speed Vehicles enabled the early development of electric vehicles. The modified vehicle testing by some provinces allowed the development of EV Conversions which led to significant industry expertise being developed and many technology companies being established, some successful. As electrification of transportation extends from bicycles and cars to trucks, buses, airplanes and boats, small start-ups that prototype conversions would benefit from government financial support and relaxed standards.

Direct Current Fast Charger (DCFC)

Supporting the efforts to develop a DCFC standard that is harmonized across North America is recommended.

National Building Code (NBC)

The appropriateness of using building codes vs zoning codes has been studied but more in depth analysis across all jurisdictions is warranted.

Utilities Commission Act (UCA)

Clarification of provincial laws on re-selling power to stratas is needed. As a strata is composed of members, allocation of power to members might not be considered re-selling and this is a significant issue for at home MURB charging. A review of provincial energy and condo laws and suggestions for amendments is needed.

In BC tenants are exempted in the Utilities Act from re-selling power, but only for a period of 5 years. This is an obstacle and should be reviewed across all jurisdictions.

Strata Property Act (SPA)

Strata Property Acts and Condo Acts across provinces should be reviewed for the scope of governing energy allocation. Most of these may be limited to property, not to energy. Electrical infrastructure is considered common property but usage of power is different.

The Strata Property Act in BC has just been amended with an Order in Council to address variable fees, but even this may be out of scope if re-selling is not taking place.

Installing EVSEs in visitor stalls that may be used by non-owners may violate energy laws that govern sale of power for use by owners. This should be reviewed across jurisdictions.

As retrofitting electrical infrastructure for EVs can be a significant expense and mortgaging of common property is not always permitted, how to save for electrical upgrades is needed to be reviewed. This may be an opportunity for federal incentives.

Landlord and Tenant Act (LTA)

see UCA re tenants of longer than 5 years. It is recommended that retrofitting apartments for EV infrastructure be supported by the federal government to enable those who rent to own an EV.

Measurement Canada (MC)

Revenue grade metering requirements for re-selling or allocation of power must be considered when reviewing utility acts. It is recommended that a standard practice be established that would not require every EVSE in a condo to have a revenue grade meter or a display of consumption.

Local Government Act (LGA)

The allocation of zoning limitations has been reviewed in the paper by Jim Hindson but a full legal opinion is needed to confirm who has jurisdiction on mandating EV infrastructure policy. Local Government Laws may need to be updated. It is recommended this be reviewed and resolved to ensure that all local governments have the jurisdiction to implement EV infrastructure.

Zoning

As the CEC and NBC are inappropriate for mandates of EV infrastructure a guide for zoning by-laws, EVSE considerations, Strata and other regulations status is under development by the City of Richmond and AES Engineering. Promotion of this guide with follow on regulatory development as needed and applicability of BC laws and engineering designs considered across Canada is needed to address harmonization and suitability in all regions. It is recommended this be undertaken with national and provincial incentives support tied to local governments implementation.

Canadian Electrical Code (CEC)

It is recommended that CSA 22.2 280-16 be updated to include tests to address externally supplied signals that direct the demand load limits dynamically. Communications failures is one issue. Fail-safe modes that will not overload circuits is another. It is recommended that the relationship between branch circuits and specific EVSEs is established correctly and maintained correctly and that this is tested for in CSA 22.2 280-16 to prevent violating CEC S8-104 (5 and 6).

Secure access to the EVEMS should also be tested for compliance with Part 1 of the CEC in the development of a Part 2 standard for EVEMSs. These are not currently addressed in CSA 22.2 280-16.

This requires that the EVSE can identify itself to the EVEMS and the EVEMS provides clear secure data entry of the circuit associated with each EVSE.

It is recommended that a new standard be developed for EVEMSs specifically. Many of the lessons learned were submitted to TSBC and described in the TSBC Problems section above. It should take input from the Bulletin being developed by TSBC. It should also consider future technologies that may integrate with building management systems which may also seek to manage loads on the same supply. It is necessary to avoid conflicting management and control. A systems engineering approach to testing should be considered as the impact of current EVEMS products span the distribution grid (transformer sizing), the building's electrical installation, the EVSE, and the EV.

It is recommended that for new or custom EVSEs prior to full certification that SPE-1000 is used to test with external GFCIs. It is recommended that the Bulletin from TSBC be used as a template for a Technical Information Letter (TIL) in all jurisdictions to accept new EVEMS prior to a standard being developed. This would provide a stepping stone for innovative new technologies to be Beta tested prior to mass production.
** Note that the TSBC Bulletin is in final draft pending release from legal review by mid March. **

It is recommended that all CSA Standards be available in libraries for public access to enable review by potential users to determine what to buy. The cost of standards is high for small start-ups without knowing which ones apply.

Technical Safety BC (TSBC)

It is recommended that all provinces look to copy BCs early acceptance of the 2018 CEC and supporting bulletin and anticipated standards for EVEMSs.

Communication (COM)

Further implementation and demonstration of OCPP integration is recommended. The research should look at alternatives for billing, authentication, and load management that may be more preventative and lower operational and electrical infrastructure costs at the building level vs the grid level.

Events

Following is a chronological list of events that are actions that relate mostly to the problems and solutions described above.

2006-10-23 CoV proposal: Change building code section 9.34.2.6 (d) “An electrical outlet per stall, with 120V minimum 15 amps and 240V minimum 30 amps shall be provided for in an attached, built-in or detached garage or carport or outdoor parking space”

2007-03-27 CEC S86 proposal SN3316 for minimum 20A, continuous rating, timing control

2008 Variable grid recognition of problems
2008-07-8 CoV Single Family raceway and outlet for EV

2009-10-20 CoV MURB by-law 20% stalls have receptacle for EV
2009-2010 Variablegrid patent filing and granted to Mike Schuler

2010-09-14 CSA EV Resource Task Group mtg at EMC Conference in Vancouver
2010-11-11 Pulling the Copper article published in evWorld
2010-4-11 BCBC change request: A powered outlet shall be provided in at least one of the parking stalls in an attached, built-in or detached garage or carport that serves each residential dwelling for use with an electric vehicle charging system for which specific installation requirements are located in the electrical code.

2011-06-9 Numerous proposals for CEC drafted for discussion.
2011-12 How Far We Drive article

2012-11- EV Ready Codes for the Built Environment: Van, LA, Oregon
2012-12-1 Maryland Code Report

2013-08-09 EV Charging – Impact Review for MURBs in BC – Guy Impey
2013-08-13 CEC Proposal SN3770 for S86-300 for load switching on branch circuit (2015 code)
2013-10-11 Blink network bought by CarCharging group

2014-09 CalGreen Report on California Green Building Standards Code
2014-11-25 Study Charging in LA MUDs
2014-12-05 AddEnergy presentation on EV Charging Strategies in MURBs

2015-10-21 Generate 2015 Presentation – load impacts on grid

2016-01-26 CSA NRC workshop on EV Codes and Standards - presentation
2016-4-13 CoV Costing Presentation to Vancouver and Richmond
2016-4-30 First Variablegrid Client request for installation ASAP
2016-11-20 Richmond RFP includes Load Management costing
2016-12-21 Zoning vs Building Code articles and examples for EV By-Laws

2017-2-21	CSA Field Approval OK
2017-3-7	CSA SPE 1000 test results
2017-03-20	First Client strata by-law draft 0
2017-04-04	Richmond Costing Report finished shows load management cost enables MURBS
2017-05-15	First Client strata by-law draft 15
2017-07-26	CSA with revised product - refused to approve to SPE 1000 standard
2017-08	CSA queries as to which standards apply and include EVEMS – fit for purpose?
2017-08-23	P. Eng quote for First Client
2017-08-26	QPS first quote 61010.1
2017-08-28	QPS second quote 280-16, 281.2
2017-09-29	UL 991 solid state devices reviewed
2017-09-21	UL 2744 Smart environments reviewed
2017-10-26	First Client Strata approval for meter
2017-10-30	CSA Special Inspection application
2017-11-6	Intertek UL2594, UL916, CSA 205, UL2231-1&2, UL991, UL1998= 4 weeks
2017-10	SAE J1772 Updated
2017-10?	QPS Quote
2017-11-8	QPS Quote CSA 280, 281-1&2, 0.8
2017-11-4	QPS Revised Quote 280, 281-1&2 no confirmation of acceptable to AHJ
2017-11-22	Richmond Report to Council passed by-law for EV Charging in 100% residential
2017-11-28	define various models
2017-10-20	Burnaby council requests staff develop EV Charging Policy
2017-10-30	J1772 2017-10 released and reviewed for compliance
2017-11-28	TSBC working group meeting re: load management of EVs to identify gaps
2017-12-6	QAI first Inspection Report
2017-12-20	order parts for 100 units and hope no changes
2017-12-26	QAI Proposal
2017-12-26	Build units for 2 customers from parts inventory of 100 boards

2018-1-1	Ontario Building Code in effect for single family houses EV Ready
2018-1-14	City of New Westminster Construction Design review
2018-1-18	TSBC meeting to discuss draft bulletin to address standards gaps
2018-1-22	First Client Special Permission approved
2018-1-23	Port Coquitlam passes zoning by-law for 100% EV Ready in MURBs
2018-1-26	First Client final inspection Variablegrid load monitored and controlled system
2018-1-10	Second Variablegrid system installed in NewWestminster
2018-1-29	First Chargepoint load managed system installed CoV and fails commissioning tests
2018-1-30	Variablegrid EOI to NRCan infrastructure funding accepted and feedback provided
2018-3-14	CoV passes Zoning by-law for 100% MURBs
2018-3-15	Variablegrid fails to find matching funding needed for NRCan funding deadline.

Appendix A Electric Vehicle Energy Management Systems

Don Chandler – EV Pioneer
2017-10-26

As it was
The 2015 Canadian Electrical Code recognizes that electric vehicles (EVs) consume a lot of power. It treats EV supply equipment (EVSE) loads as being continuous, does not allow any de-rating factors to be applied to such loads, and requires dedicated circuits. This is because EVs can load a circuit to the maximum for long periods, particularly if charging slowly. In some ways, EVSE loads are like block heaters as described in Section 8-400, but they differ in one fundamental way: block heaters may draw power for days on end, while EVs draw power only until the battery is full. EVs also typically draw 3 to 25 times more power daily. Section 86 provides most of the requirements for EVSEs, however, Section 26-710(o) mandates installation requirement for dedicated EVSE receptacles, where local regulations (i.e. building or zoning by-laws) may specify policy issues for EV infrastructure. Section 8 mandates EVSE load calculations.

Problem
One of the problems identified by early adopters responding to building regulations for EV infrastructure is that it is expensive to install. This is mostly due to the requirements for dedicated circuits. In fact, most EVs only draw power for about an hour and a half or 2 hours on a 240V 40A circuit each day. This reduces the infrastructure utilization in a larger building to about 10% on average. However, an EV may draw power for 3 or more times that, particularly as batteries get bigger. Average consumption depends on how far we drive, and not the battery size. Some days (about 1 day a month) we may need to charge for 6 or more hours on this 40A circuit if we drove a long way that day, so the full capacity is needed, even if it is not always in use.

Why change
In larger buildings like condominiums, the distances to the parking garage are greater so more copper is needed. This cost, as well as the larger distribution equipment required, makes the infrastructure very expensive. One advantage, however, is that as a shared property it is possible to share power and wire. Unfortunately for condo dwellers, the code has not provided for this, other than by allowing switching between an outlet for a dryer and an Electric Vehicle Supply Equipment (EVSE) in a single family home. [see Sub-rule 86-300 (3)]. What was needed was to enable the sharing of power more dynamically, and at multiple levels of the distribution, much as the NEC Article 750 in the US does. This would make more efficient use of the wire and the equipment, thus lowering the costs.

What the change is
I first submitted a request for a code change to address this need almost 6 years ago. After a great discussion and many improvements, the final version was accepted for inclusion in the 2018 code. The change allows for EV energy management systems (EVEMS) to control EVSEs. It also provides for appropriate demand loads for the calculated load for shared circuits and feeders and supply. For dedicated circuit solutions, it provides for de-rating, similar to block heaters, but recognizing that the faster we charge, the sooner the power is available to charge others, knowing that everyone does not charge at exactly the same time.

Rationale behind the change

The amount of energy needed to charge is dependent on some primary principles: the distance we drive each day and the efficiency of our cars The power we need depends on energy needed and the time we arrive home and plug the EV into the electrical infrastructure. A few other variables also come into play, such as seasonal differences, week-day vs week-end differences, demographics of each building. The total power needed is also dependent on how many neighbours are sharing a supply of power. This is basic statistics: the larger the population, the lower the standard error of the mean. The likelihood of one EV owner arriving home empty and demanding a full charge in a short night is much higher than 20 EV owners all arriving home empty and all needing a full charge.

Considering these principles, it is possible to provide some latitude in our demand calculations. This was the basis for the code proposal to Section 8 sub-committee. The new code change considers all these factors and allows for better optimization of the wire and equipment. In fact, some technology solutions that monitor uncontrolled loads can utilize up to 98% of available power at continuous safe limits. Safe limits should also consider drift characteristics of breakers as they age, as operating at their limit most of the time can eventually cause some tripping to occur.

<Insert abbreviated code change text here or link to code change, or at end of article.>

How to use these code changes to reduce cost

For dedicated circuits, the de-rating table provided can be used to reduce the supply needed. For slower charging on what is known commercially as Level 1 (120V 20A circuit or nominal 2 KW supply) there is no reduction, as the average time to charge is most of the night and almost everyone will be home and charging at the same time. As the power is higher on Level 2 charging on a 240/208V 40A circuit or a nominal 8 KW supply, the average time to charge is only about 1-1/2 or 2 hours and people start arriving home mid-afternoon until almost midnight, so some are finished charging before others arrive home. In this case it is possible to de-rate further.

For shared circuits, the more EVs share power, the less it can cost. However, this also creates greater distances in wire size and length. Sharing about 8-16 EVs seems an appropriate compromise. Where only 2 to 4 EVs share power, the reduction in cost is much less.

Various EVEMSs use different methods to share power. Some are quite simplistic and simply divide the power equally between connected EVs. Others will re-distribute power between shared EVSEs according to their ability to consume power. (Plug-In Hybrid EVs often have only a 20A charger). As batteries approach a full charge the internal resistance increases and charging slows down for the finishing charge and cell balancing. This power can be redistributed in some products. Power sharing can occur on the same phase of the same circuit or at the panel level by overloading the panel. The EVEMS ensures that safe limits are adhered to. Some EVEMSs may receive OCCP v2 protocol signals from the utility providing a predicted profile of available power for the next 24 hours. They can use these to adjust their algorithms to help the grid balance loads. However, this may mean a higher cost for the building distribution as the EVEMS may want to charge faster when power is available. As the peak loads on the grid is non-deterministic, the calculated load must still account for the maximum allowed by the EVEMS. Designers need to choose whether to help balance the distribution grid, or the building infrastructure.

Only if the EVEMS monitors the circuit or the feeder or the supply that is shared and uses it to control the EVSE, can the calculated load be reduced to zero for the EV loads, or to the maximum of the available power within the system capacity at each level (building supply, feeder, or branch circuit). In these systems, it is possible for the supply, feeder, or circuit loading to be set at a specific maximum

value not to be exceeded. If there is enough power available overnight and under dinner hour peaks, it may be possible to charge all EVs without exceeding the existing dinner hour peak, thus helping the distribution grid load. This is a very efficient use of the wire and the equipment, and reduces the cost. The maximum rating could also be set to just under the demand charge level to ensure maximum charging performance without exceeding a cost threshold. As the response time of the system is dependent on the response times of the EVs, which can be up to 4 seconds, a 20% margin is still needed to avoid nuisance tripping. .
Time of use (TOU) billing exists in some provinces, which impacts the design. The power needed to charge all EVs is driven by the time available to charge and the distance driven (or battery depletion). If TOU billing offers cheaper rates overnight, it becomes a method of managing the load by shifting the charging activity to overnight. If EV owners take advantage of this, it can cut the time available to charge in half (as daytime hours are avoided) and thus double the power and infrastructure capacity needed.

Smart load management solutions can also reduce the peak loads, and even completely flatten the load profile of the building while EVs are charging.

These alternative approaches compete and affect different parts of the infrastructure. TOU billing may reduce the infrastructure needed by the utility in the local distribution, whereas smart load management systems can reduce the infrastructure costs in the building.

Technology is being developed to enable vehicle to grid (V2G) designs with feed-in tariffs. By selling power back to the grid during peak times, the EV battery is further depleted requiring more energy to charge overnight in much less time. This can quadruple the infrastructure needed and accordingly the cost. Utilities may eventually offer enough reimbursement for V2G designs to make it worthwhile. This would be particularly viable in dedicated circuit installations ,but these are typically four times the cost of load managed designs.

Renovations always cost more than new construction. Installing infrastructure in all parking stalls in a parkade at time of construction is the least expensive. A load managed and shared design is likely the least expensive, and in most cases a design can be budgeted at well under $1000 per stall. To do this same installation as a retrofit may be 3 to 5 times more costly. If a retrofit is done one stall at a time the cost may be upwards of ten times the cost of doing all stalls in new construction. Some installations may consider only roughing in the conduit in the parkade in an attempt to save money at time of construction. This is false logic as the cost of upgrading the equipment in the electrical room is much higher.

The purchase and installation of the EVSE can be deferred until the time of purchase of an EV. However the mounting hardware (threaded studs) should be installed near the outlet at the time of infrastructure installation. This makes the installation of the EVSE much simpler and may often be done without an electrical permit if the design is approved initially and the connection is by plug and receptacle. When a condo unit is sold, the EVSE must sell with the unit if it is permanently installed, but if no tool is needed to remove it, then the unit owner may take it with him for use at his next residence provided it is compatible with the new building wiring and system.

Metering
It is best to install a single meter for the entire parkade which is less costly than one for every EVSE.

In some products, the EVSE may have a revenue grade meter internally which might be used for billing but this would likely increase the cost of the EVSE. It does however shift the cost of the meter from the infrastructure installation by a developer or condo association to the later purchase of the EVSE by the EV owner.

In most provinces, the re-selling of electricity is restricted to utilities and can only be sold for use by the owner. This is an obstacle to public access EV charging in public parkades. However, a single meter in a condo building for all EV charging is registered to the condominium association which is composed of members who own the units. As the association is considered to be a person, re-selling of electricity is likely not occurring. However, if an EVSE is installed in a visitor stall for use by non-owners, then in some provinces it would not be allowed by the utility regulations. A typical exception to the restriction on reselling of electricity is for tenants, such as in apartments.
In all cases, the collection of costs for electricity should not exceed the costs billed by the utility, based on that single meter. How the condo association chooses to apportion the costs is more flexible. A simple division of the bill by the number of EVSEs is possible but not as fair as adjusting the allocation based on actual use, as metered by the EVSE or some other basis of estimate such as mileage and vehicle efficiency.

Some examples

Level 1 120V 20A dedicated circuit
This is a simple approach but only provides the average energy needed daily. Half the EVs will require more power. Only in situations where distances are low and time available to charge is long is this suitable. The slower trickle charging does make efficient use of the wire but at a lower voltage so less efficient partially due to the power needed to maintain the battery temperature while charging for longer. It also lacks the metering needed for fair billing, so estimates of consumption must be acceptable to the users. The EVSE comes with the EV so this cost is avoided.

Level 2 208V 40A dedicated circuit
This approach provides the highest performance at the highest cost and, depending on the EVSE, may lack metering for use in billing. In most cases, the main transformer size would need to be increased by double. The EVSE cost may be much less. In larger parking lots, the derating table may be applied to reduce the demand load by up to 30%. The derating makes sense in overnight residential parking lots. For public lots where there is a turn over of vehicles every few hours, or in northern climates, a more conservative rating is appropriate. Over 300 km of range can be charged overnight, which is over six times the national average.

Level 2 208V 20A dedicated circuit
This approach cuts the power needed in half from the 40A solution, but the maximum energy it can provide (~26 KW hrs) overnight in 8 hrs only provides 133 km range or about 3 times the national average, which provides a full charge only about 90% of the time. This may be sufficient where long distances are not travelled on consecutive days. Some derating may be applied.

Level 2 208V 40A sharing 2 EVs per circuit per phase.
Similar to the above design in energy available, this allows for more range when one EV arrives home before the other and TOU billing is not used. The total energy needed by two users is normally less than double that of the highest user as the likelihood of both users having empty batteries is less than

just one being empty. The 2 EVSEs and energy management system are typically internal to one product. In some simpler products, the allocation simply divides the current in half when 2 EVs are connected. In others, the current is monitored in each EVSE and reallocated between them as one reduces it's power consumption and finishes charging. These units are typically sold and approved as a single EVSE with 2 charge ports.

Level 2 208V 40A EVSEs sharing 4 EVs per circuit per phase.
This design is one of the more cost effective, as it takes advantage of the statistical benefit of sharing more EVs on a single circuit while using the full circuit for the first EV to arrive home. This design is similar to the 2 shared unit but shares 40A between up to 4 EVSEs. When all 4 are connected, each EV is allocated just 10A. The EV Energy Management is embedded either in one master EVSE or distributed amongst the 4 EVSEs with communications between them. A CB and Energy Management may be in a base unit that is approved separately and sold with the group of 4 EVSEs. In some cases this system may include communications to a building management system over Zigby or to the utility using OCPP protocols to limit the load during peaks and avoid demand charges. Such monitoring is often not fast enough to prevent tripping a CB and the calculated load must reflect this. All components installed, including building management equipment must be approved.

Level 2 208V 40A EVSEs dedicated circuits but overloading the panel 4x
This approach also shares 4 EVSEs at the same time but does so by overloading the panel and uses dedicated circuits from the panel. Control may be done remotely. It limits the upstream infrastructure needed but uses more copper to the EVSEs so may be slightly more expensive. Where remote control is done, an EVSE is not activated as a load unless it is permitted by the remote management system. The rating of the energy management system would reflect the maximum load that the panel is set to accommodate. No monitoring of the upstream feeders is needed as the only circuits permitted in the panel are controlled as one product. Typically a panel may be overloaded up to 3 or 4 times and still provide reasonable overnight performance as each car will complete charging in an average of about 2 hours.   All components installed, including communications and computing equipment must be approved.

Level 2 208V 40A EVSEs sharing 12 EVs per feeder per phase on a 150A CB for 8 hours
This design has more EVSEs sharing a circuit, which provides a statistical advantage on the power needed. It uses a 150A trunk line feeder to groups of co-located EVSEs. The sharing makes good use of the copper wire and minimizes the upstream equipment sizes needed. However, the larger breaker increases the cost of the branch circuit panel, from a panel board to a distribution board.
The performance is also high and comparable to dedicated circuits with high amperage feeders. Similar to the 4 shared on a circuit design above, the energy management may be embedded in the EVSEs with local communication amongst them. The demand rating for such a system would be 150A but it would give excellent performance, ensuring all EVs are charged fully overnight. Such designs are evolving and may include interfaces to building management systems or direct monitoring of the supply using CTs. The response time of the system will determine the applicable rating to ensure CBs are not tripped. Building management systems often only report 15 minute averages. This may help to limit loads to stay within demand charges, but not the calculated load. All components installed, including communications, CT sensors and building management equipment must be approved.

Level 2 208V 40A EVSEs sharing 12 EVs per phase on a 80A CB from mid-afternoon to 7AM
This design may share any number of EVs on a circuit of any size resulting in variable performance.

With 12 EVs on an 80A CB and no TOU billing to limit the time to charge, excellent utilization can be achieved for minimal cost. This design may use monitoring of the circuit and the panel or building supply to optimize the use further. Because the system can limit current to the calculated load or lower within a 5 second response time, the demand load is zero and does not increase the building supply needed. The result is that charging occurs mostly below the typical peak load, dynamically varying the power available for charging. In most cases, all EVs in a building can be charged without increasing the building peak load and well under the calculated load. The resulting building load is flat and utilizes up to 98% of the available power. This optimal design is likely between 8 and 16 EVSEs sharing a feeder but it depends on the parking lot layout and choice of panel and CB sizes given costs. Three phases are used such that 2 wire runs for each phase can reduce the amount of wire used, particularly if each circuit is T'd mid-span in a 3 circuit configuration from a central electrical room. It is most optimal on parking lots of 8 or more stalls with 240V and 24 or more stalls allocated evenly over a multiple of 3 circuits with 208V. Monitoring data is also used for billing, apportioning estimates within 1% accuracy, though not revenue grade. Where the CT monitoring is responded to within 5 seconds ,the demand load can be zero and the demand rating of the energy management system configured in the field by the installer to the calculated load or less. Often the demand load is set just under a demand charge level or limitation of a utility rate.

The energy management system may be located anywhere provided appropriately responsive communications are used to connect the CTs and the EVSEs. Ideally it can be located in the electrical room near the CTs with wired or wireless predictable LAN communications to the EVSEs. The wireless LAN components would use standard routers, etc. Such a management system is also potentially configurable to respond to signals from the utility to limit loads during specific time periods. The OCPP protocol is gaining popularity world-wide for both billing and utility level control purposes. The energy management system is basically just software running on approved computers and communicating using ELV or wireless communications plus CTs. The system is configured in the field and the appropriate rating established in field installation according to the manufacturers installation instructions. In some installations it is possible to overload the branch circuit, panel feeders, and building supply where CTs are installed and monitored at all levels. Ratings for each level need to be configured in the field according to the manufacturers installation instructions and approved accordingly. The higher the rating that may be configured within the available capacity, the higher the performance. It is ideal in older buildings with limited capacity or new buildings seeking minimal infrastructure costs. All components installed, including communications and CT sensors must be approved.

Level 2 208V 40A dedicated circuits with Time of Use billing

This solution provides good performance and can take advantage of TOU billing price reduction. It helps the utility reduce costs at the expense of the building infrastructure costs. When combined with other load management systems, the competing strategies may not achieve optimal results. As time for charging may be limited to off peak hours, higher power levels may be required to provide adequate performance. If vehicle to grid technology is implemented, more power is used from the EV and will need to be replaced in off-peak hours requiring even high power levels in the building infrastructure.

Conclusion

Load managed or shared designs may cut the cost of EV charging infrastructure to less than $1000 per stall in new construction, and be more comparable to dedicated circuit costs in single family houses.

These designs also significantly reduce the impact on the grid. The code change for EV energy management systems is a breakthrough that enables recent technology developments, and opens the door for EV adoption by condominium and apartment residents. It is also grid friendly: by spreading the load over time with less infrastructure, the utility will benefit by selling more power with less cost. The building infrastructure will cost less, but the smart EVSEs will cost slightly more than dedicated charge stations. Time to charge, power capacity, and managed utilization will always compete to achieve a needed level of performance for a limited cost.

The following definitions are as per the electrical code.

Electric vehicle, Electric vehicle supply equipment (EVSE), Electric vehicle energy management system, Energized, Outlet

Level 2 charging means a Level 2 electric vehicle charging level as defined by SAE International's J1772 standard.

All new parking spaces serving residential occupancies, excluding visitor parking spaces, shall have an energized outlet installed adjacent to the space for the purpose of electric vehicle charging.

Ten per cent of all new staff parking spaces serving commercial occupancies, excluding visitor parking spaces, shall have an energized outlet installed adjacent to the space for the purpose of electric vehicle charging.

The electrical infrastructure shall include revenue metering that permits apportioning of energy costs to persons when EVSEs are installed.

The Manager of Engineering may specify utility and billing communication protocols and sufficient performance rate standards as well as management guidelines.

Enforcement must adhere to the Zoning By-Law.

Engineering Bulletin

EVSEs should support OCPP protocols for receiving utility signals and billing.

The energized outlet shall be capable of providing Level 2 charging that may be load managed.

Performance Intent

Where an electric vehicle energy management system is implemented, it must provide a sufficient performance rate of electric vehicle charging such that electric vehicles are able to fully charge daily over the average times they are normally home or at work and available to fully charge 97 per cent of the time, based on the daily driving distance statistical distribution of Metro Vancouver households and average EV energy efficiency.

The following table interprets the sufficient performance rate but does not preclude other configurations from meeting the intention of the sufficient performance rate described above.

Number of parking spaces sharing a supply	Minimum average KW supplied to EV
1	6.6
2	3.3
3	2.2
4 – 9	1.7
10 – 11	1.5
12-15	1.4
16-22	1.3
23-24	1.2

A configuration such that each EV is assured to be provided with a minimum of 12 kWatthrs of energy over an 8 hour overnight period when sharing a 40 A circuit with 4 EVSEs or equivalent also meets the sufficient rate requirement.

Management Guidelines

4) The party responsible for paying for EVSE and its' installation is clearly delineated and permission procedures to do so is established.
5) EVSE ownership is established.
6) There is a means to reconcile common parking area only electricity costs to individual drivers that is consistent with the Utilities Commission Act of BC.
7) In cases where EVEMS is used, EVSE that are compatible with that EVEMS will be installed and the EVEMS is installed, managed and maintained. Outlets and the panel are appropriately label to avoid conflicting use, as per the electrical code.
8) Billing rules are established.

In order to ensure these issues are managed appropriately, an owner-developer must:

1. *File Strata Bylaws at the Land Title Office Establishing how the strata will manage EV Charging assuring billing does not exceed the utility bill for electricity and any common meter is registered to the strata corporation (and its members) and the above management issues are addressed.*
2. Example strata bylaws are located in an appendix to this Bulletin

Appendix C Input to Standards Changes

Detailed checks / tests / rules to be addressed in EVSE standard, EVEMS standard, or permit installation checks

EVSE standard 22.2 280-16 Recommended changes

Amps per charging station = demand rating on label

Documentation in installation manual of management and control features of EVSE including inputs and protocols and response. (use-case)

A clear description of the EVCE design and operation
EVSE label shows approved for use with EVEMS brand

Fail-Safe Condition – test for loss of communications or EV non-responsive – demand rating reduce to i Amps on label

The EVCE in the case of a loss of communications between the EVEMS and the EVCE, when it is evident automatic restarting after a power cycle or the lack of communications is liable to create a hazard a fail safe condition is established. Once safe operating conditions (power and communications) are restored the EVCE shall conduct a safe start-up with random delay time.

Type of control / management: supplied by manufacturer EVEMS model(s) or other brand or OCPP or other protocol

EVEMS standard to be developed

Demand load cannot exceed the electrical code (80% of supply / CB) nor calculated load
EVEMS continuously operational while charging

Capable of controlling loads affecting service?, feeders?, branch circuits

Capable of monitoring service, feeders, branch circuits and controlling affected loads

Response time of EVEMS and EVCE and EV to monitored loads

Fail-Safe Condition test for loss of communications with EVCEs or other inputs – demand rating reduced to i Amps for affected EVCEs

Capable of managing and controlling power production equipment (V2G)
Documentation on suitability of third party inputs to EVEMS for EVCE (OCPP) or building management systems (Zigbee) and protocol.
EVEMS Administrator required? Operator permit # and user ability to control system.
documentation of management and control features of EVEMS including inputs, outputs, protocols and responses (use cases)

A clear description of the EVEMS system design and operation
The EVEMS shall disable the EVCE in the case of a loss of communications between the EVEMS and the EVCE, when it is evident automatic restarting or the lack of communications is liable to create a hazard. Once safe operating conditions (power and communications) are restored the EVEMS shall conduct a safe start-up with random delay time.

Demonstrate that the EVEMS, by means of both control and management of loads, meets the fundamental principles of protection for safety mandated by the Canadian Electrical Code and will not cause the loading of branch circuits, feeders or the service to exceed the requirements of Rules 8-104(3) and 8-104(5).

Permit bulletin to check for on EVEMS installations

Documentation to include training records of permit holders, owners, (operators, administrators),

Rating V, A, Qty; Load under control / management A/ unit;
EVEMS documentation clarifies if an Administrator required? Operator permit #
Documentation includes EVEMS load management plan

Connected load nameplate markings per circuit and panelboard and switchboard marked in log and on panel and switchboard is total load for each and maximum calculated load managed
Documentation to include system alterations and upgrades.

Utility notification if load on transformers is increased on failure of EVEMS
Identify all loads and do load calculation (0 unless set higher than calculated load for rest of building for improved performance if equipment ratings allow for it)
A management plan on how; the EVEMS will control the loads, and document the addition, alteration, or removal of equipment will be maintained and is the responsibility of the Asset Holder

Total Load under control / management A.
Utility is informed
Plans and specs of equipment and electrical system incl. Load calculations Rule 2-014
Load Calc Rule 8-106
Identify safety objectives, by section as specified above of applicable regs and codes
Specify alternative means by which it is proposed to meet the safety objectives.
Additional safety means to meet objectives
Any other objectives, alternatives and evidence that the alternative will meet the objectives identified.
EVSE label shows approved for use with EVEMS brand

EVEMS approved for the intended purpose of controlling EVCE