

## Pulling the Copper

*VEVA asked the city of Vancouver to develop regulations to mandate residential infrastructure for electric vehicle charging. The city responded positively and we now have thousands of homes wired for emerging electric vehicles. This is the story of what we went through to achieve this. We hope that others can learn from our experience and enable the infrastructure needed by emerging EVs. Build It and They Will Come.*

VEVA members sat down three years ago to debate the challenge of promoting electric vehicles. We asked ourselves “What can a small non-profit hobby organization do to bring about the adoption of electric vehicles?”

We realized that it takes a large company to build EVs and we were only a hobby club. We did have a lot of end user experience as many of us had built conversions and drove them daily. We thought we could influence public opinion through promotion at the grass roots level, attending community events and showing our EVs and talking to the public. Our target was to convince 5% of the early adopters (Prius buyers) that “My next car will be electric”. This became our slogan and we attended some 30 public events per year over the past 3 years promoting this.

We garnered media attention doing this and were interviewed for some 30 media articles per year. The media is a very powerful tool to promote, but getting their attention requires actually doing something. The more we did, the more attention we got. The other thing we realized is that politicians pay attention, as the media tend to influence voters. One politician commented to me at a community event: “Your EV is getting more attention than I am”. The politician responded by supporting EVs.

Lobbying governments was also considered. We quickly realized that different governments could only do different things due to jurisdictional restrictions. For example, the federal government controls vehicle safety, provincial governments control highways and which vehicles they allow on them. Cities on the other hand own buildings and manage streets, or so we thought. We brainstormed a number of ideas to present to the City of Vancouver in response to an invitation to act as a local stakeholder in a community outreach effort by the Sustainability Department. Beyond the easy things like parking incentives, access to HOV lanes (which are nice but not earth shattering), we asked them to help build the infrastructure for EVs. We explained that EVs have limited range and need a place to plug in. Virtually no garages or parking spaces in any homes or high-rises or businesses or public parking lots had sufficient power outlets to charge power hungry EVs. We decided to focus on residential parking as that is where the majority of charging will take place. It also could be implemented with by-law changes only and no direct cost to the city, so was more likely to be accepted. Costs are ultimately passed to the end users.

As it turned out, the Building and Electrical Code in Vancouver is administered under the Vancouver Charter: This means what is normally a provincial / state jurisdiction is passed to the city. This was a key factor although we didn't realize at the time just how significant it was. This situation is also unique to Vancouver. We worked with the city staff to draft recommended changes to the local building code. Our original suggestion was to modify Section 9.34.2.6 (d) to say "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". The city engaged their resources and then indicated that some of the supporting changes we proposed would have to be put into the electrical code, not the building code. To address this, we modified our request for the building code to simply suggest "outlet for EV charging in every parking space of a residential property" which would include houses, condos and bike rooms.

Paramount to our goal of enabling a lowest cost yet still adequate infrastructure was a realization that Level 1 or slow charging on a standard 120V 15 Amp shared circuit outlet would not suffice for power hungry EVs. To address this we needed to modify the national model Canadian Electrical Code. We went on to work closely with Electric Mobility Canada (EMC), a national level lobby group, to formally request the changes. We quickly joined EMC and then volunteered to participate in the development of Section 86 of the Canadian Electric Code (the US counterpart is Section 625 of the NEC). We proposed a change to the electrical code which evolved through peer review into a requirement for a 120V 20Amp dedicated circuit for level 1. This would yield a charging speed of 10 Km (6 miles) per hour of charging, enough to get 100 Km or 60 miles range on an overnight charge. This is double the national average distance travelled daily in Canada and sufficient for PHEVs, NEVs and low mileage BEVs.

We also realized that the code was written for the technology available in the 1990s (paddles), but now most of us had unique chargers that connected conductively to all sorts of higher power 240V outlets. We proposed that receptacles for these charger plugs be specifically approved for use in EV charging and that inductive charging be excluded from the Code.

It is important that the connection to the vehicle be uniform for universal access to charging. The connection at the wall to the grid needs to support whatever a car demands and what ever the grid can supply. As the SAE J1772 standard was still under revision, we simply requested that any approved receptacle be allowed. Thus common EV plugs such as a L6-50R or 14-50 stove or dryer plugs would be allowed. When the J1772 standard is updated along - with the SAE J2836 to define the communications requirements with the grid - new electric vehicle service equipment (EVSE) will emerge in the market and users will be able to simply replace the pre-wired receptacle. It seems today that a 220V 40A supply is the recommended choice of Level 2 best practice. As there

aren't any 40A receptacles this translates to a 50A circuit and receptacle which under continuous load at 80% can supply 40A. Likely on board chargers will only draw up to 32A at 220V which is consistent with European standards and will deliver about 33 Km (20 miles) per hour of charging. Although many of us would like to see even faster charging, the cost of this luxury is prohibitive.

As these changes to the electrical code were working their way through the standards expert review process, we simultaneously proposed changes to the local building code that outlets be required. The electrical code only tells you how to wire the outlet safely, not that you must install it. Only the building code or zoning by-laws can mandate installation. We also knew that developers typically build to what is required by the code and it was unlikely that anything voluntary would be adopted in time for emerging EVs. An opportunity to get approval for outlets in single family homes arose when other Green Building initiatives were being proposed by the city. The city added the request for EV outlets to a list of other energy efficiency measures and it passed council unchallenged. Unfortunately, the model electrical code changes were still in the works and would not be approved for another week, or adopted for another year. As a result the electrical code did not yet support the demand load calculations and the specifics necessary. The building code could provide for the space, but not the copper. The electrical code has safety as its objective and only deals with how to wire, it does not have a mandate for a sustainability objective. The electrical code cannot mandate EV plugs. As a result the building code request was downgraded to a rough in or requirement for a raceway (conduit) only. In reality most new homes not only install the required raceway, but also complete the wiring to a receptacle.

In order to provide a mandate for the electrical code, the building code should reference it for implementation details. We initially missed this. Without this link, the requirement might invite legal challenge and be unenforceable.

About the same time, we had suggested electric outlets be required in bike rooms in condos for two reasons: The increasing number of eBikes in our city and even more lost sales due to the lack of charging infrastructure. City staff saw an opportunity to add this to a report that was addressing other issues such as bike security, and included it in the report on parking by-laws. This also passed and now the increasing number of electric bikes and scooters in Vancouver will have a place to charge in new buildings. We changed our slogan to "Vancouver Plugs In"

Next, we and the city followed up with the remaining multi unit residential buildings (MURBs). This required more work and substantiation. A costing exercise completed by a consultant for the City revealed the higher cost for these due to the fact that larger buildings have their own electric transformers and distribution centres, which are costly, as well as longer runs of copper and conduit to the parking spaces. This cost was considered an obstacle to

developers and the request for 100% coverage was again downgraded to a reduced percentage of parking stalls being required to have outlets. The argument at the time was that EVs were not yet available and demand wasn't established. After some public media debate with local developers' organizations who opposed it, the proposal was passed and adopted at 20% coverage with plans to review it in future. The ongoing support of our local utility BC Hydro, the Provincial Governments Intergovernmental Working Group, and dedicated city sustainability staff helped to keep the momentum, without which none of our team's goals would have been achieved.

In the end, we were left with an orthogonal mess of regulations covering single family homes and duplexes in one by-law, eBikes in another and MURBs in yet another. The building code is divided into small buildings up to 600 sq meters or 3 stories (about 6 units) and larger buildings. The electric code separates houses and apartments. As we're under taking proposals for more revisions to the electrical code ( to define demand load calculations for the dedicated circuits and specifically include emerging electric vehicle charging equipment such as the new plug defined by SAE J1772), we hope to reconcile these by-laws into a more uniform approach that requires a completed connection for a percentage of all residential parking stalls in both houses, bike storage rooms and condos.

Given the popularity of our team's achievements, others became interested in copying what we had done. Enquiries came from all over the continent. This led us to look into how others could copy what we had done, and we realized just how fortunate we were. The province had the foresight recently to introduce Bill 10 that extended the traditional scope of the building code to include sustainability and the reduction of GHGs as an objective in a new Part 10. This was key. Vancouver, as it turns out, is also unique in that it has its own charter which gives it authority to make regulations about building and electrical codes w.r.t. GHGs, normally the jurisdiction of provinces or states. This was also recently added to the Community Charter and Local Governance Act which now enables other municipalities in BC to follow suit.

Without this increase in scope, we could not have made the changes for EV charging infrastructure. The model National Building Code does not have this sustainability objective and so our changes would not be accepted in it. The model National Energy Code for Buildings is also restricted to energy conservation by the building itself, not the things that connect to it temporarily such as cars, so our changes would not be accepted there. Most provincial and state governments simply adopt these model codes so we found there were limited means to get our changes spread. Recently the province of Ontario passed a Clean Energy Act that does extend the scope of the building code to address not only conservation but also GHGs and clean air. Thus they should be able to copy our initiatives. Other provinces are rumoured to be working on such scope changes, but they might only copy the national code concepts of energy efficiency of the building and do not extend it to GHGs or clean air at this time, as

far as we are aware. The electrical code objective remains restricted to safety, not climate change; it also traditionally looks only to the Building Codes for mandates.

Unfortunately, in 1867 our forefathers did not have a crystal ball to consider the environment, the air, or the impact of future oil exploitation in dividing up responsibilities between the federal and provincial governments. As a result, it is still unclear who has jurisdiction over the atmospheric environment and how to include it in the established legal structure. Some provinces (and states) are charging ahead defining strategies, laws and trading schemes to address global warming. The federal government is also claiming jurisdiction and is negotiating deals with international treaties such as Kyoto and Copenhagen. When they attempt to ratify these rights, the courts will eventually decide who has jurisdiction and someone will lose. This jurisdictional quagmire was at the heart of the EPA's rejection of CARB's EV initiative.

In the meantime we are left in a vacuum of jurisdictional mandates with few easy places to plug in our vehicles or our infrastructure initiatives. Alternative approaches may have to do, using other influence or incentives. Other approaches, such as zoning development approvals or covenants could also hinge on support for green initiatives, something that some forward-looking local jurisdictions are doing for their green initiatives. In fact, the city of Vancouver made requests of developers early in this process to put outlets in showcase developments already under construction for the Olympics. They also influenced other developments through zoning restrictions. Alternatively, incentives could be used, but they cost a lot of taxpayer dollars. In the end the car owners will pay, but more directly, as most all Canadians will be driving without oil in the future.

A similar situation exists south of the border with most states having jurisdiction over building codes. Each state tends to handle it differently, which makes it even more unwieldy to develop a national infrastructure for EVs.

When we started, we thought it would be a simple matter to pull the last few meters of copper needed, but instead it appears we will be pulling the plug on EVs until we rebuild our infrastructure, educate our grid to be smart, establish communications protocols between auto mobiles and the utility providers, update undersized ageing transformers and distribution equipment, allow public charging stations on our streets and in lamp posts, redefine or extend the jurisdictions established in our constitution and work cooperatively to a sustainable future.

Fortunately, there are efforts under way involving all the major players and connecting in to government departments and standards bodies, auto makers, and utilities that provide the power both locally and internationally. Interestingly, the Electric Vehicle Association of America was the first to develop electric standards for charging plugs in 1913 and volunteers still seem to have their

hand in it. Automotive OEMs and utilities have the most to gain or lose and will likely lead the charge. Developers will have to pay initially and will likely complain until they realize the opportunity to differentiate their buildings.

Somewhat in parallel with this we considered public charging. Although most charging will be done at home overnight, range anxiety and street parking dictate that some public charging be made available. We suggested to the city that they identify existing power outlets in city owned parking lots that could be used for EV charging and simply put a sign on them. Many outlets exist now, typically for power washers. We also suggested this to the Parks Board. They have parking lots, street lights and community centres with available power. As a second step we suggested they look to where sufficient power existed nearby and could be extended to EV Charging outlets easily. This was the low cost approach. Both the city and the parks have approved this in principle and are exploring options and budgets for public charging infrastructure. Once the copper is in place it will be a simple matter to add signs and payment / management systems. Many players are already exploring this opportunity. Regulations governing land use and access to public lands for public charging managed by private vendors will also need to be developed.

Finally comes the challenge of retrofits and renovations. This will cost much more, and may require incentives, but at least our new construction will plan for the future.

Whatever unfolds, enthusiasts must not pull the plug on promoting EVs yet. There is still much work to be done and copper to pull. Much of this can be done by volunteers of small hobby clubs when they become involved in the local and national standards development processes. They also need to engage local government staff and leaders in cooperative efforts as VEVA has done. VEVA is a chapter of EAA. Other EAA chapters can approach their local governments and request by-law changes as we have done. Most cities will likely have to modify zoning or other construction by-laws rather than the building code. Whatever by-law is changed it must include the objective that enables it to regulate and it must refer to the applicable electrical code for implementation details. Provinces and states have the jurisdiction to change building code objectives to include sustainability and GHG reduction and to enable new regulations for EV infrastructure to be added.

Whenever a change of this complexity is requested, it requires supporting documentation. National model codes have standard change request forms that outline most of the information that policy decision makers require. This information can be assembled and provided by volunteers and EV enthusiasts. The more work that volunteers prepare and provide to policy makers, the easier their job is and the more likely it would be to gain acceptance. If you hand the policy makers the information they need on a silver platter, it goes a long way to build cooperation and the early adoption of EVs.

Typically the information that is needed to support a code or by-law change includes the following: 1) an explanation of which objective of the code or city plan is being addressed (GHGs, safety, health); 2) what the problem is (e.g. clarification, safety, new technology, compatibility with new products); 3) what the proposed solution is and the specific wording of a new regulation; 4) a solid justification with scientific analysis; 5) what the quantifiable benefit is such as tons of GHGs reduced; 6) what the energy savings are; 7) how it improves public health; 8) what the cost benefit is to the government; 9) how the new regulation can be enforced; 10) what alternative approaches could be used; and 11) who the key stakeholders are and what their level of support is. EV Infrastructure is often enforced through electrical inspections, but electrical inspectors are generally unconcerned with the building code or zoning by-laws so don't look for mandates from them. A simple by-law wording to state that: "Each (or x% of) parking space serving a residential occupancy shall have installed electric vehicle charging infrastructure in accordance with the electrical code" is sufficient. This one sentence can change the world.

Whatever information local organizations develop will help others if it is shared through publication. A small non-profit hobby organization can actually do a lot to promote EVs.

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Plugging In at Home for an overnight charge  
Plugs In at City Hall to attract Automakers

Vancouver



