TRANSPORTATION INFRASTRUCTURE & PUBLIC SPACE LAB

TIPS LAB

ELECTRIC VEHICLE FAST CHARGING INFRASTRUCTURE
Deployment Staging and Siting

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

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1. Introduction

The purpose of this report is to provide recommendations for a deployment sequence for Electric Vehicle Public Fast Charging Stations for the Province of British Columbia. In addition, it provides flowcharts to assist local and provincial authorities in selecting EV (Electric Vehicle) Fast Charging sites.

The introduction of new infrastructure to an existing built fabric is an exciting and challenging exercise. To the utility charged with this task, there are a broad range of considerations: the basics of range coverage and relieving range anxiety; locating stations where they will most easily attract drivers; considering what drivers might do while charging; and evaluating feasible economic and business models while integrating successful branding and wayfinding strategies. Locating each station strategically within the introduction of the broader network is key to the success of the charging infrastructure and the overall adoption of EVs.

In British Columbia, the provincial government has an interest in promoting electric vehicles to reduce carbon emissions. As nearly all of British Columbia's electricity is renewable resource-based, EVs can be a highly sustainable method of transportation, if electricity demand is well-managed. To encourage the adoption of EV technology, the provincial government has created the Plug-in BC Working Group with a mandate to install a network of highly visible infrastructure. There are many other stakeholders who have a critical role in the deployment of this infrastructure: city and town authorities, future station owners, EV owners, the utility, and other commercial owners who may want to incorporate EV charging as part of a green business strategy.

Fast charging presents a short-term market adoption gap to EV friendly regions: the infrastructure is necessary for basic functionality and to enhance public confidence, but is not anticipated to immediately provide a robust business model whereby electricity can be sold for a profit. The infrastructure and installation costs of fast charging stations are estimated to far outweigh the profit potential in the early stages. However, public charging does play a significant role in promoting the use of EVs and relieving range anxiety in EV drivers. In Japan, a pilot project by the utility TEPCO (Tokyo Electric Power Company) showed that although the public charging infrastructure increased the confidence of EV drivers by significantly reducing range anxiety, drivers still returned to charge their car at home. The change in behaviour, however, was significant: prior to the public fast charging stations being installed, most drivers returned home consistently with greater than 50% charge remaining; after the public stations were installed, many returned home consistently with less than 50% charge. From cases like this, it can be concluded that a reliable network of public fast charging stations is necessary to bolster driver confidence and encourage widespread EV adoption.

Province Scale Considerations

In determining deployment sequencing there are several indicators which can be examined. These indicators include population density, hybrid ownership, EV ownership, and origin-destination information. In applying these indicators to the examination of cities and towns, and the highways that connect them, we have developed a robust picture of the province and made recommendations on infrastructure deployment at both a city and corridor scale.

City and Highway Scale Considerations

In determining how the infrastructure should be deployed more locally, there are several criteria to be considered:

- Station location for visibility and convenience
- Station design, including branding strategies and potential synergies between charging and other activities
- An evolving business model
- Synergies between location, design, and the business model

In previous research, we examined these criteria in combination with the indicator information to determine a methodology for siting at a city and highway scale.

Street Considerations

Investigating street siting for stations requires thoughtful consideration of traffic patterns, electricity availability, property availability, visibility, cultural branding, and other planning and economic considerations. In this research we have developed a process to guide municipalities through siting stations – from the city and highway scale down to the street scale.

Economic and Development Potential in Siting Considerations

The explorations necessary for the development of a deployment methodology also raise deeper questions about the potential of this new infrastructure. The introduction of fast-charging stations in the early 21st century has a clear parallel with the introduction of gas stations in the early 20th century. In many cases, automobiles and gas stations were introduced without any regard for their urban impact, while in others, they were introduced in clear service of a new idea: the clean, functionally-separated, futuristic, highway-driven city. An awareness of this history highlights the opportunity for fast-charging stations to either be deliberately like gas stations, or deliberately different; if the "deliberately different" path is chosen, even in a portion of cases, new potentials are unlocked for fast-charging to have a larger impact on the reduction of emissions and fossil fuel dependence, as well as positively affecting the economic and cultural life of cities. For example, where gas stations have almost without exception represented a drain on small town centres by focusing economic activity on the highway strip, fast-charging stations might be embedded within small towns, turning the constraint of charging time into an opportunity for interaction with local businesses, cultural attractions, or public amenities. In a larger urban setting, fast-charging stations might be synergistically located with potential electricity producers, highlighting the role of energy in the city. These are just two examples of the ways decoupling fast-charging stations from the conventional gas station model could foster a qualitatively different relationship between cars and the city than that which was accepted for the previous century.

2. Background & Previous Research

2.1 Introduction to the Planning Framework

The research contained in this report is based on previous research carried out for BC Hydro and CEATI (Centre for Energy Advancement and Technical Innovation) which evaluated the siting of stations from a planning perspective and developed a framework for the approach. This research takes the framework to a more detailed site level – locating a site on the ground and analyzing traffic constraints/visibility/distances as well as identifying a process for incorporating the invaluable input of municipalities and stakeholders. This research further provides a recommendation for staging the network deployment on a provincial scale.

The previous research began with important content areas such as network scenarios, siting synergies, interface design, branding, and business models clearly defined; however, their organization and relationship to each other were less clearly defined. As the research unfolded, salient questions emerged such as: what are the overall objectives for introducing electric vehicle infrastructure? Though it was clear from the outset that time would play a role —that an entire network could not be deployed at once—it became increasingly evident that a defined timeline from network inception to maturity should act as the backbone for the framework, infusing the whole process with the recognition that the network will evolve elastically. Once the importance of a timeline was acknowledged, dates were attached to the deployment for working purposes; these could easily change. With BC Hydro aiming for immediate deployment, the timeline begins in 2011. It is projected towards 2020, a date that many public bodies have adopted to meet a first set of robust sustainability targets—the City of Vancouver with it's "Greenest City 2020" campaign among them (see Figure 2).

For the time being, EV market maturity is defined as 15% of total new vehicle sales (see Figure 2). Optimistically, this number may evolve upward, but currently we have considered full EV adoption to occur when 15% of the new buyers in the marketplace are choosing EVs. As the adoption process remains consistent, the numbers can be refined as EVs arrive in the marketplace and uptake is better understood.

The timeline concept dovetails with the well-defined "speed of adoption" pattern that typically unfolds with any new technology, from an iPhone to a hybrid vehicle. Detailed in the next section, this pattern encompasses the categories of innovators, early adopters, early majority, late majority, and laggards. The timeline also coincides with the key objectives detailed in Section 1.4.2. While all of the objectives are important, those such as visibility and convenience are the most critical at the outset, when a potentially sceptical population needs to be enticed to adopt the new technology. Other objectives such as the displacement of gas vehicles, decreased use of energy, and use of cleaner energy, would only have a measurable impact in the long term.

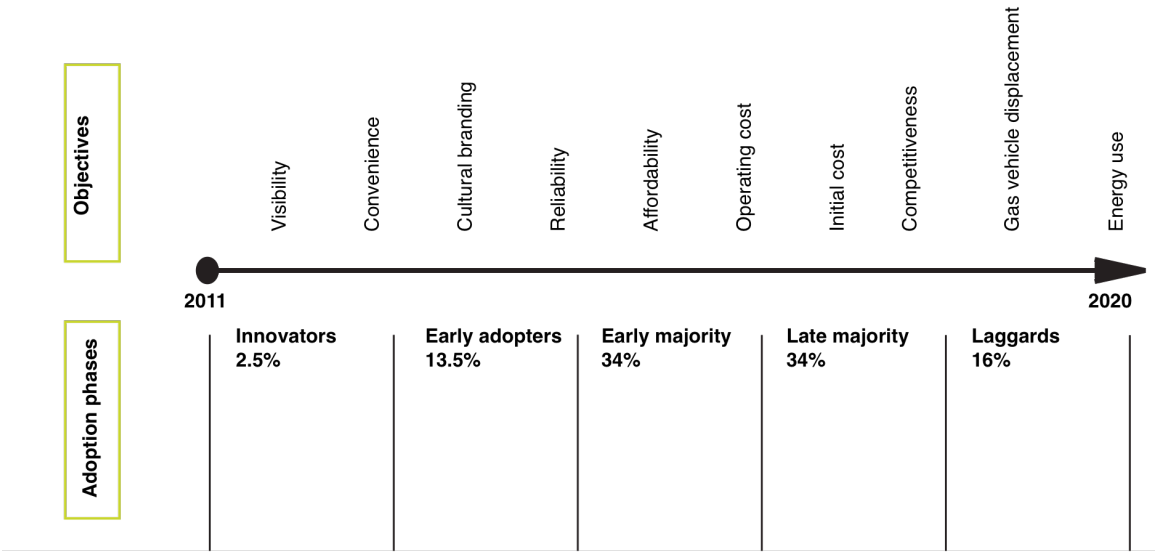


Figure 2-1 Planning Framework Objectives and Adoption Phases

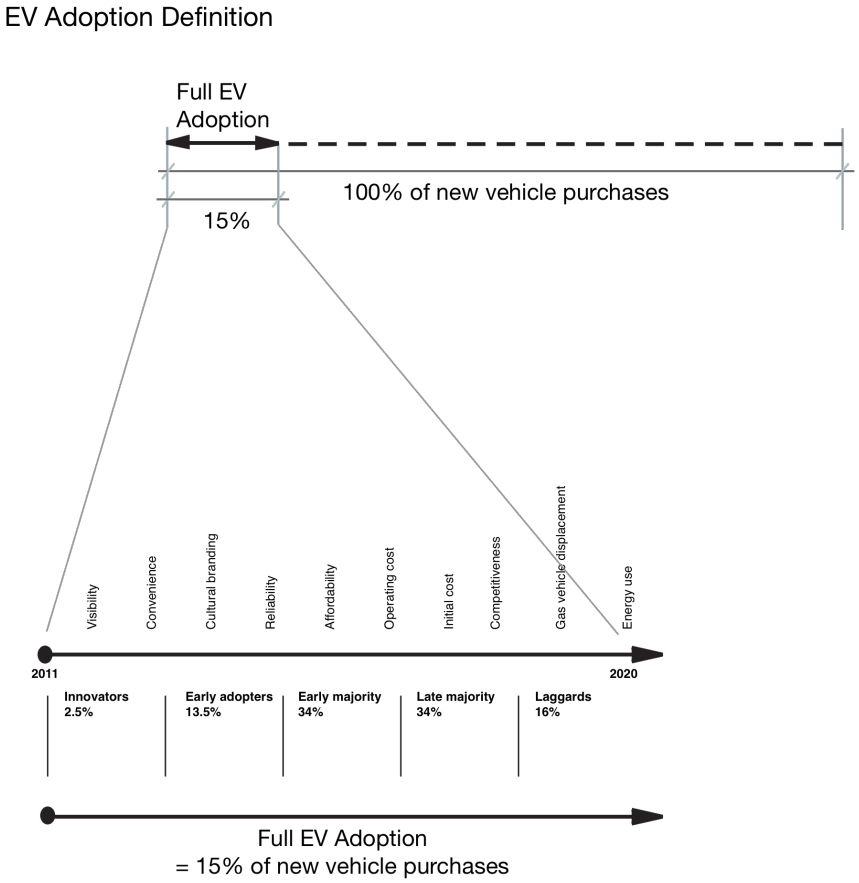


Figure 2-2 EV Adoption Definition Diagram

Adoption Phases for New Technologies

The adoption and diffusion of innovations in products and services tend to follow a well-defined path as studied and documented in the work of Everett Rogers. Rogers was a rural sociologist who spent his life researching the adoption patterns and the diffusion of innovations.[1] Innovations are first sought after by relatively small groups of people known as *Innovators* and *Early adopters*. By briefly reviewing Rogers' work, we can understand the core adoption and diffusion of innovation processes that are at the heart of the EV charging station infrastructure development project we are studying.

Rogers conceived of and tested his ideas empirically across a broad range of products, services, and adopter populations. He broke adopters into five groups: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. Rogers was able to characterize each group according to specific socio-economic traits. For example, *Innovators* are first to adopt innovations and have a high risk appetite. They are the youngest of the adopter groups, are typically members of the highest social class, have significant financial acumen, possess significant social ties (particularly to other innovators), and are knowledgeable about science and innovation. Their financial well-being allows them to take risks and bear failures. The graph in Figure shows the adoption curve of an innovation (orange line) and the distribution of Rogers' five classes of purchasers who are normally distributed across the bell curve (blue line). We anticipate that the adoption of EVs, hybrids and other energy-saving vehicle technologies will follow these patterns with their individual and cumulative market share contributions.

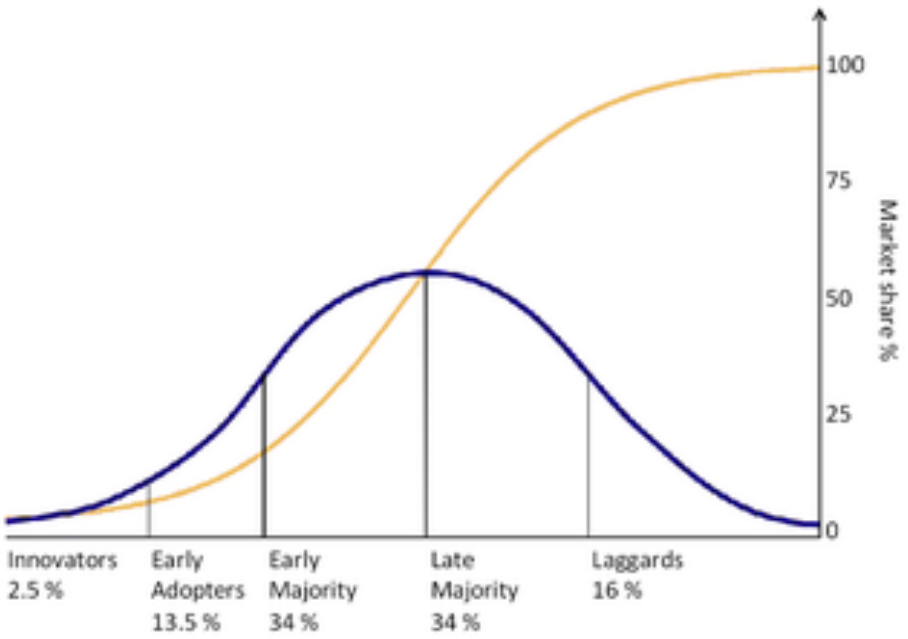


Figure 2-3 Graph of Adoption and Adopters and their Cumulative Market Share Contributions

Source: http://en.wikipedia.org/wiki/Diffusion_of_innovations

[1] See the most recent edition of Everett Rogers, *Diffusion of Innovations, Fourth Edition*, (New York, NY: The Free Press), 1995, for a wealth of conceptual and empirical information on the adoption of new products and services.

Table 2-1, provides brief definitions for each of the five classes of adopters. We can refer back to these definitions as we confront issues with EV station siting, branding and the business model, all of which rely on understanding adoption patterns and processes.

Table 2-1 Technology Adopter Patterns

Adopter category	Definition
Innovators	Innovators are the first individuals to adopt an innovation. They are willing to take risks, youngest in age, have the highest social class, have great financial lucidity, are very social and have closest contact to scientific sources and interaction with other innovators. Risk tolerance has them adopting technologies that may ultimately fail. Financial resources help absorb these failures. (Rogers 1962 5th ed., p. 282)
Early Adopters	This is the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. Early adopters are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters. More discrete in adoption choices than innovators. Realize judicious choice of adoption will help them maintain central communication position (Rogers 1962 5th ed., p. 283).
Early Majority	Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters. Early Majority tend to be slower in the adoption process, have above average social status, contact with early adopters, and seldom hold positions of opinion leadership in a system (Rogers 1962 5th ed., p. 283)
Late Majority	Individuals in this category will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of scepticism and after the majority of society has adopted the innovation. Late Majority are typically sceptical about an innovation, have below average social status, very little financial lucidity, are in contact with others in late majority and early majority, and have very little opinion leadership.
Laggards	Individuals in this category are the last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little to no opinion leadership. These individuals typically have an aversion to change-agents and tend to be advanced in age. Laggards typically tend to be focused on "traditions", likely to have lowest social status, lowest financial fluidity, be oldest of all other adopters, in contact with only family and close friends, very little to no opinion leadership.

Source: http://en.wikipedia.org/wiki/Diffusion_of_innovations

Objectives for Public EV Fast Charging Stations

The objectives for the public EV fast charging station network were derived through a planning and business lens over a range of scales, from the micro-urban scale of a parking space, to the global scale of emissions reductions. These objectives attempt to address the concerns of all stakeholders, though some objectives may be more important to individual stakeholders over the course of the network deployment. For the framework, the objectives have been prioritized over the course of deployment in the following order:

Visibility: increase the public awareness and market profile of EVs, establish high-impact branding and contribute positive urban design in station locations.

Convenience: provide service in obvious, well-signed locations, ensure short wait times, and provide a simple user interface .

Cultural branding: position EVs as progressive, green, politically aware, and innovative, building on their ability to decrease GHG emissions and their appeal as a new technology.

Reliability: provide robust maintenance and service support, prioritize consistency across different types of fast-charging stations.

Affordability (Consumer): maintain competitive rates through early phases of adoption, i.e. rates may fluctuate to remain competitive with gas prices.

Operating cost (Utility or Service Provider): minimize operating costs through vandal-resistant design, simple user interface, preferring automated stations over manned stations

Initial Cost (Utility, Service Provider, or Land Owner): minimize installation costs through pre-fabricated or mass-customized units and standardized installation methods, work with financial institutions to provide favourable terms.

Financial competitiveness (Land Owner): work towards financial performance on highly valuable urban land, prioritize deployment as an add-on to existing business, consider locating stations on under-utilized or under-performing sites.

Displacement of gas vehicles: ensure network robustness so that EVs are a clear alternative to gas vehicles rather than an additional mode of transport, increase market share to at least 15% of total vehicles to have a measurable impact on the purchase of gas vehicles.

Energy use: continue to increase EV market share to magnify the impact of EVs which are one-to-one more efficient than gas vehicles, promote efficient driving patterns through network deployment, reduce the need for single occupant vehicles (SOVs) with emphasis on other forms of electrified transport, i.e. buses, streetcars, light rail.

Framework Areas

With adoption phases and objectives tied to the timeline as the backbone of the framework, the substance of the framework can be fleshed out. This substance is focused in three areas: station location, station type, and business model, each phased over the duration of the timeline. The methodology and conclusions for each of the three areas form the body of this report. They also form the critical points of investigation to be examined if this framework is applied to other jurisdictions.

Table 2-2 Framework areas and description of each

Station Location	Strategic, geographic information-based locations deployed as a tiered network serve the evolving objectives.
Station Type	Defined by land tenure, formal typology (i.e. curb-side vs. stand-alone business), and branding strategies, these types tie in directly to the business model, facilitating early adoption and evolving toward market maturity.
Business Model	Defined by diminishing degree of subsidy, these illustrate a path toward a fully sustainable business model, facilitating short-term adoption goals while supporting long-term financial competitiveness.

This framework gains its strength from synergies and elasticity. Continuous synergies between the three parts over the course of network deployment create a positive feedback loop; at a given time, the business model reinforces the station location and station type, and vice versa. These synergies taken together reinforce the objectives relevant to the given phase of deployment. Elasticity means that the framework can easily be tailored to the unique conditions of different jurisdictions as well as contend with the inevitable flux of conditions over time. In its most obvious form, this means that adoption phases and the overall timeline can be shortened or lengthened to suit; it may also mean that overlaps between phases are shortened or lengthened and new synergies identified.

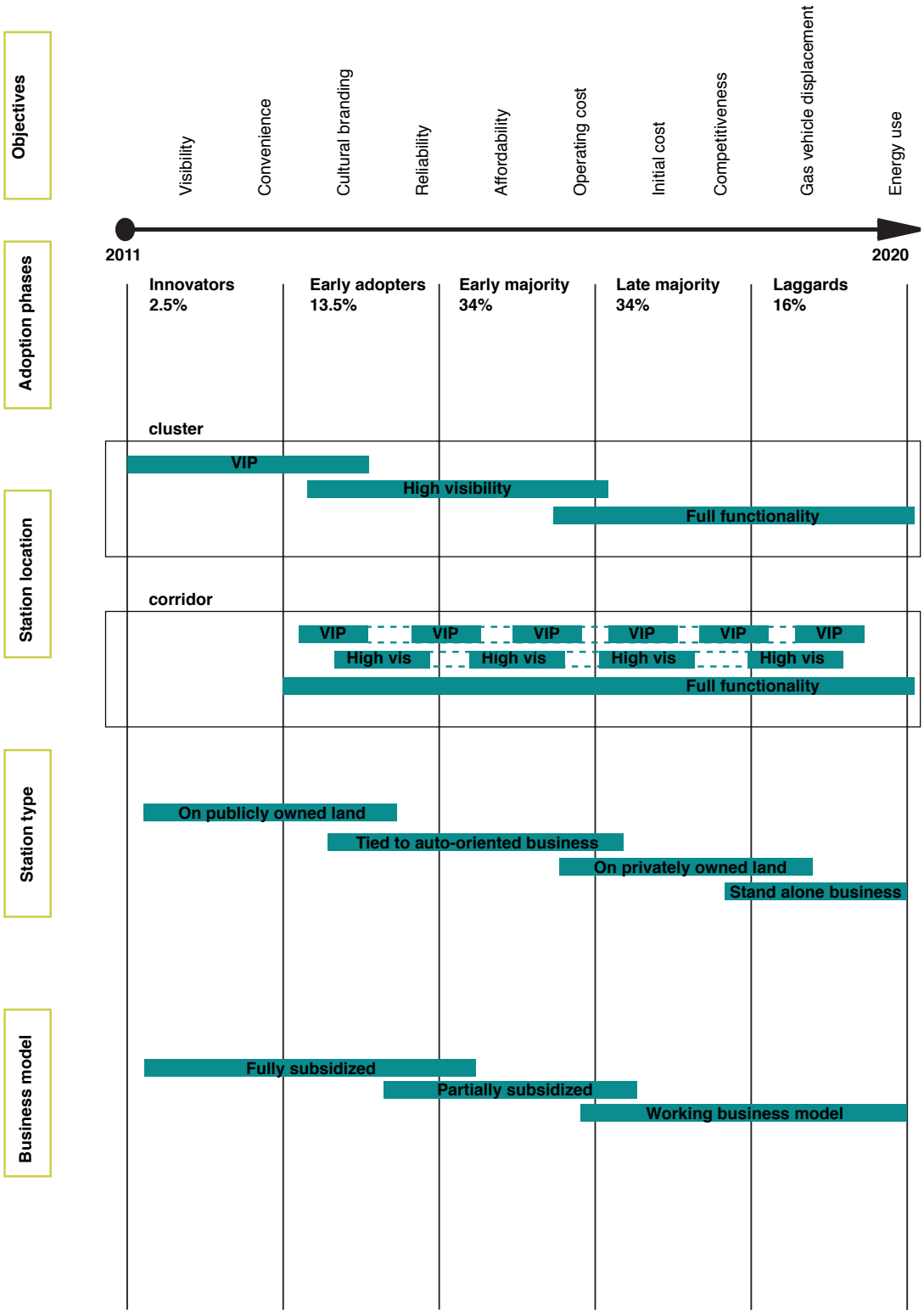


Figure 2-4: Planning Framework

3. STATION LOCATION

3.1 Cluster and Corridor Differentiation

For the purpose of this framework, the station location methodology has been differentiated between "clusters" and "corridors". "Clusters" are cities, towns, or regions of development where stations are to be located and "corridors" are highway routes that require charging infrastructure. The two are differentiated because they require unique station location methodologies. In the case of a highway, the station location methodology is based on an analysis of vehicle range and an assessment of how the range can be met with the existing spacing of towns or developments along a route. "Clusters", on the other hand, are defined by extensively intersecting networks that provide frequent and varied opportunities for locating fast-charging stations.

The approach is different for each: corridors are straightforward with a range being identified and the stations positioned accordingly along the length; clusters are investigated from the perspective of population density, commercial activity areas, hybrid ownership, amount of traffic on streets, and important points in the town/city.

3.2 Corridors

Highways have been designated as corridors for the purposes of this framework to help describe the nature of the infrastructure they will require. The defining characteristic of corridors is the relationship between distance covered and the range of available electric vehicles. If electric vehicle range is not accommodated along corridors the vehicles become ineffective. As a result, the "full functionality" phase is critical for a length of corridor and must be introduced earlier than in the cluster context, where home and office charging will be widely available. The prioritized objectives are still relevant, but more of them must be addressed at once.

3.6.1 Corridor Staging

As mentioned above, the "full functionality" phase would be the first to be introduced along a length of corridor in conjunction with "early adopters" to make intercity travel viable as early as possible. "VIP" and "high visibility" stations still play an important role, though one qualitatively different than in the cluster context. Within a corridor, VIP and high visibility stations could double as full functionality stations while promoting the distinct character of a given location. Electric vehicle charging infrastructure has the potential to positively affect the urban and interurban context in distinct opposition to the impact gas stations have historically had. Where gas stations have led to sprawl and homogenous highway-side development, promoting the convenience of the strip as their main attraction, electric vehicle infrastructure could be largely place-based, tying into the unique identities and attractions of small towns or the outlying areas of large cities. This would help bolster the "cultural branding" objective by helping local economies and repositioning autonomous road travel as a positive influence.

3.3 Clusters

A specific station location methodology has been derived to address the unique parameters of clusters, supporting the prioritized objectives identified in Section 1.

3.4 Network Development with Station Types

The general approach to locating stations and the phasing of stations is considered as a tiered network that will serve evolving objectives over time. A diagram describing this can be seen in Figure 2-4.

At the beginning of the process, the primary objective is to enhance visibility of the EV charging stations to introduce public confidence, reduce range anxiety, and show support for the EV. Subsequently, more objectives come into play to bolster consumer confidence through the reliability and affordability of the network. As the continuing good faith of early adopters will be crucial to promoting ongoing adoption, it may be important to prioritize stations that serve high concentrations of early adopters. As the network matures, full functionality, distributed throughout a cluster, will become the goal. These four types of stations have been designated Stage 1: Very Important Place Stations, Stage 2: High Visibility Stations, Stage 3: Early Adopter Stations, and Stage 4: Full Functionality Stations (See Figure 3-1). Each type has a more specialized social function linked to the stage of EV adoption and enables a priority staging of the network. Ultimately, the four station types will work together to form a complete network.

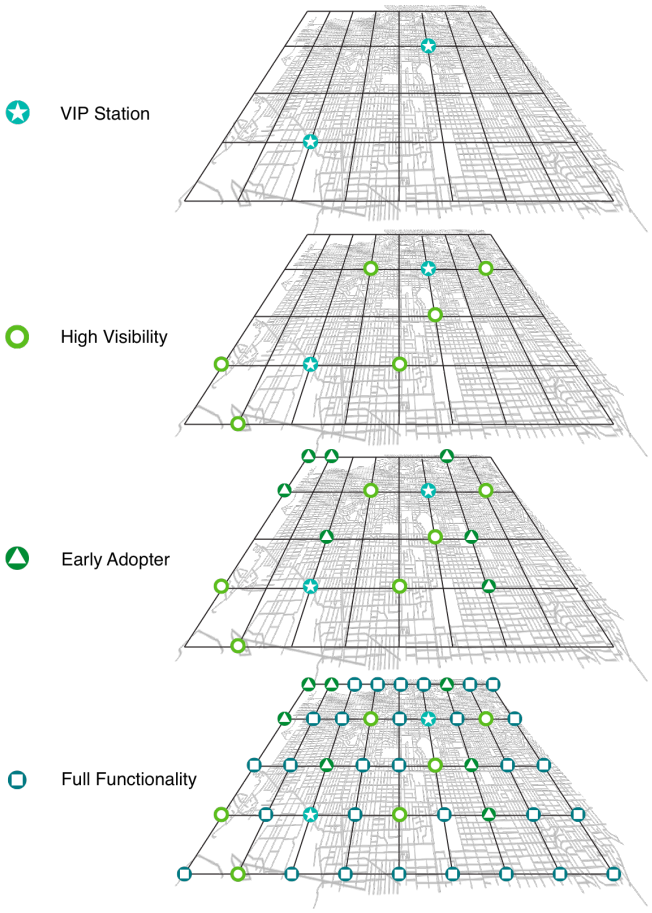


Figure 3-1: Network Staging Diagram

3.5 Stakeholders

As in any project of this scale, multiple levels of stakeholders have an interest in the outcome. Each stakeholder brings different values to the project and will prefer certain decisions over others. It is important to maintain an awareness of this over the course of the project in order to attain an outcome that will be most successful for all involved. The following stakeholders and their interests have been identified, however, these working assumptions may be modified based on real world feedback over the course of the project.

Provincial Government

The British Columbia government is the lead in the initiative to reduce green house gases through the introduction and adoption of electric vehicles. Their overarching interest is to reduce green house gas emissions. They therefore favour the use of electricity from renewable sources to power EVs and increasing the adoption of EVs in order to displace gas vehicles. They are interested in being seen as visibly promoting EV use and supporting the new infrastructure necessary for EVs.

BC Hydro

BC Hydro, as the main electric utility in the province, has an obligation to serve all new loads including electric vehicle charging stations. Overall, they are interested in reducing energy use and reducing GHG emissions. As building new hydro infrastructure is costly, they are attempting to meet increased demand largely through energy efficiency and conservation, though one new hydro project is underway. It is also in BC Hydro's interest to manage peak loads, ensuring that the amount of electricity produced is used effectively by encouraging charging and other electricity uses at off-peak times. BC Hydro does not have an official mandate to support EV adoption but they are proactive and engaged in the EV adoption process; they have been preparing for the arrival of the new load by conducting numerous studies and vehicle demonstrations to thoroughly understand the impact of a new transportation load on their system.

Municipalities

The municipalities will be the lead in the station selection process and will be the party facilitating the consultation of other stakeholders in this process. The municipalities involved are interested in being good citizens and respecting their constituency's interests as well as promoting economic development in their towns.

Land Owner

The land owner is any entity that owns the parcel of land the electric vehicle charging station is built on. Land owners may be municipalities, other public bodies, private entities, or BC Hydro itself. The land owner's prime interest is most likely the profitable use of the land, though they may be driven by other potential benefits such as green branding. Land owners would likely favour smaller stations combined with other business opportunities for more profitability.

EV Owner

The EV owner is the general population consumer who has acquired an electric vehicle and will be a customer of the electric vehicle charging station. Their primary interest is most likely in the convenience, reliability, and affordability of charging. The EV owner will prefer stations located in proximity to other destinations, such as a commercial artery or a community centre, so they can make use of their time while they charge. Ubiquity, availability, and economy will be important.

Service Provider

The service provider is the entity responsible for the day-to-day operation of the electric vehicle charging station. The service provider could be a variety of entities such as:

- The host business, such as a gas station or retail outlet
- The utility, if the local utility adopts a business model for providing public EV charging services
- A third party membership-based service provider such as Coulomb or CAA

Although a natural market service provider may not be an evident immediate stakeholder, they are important to consider in the context of working towards a viable business model. The service provider will be interested in the culture and branding of the stations and the customer's attitude towards the stations. They will also be interested in EV market share and the station profit model.

3.6 Charging Basics and Range Mapping Analysis

Charge type	Voltage	Time to max charge
Level 1	120V AC	7-8 hours
Level 2	240V AC	4 hours
Fast charging	DC	30 min

Table 3-1: Charging Levels and Times to Charge

This report is concerned with fast-charging, which will almost exclusively occur in the public realm. While the rare individual might install a fast-charger at home (roughly equivalent to installing a gas pump at home), this is unlikely due to cost and permitting requirements. Level 1 and Level 2 charging may occur in the public or private realm. The City of Vancouver already requires new homes to be "electric vehicle ready" with appropriate electric chases in garages. Larger residential developments are also already beginning to include Level 1 and Level 2 charging. Level 2 charging in North America requires a special installation typically put in solely for electric vehicles. Workplace charging is also becoming more common, and may be either Level 1 or Level 2.

The public charging addressed in this report may include such locations as streets, grocery stores, coffee shops, community centres, airports, transit hubs, and rest stops.

3.7 Electric Vehicle Range Mapping.

In order to identify a realistic range to be applied to corridor maps, an extensive analysis was conducted of available and projected electric vehicles. The manufacturers' estimated ranges as well as the EPA values that should be applied to those estimates were evaluated. From the analysis that follows, it was concluded that a range of 73.5 km would be realistic to consider in the corridor context. See appendix B for a summary of the study.

The analysis first surveyed all electric cars on the market and then narrowed the study to those that would be available in the geographic region being considered (British Columbia). Only cars that are highway worthy were considered. Highway worthy is defined by the following conditions: vehicle speed of greater than 100km/h, vehicle range (given by the manufacturer) of greater than 100km per charge, and four seats. The distances claimed by the manufacturers,

however, need to be modified based on the types of ranges achieved in EPA tests, which more closely reflect real-world performance.

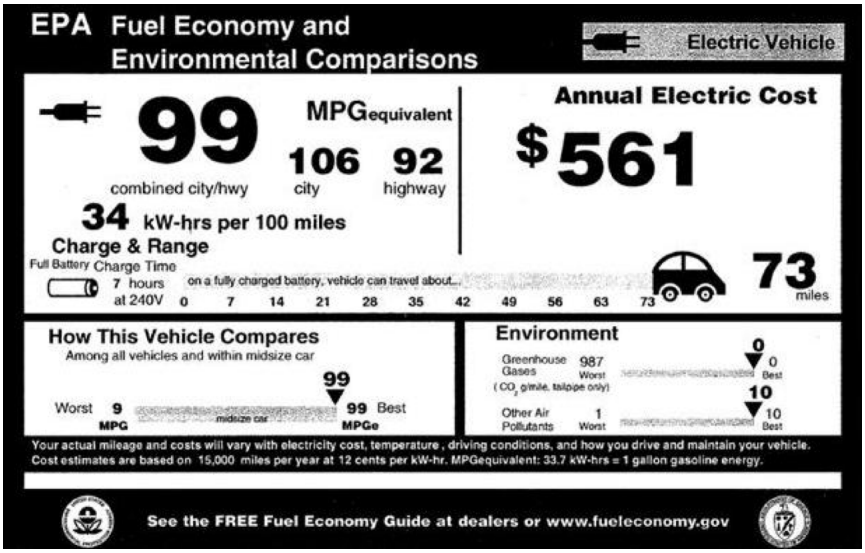


Figure 3-2: EPA analysis of an EV

This was accomplished using the EPA rating figures which are already available for the Nissan Leaf. The EPA test projects a range of 73miles / 117.5km for the Nissan Leaf, while Nissan claims 100miles / 160km. The EPA figures are based on a detailed 5-cycle test which includes city, highway, high speed, air conditioning, and cold temperature. Cars may achieve better performance than the EPA figures suggest, however, the conservative estimate is appropriate for range mapping.

From this study, we conclude that the real range for the Nissan Leaf is 73.44% (117,5km / 160km) of the nominal range given by Nissan. Applying this percentage to the car with the lowest range in the overview, the Blade Electron (which has a nominal range of 100km), provides a minimum range for commercially available, highway worthy cars of 73.5 km (100km x 0.7344). This translates to the maximum feasible distance to be allowed between highway charging stations. Though future advances in battery technology are likely to allow a greater range, this relatively frequent recommended spacing will help to comprehensively serve a more saturated market in the future.

This analysis will be examined in more depth in future. A more detailed analysis of grades and electricity consumption to ascertain more accurate distance capacity for the vehicles may be required.

4. Network Staging

4.1 Network Deployment Strategy

The general goal of the network deployment strategy is to provide a network of stations to support EV adoption that the public understands and feels confident about. The placement of these stations is key in the understanding of the public and in their convenience but signage and

presence in the virtual realm (on GPS systems, web etc) is also critical in the perception of the robustness of the network. The more robust the network, the more likely individuals are to seriously consider buying an EV. Budget and resource constraints being a reality, the question considered was how to make a robust feeling network using as few stations as possible?

4.2 Leveraging the Level 2 Charging Station Presence

In order to give the perception that the network is robust, leveraging the Level 2 stations will be very beneficial. The Level 2 stations should be branded and visually similar to the Fast Charging Stations and in this way, the public will feel that the EV is much more supported than if the two station types are independent from each other. Also, in order for the network to feel like a network, a consistent signage and visual presence, both in Level 2 and Fast Charging stations should be maintained from one station to the next. If branding of hosts or co-branding is desired, this can be designed into the intent of the visual appearance of the stations.

4.3 Options for Level of Service and Staging

Level of service to the public is related to, but different from, staging. The level of service to the public must be decided upon based on the goals of the regional EV proponent(s) and the budget available. Once this has been decided, the staging plan can be implemented. The level of service describes what areas will be covered by the charging stations—will it be the whole province, for example, or targeted cities and highways? On one end of the spectrum is full service: this would include public fast charging stations along all highways (corridors) and convenient public stations in proximity to most destinations within urban areas (clusters). This level of service, while desirable, requires considerable investment at the outset and may not be feasible from the financial standpoint of the investing authority, raising the question of whether to concentrate service within focused areas or disperse service over a broader area, or some combination of the two. Staging the roll-out of public stations in limited areas may help to answer this question. As stations are strategically installed, information on usage can be analyzed to confirm the most effective locations for future stations.

Service Level and staging can be considered in more detail once proponent(s) can identify a budget and specific goals; however, in general, the Service Levels can be considered as follows:

1. Full service clusters (all cities fully covered) and full connectivity corridors (all corridors)
2. Selected clusters (selected cities) and full connectivity corridors (all corridors)
3. Selected clusters (selected cities) and partial connectivity corridors (selected corridors)
4. Targeted cluster portions (parts of selected cities) and selected connectivity corridors (selected corridors)
5. Targeted cluster portions only (parts of selected cities) or selected connectivity corridors (selected corridors)

Partially servicing a corridor route would be ineffective given the limited range of EVs, so any corridor deployment must be done all at one time.

Since the budget is limited for the first stage of the network in BC, an approach has been proposed which moves from Service Level 3 in the next few years to Service Level 1 in the future (perhaps 2020 depending on EV uptake). Our opinion is that individual stations placed outside a

network of stations will not convince the public that the EV is supported and the public may question the point of their installation. The idea is therefore, to install enough stations in a particular region to show the public that the EV is well supported.

4.4 Seed Networks

In order to operate within limited budgets and still create meaningful networks, a 'seed network' approach was developed. A 'seed network' provides coverage of a regionally defined group of cities and towns connected by highways, concentrating resources to instil confidence that the network is convenient and sufficiently serviced. It could also be equated to a midway point in the Early Adopter stage in the previous staging discussion; however this will partially be dependent on the commercial, demographic, and transportation characteristics of the town or city under consideration. Station density must be sufficient to create the appearance of a robust network, rather than a station or two placed in isolation. Compared to current gas station density, EV Fast Charging stations may appear sparse, however this may soon reverse as gas stations continue to retrench and EV stations spread.

A seed network targets resources in areas where early EV uptake is expected (using hybrid uptake as the accepted predictor) and population density ensures that highly visible stations will impact the most people allowing the public to understand that the EV is being supported. Decisions for individual station placement have been discussed previously and staging is discussed below.

4.5 Network Staging Indicators

Indicators of early adoption as well as data on where people live and work provide valuable information about where in the province the new infrastructure should be deployed. Each of the indicators can be examined individually and then overlaid to determine productive relationships. In overlaying the mapping, patterns and consistencies emerge which provide direction for staging decisions.

In order to recommend a deployment approach, the following information has been examined and overlaid:

Population density (Figure 4-1)
Hybrid adoption (Figure 4-2)
Current (very recent) EV car ownership (Figure 4-3)
EV dealership locations (Figure 4-4) (where the car companies have chosen to sell EVs – indicative at this early stage of likely uptake)

Further data on highway Annual Average Daily Traffic is forthcoming; ideally, Origin-Destination (O-D) data for the province would be examined. The O-D data does not seem to be available on a provincial scale, although some regions have this data.

Population density

Population density is an indicator of uptake not only because a large number of people live in an area but also because a higher population density allows a greater number of people to notice the EV stations, providing potential incentive to adopt an EV. It is interesting to note the fastest growing regions in BC: Greater Vancouver, Victoria, Nanaimo and the Okanagan. This may be indicative of future population. (Figure 4-1)

Hybrid adoption

Hybrid adoption is considered a good indicator of future EV uptake. As such, we have relied heavily on hybrid ownership information to target early adopter areas. Hybrid information is provided by ICBC (Insurance Corporation of British Columbia). Due to privacy constraints, we have an information resolution of three postal code alpha-numeric characters. The most Hybrid adoption has taken place in Greater Vancouver, Victoria and Kelowna and this is similar to EV ownership to date. Maps of this information are included. (Figures 4-2 to 4-3)

Current EV Ownership Data

Although EVs have only been on the market for a few months, we do have information concerning cities where EV owners reside. This provides a very preliminary indication of likely EV uptake and also indicates where the people who might use the stations are currently located. (Figure 4-3)

EV Dealerships

Data is available on car dealerships which are intending to sell EVs. It is anticipated that this is a good indicator at this stage of where early adoption might take place. Not all dealerships will sell EVs as the staff, both sales and maintenance, must be specially trained. (Figure 4-4)

Figure 4-1 Population density

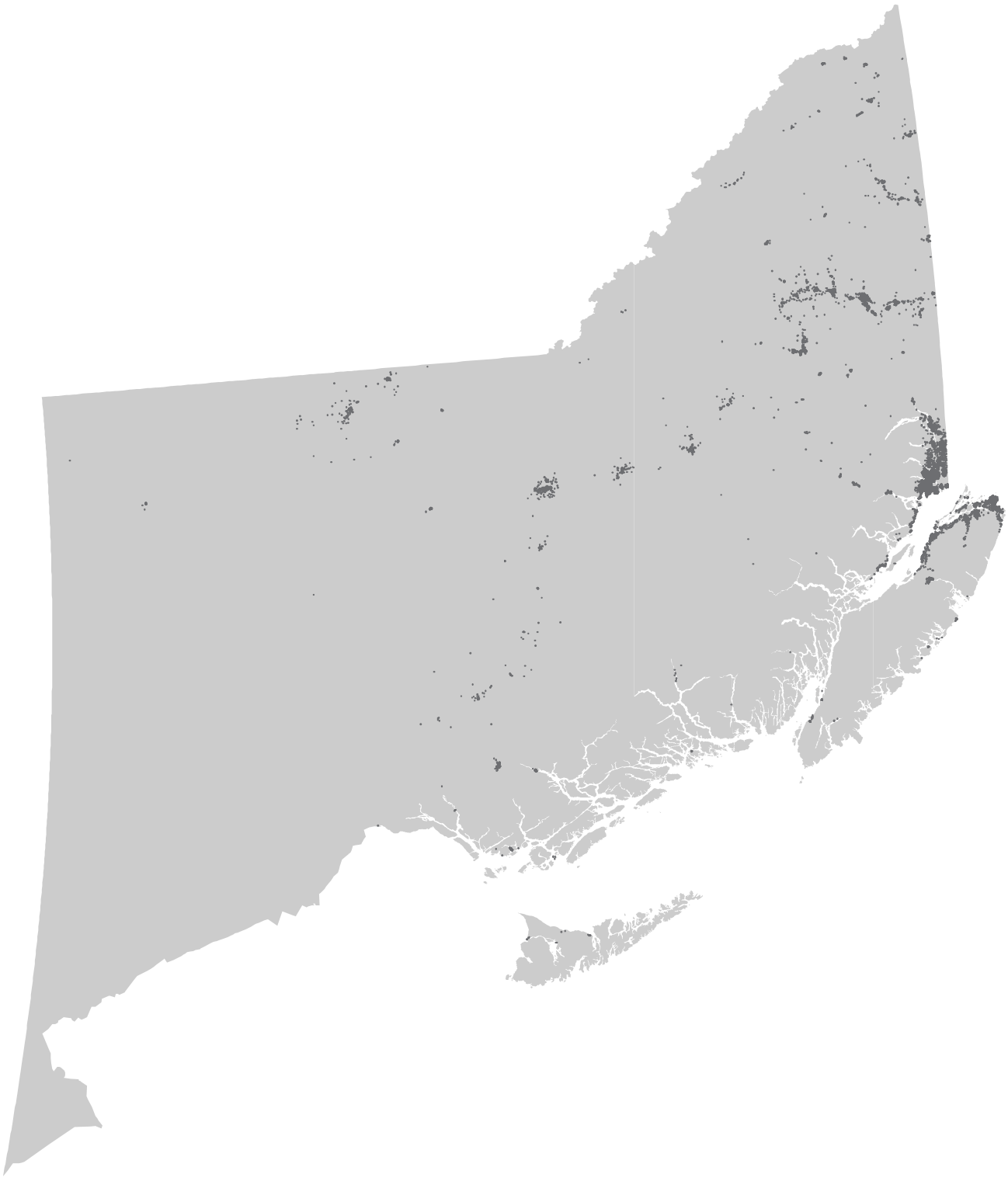


Figure 4-2 Hybrid ownership

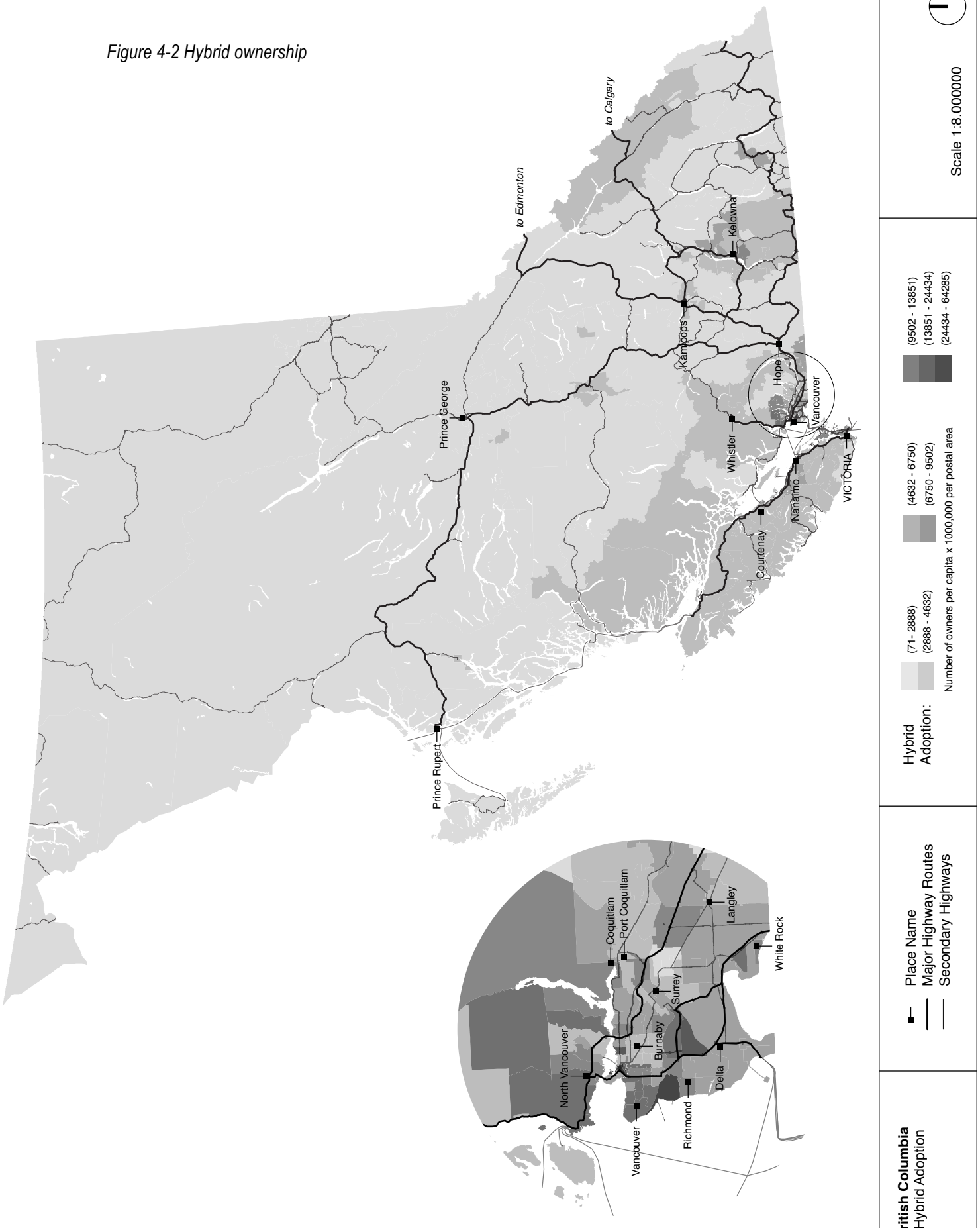


Figure 4-3 Current EV car ownership

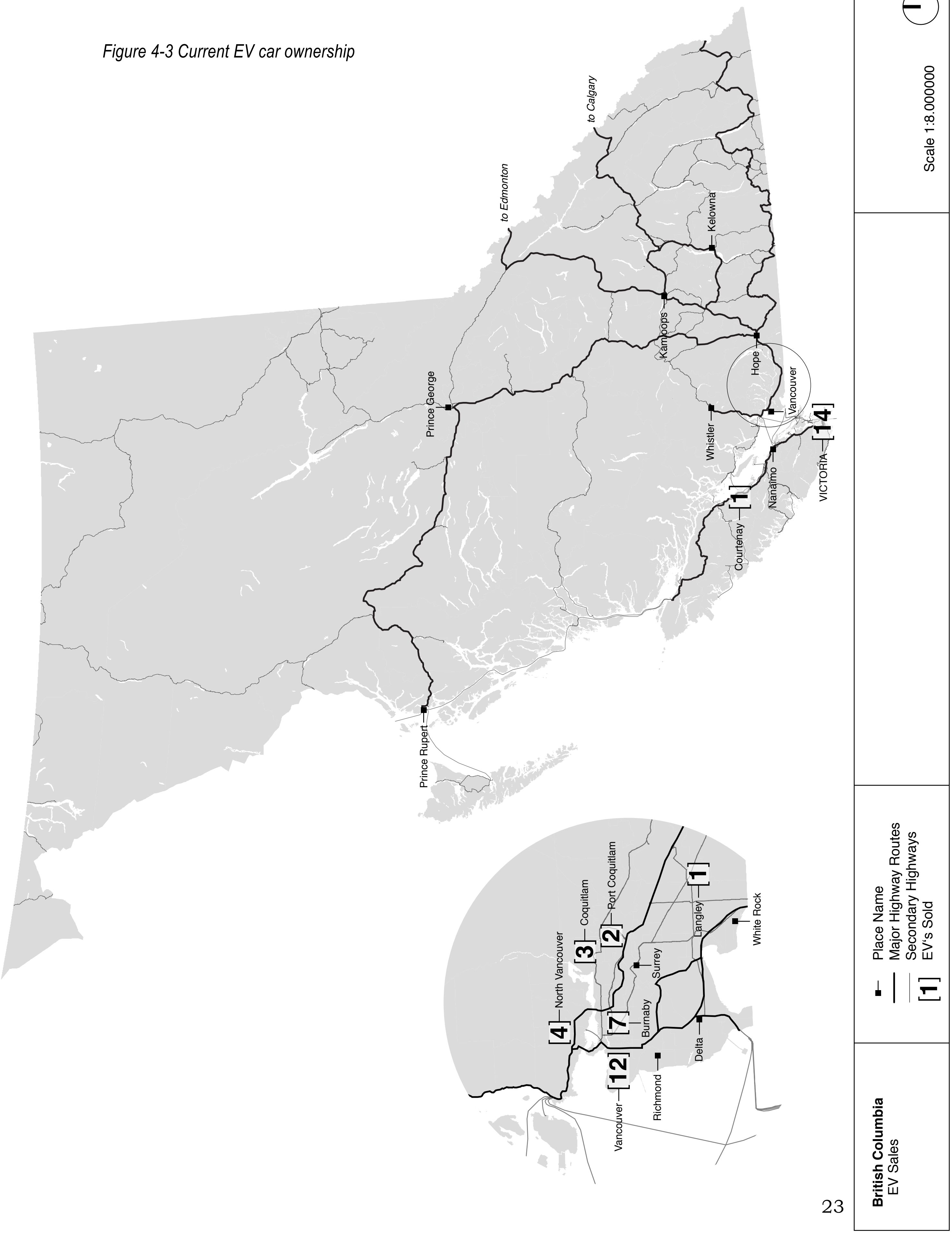


Figure 4-4 EV dealership locations

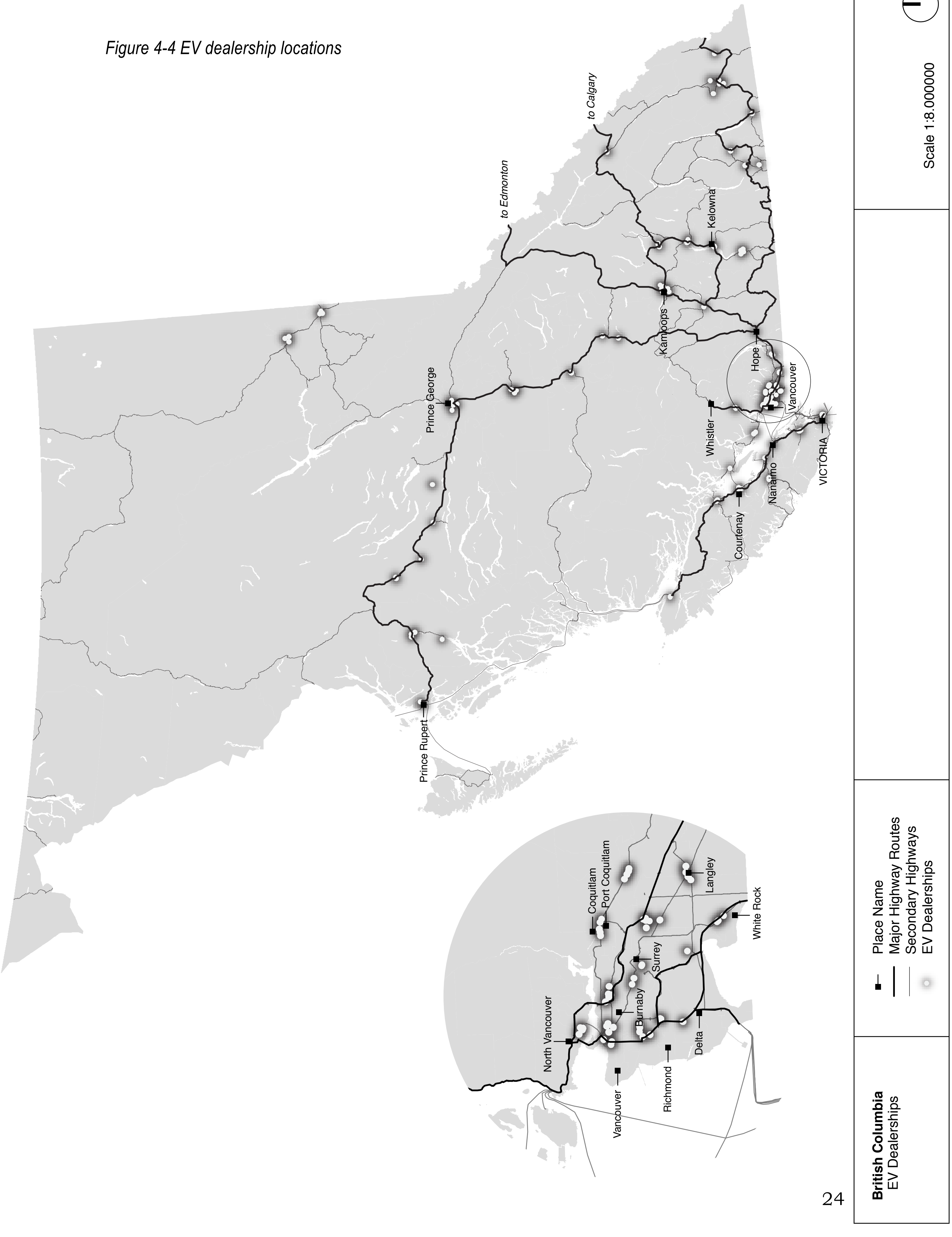
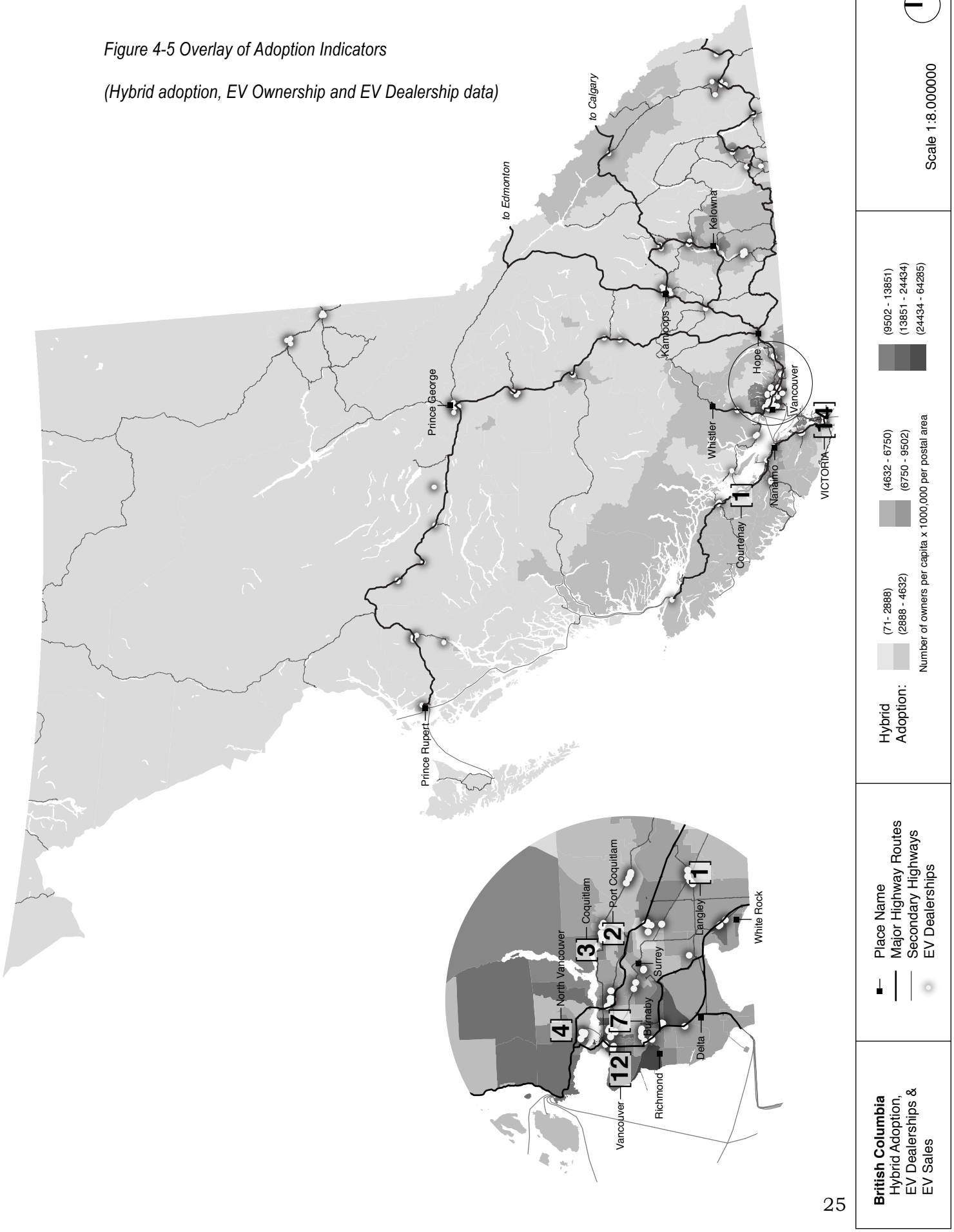


Figure 4-5 Overlay of Adoption Indicators

(Hybrid adoption, EV Ownership and EV Dealership data)



4.5 Provincial Deployment

In deploying provincially, the first set of stations being implemented would be the Very Important Place stations (VIP). These stations are meant to call attention to the fact that EVs are supported. They should go into places with high population density and high visibility, such as major tourist attractions, where significant numbers of people will see the stations. The best indicator for a VIP station is population density, so this has been the primary consideration in the deployment of the VIP stations.

Soon after the VIP stations are deployed, the Corridors will begin filling in to connect these stations and support travel from one centre to another. Depending on the deployment option chosen, the Corridors may facilitate connection of as many major centres as possible with as many other major centres as possible. The approach for this, as previously described, involves planting seed networks and then connecting them. The focus for these stations is more on connecting centres than developing the market in the centres themselves.

After corridors have begun being deployed, the High Visibility stations will begin to be installed. The 30 stations planned for in this deployment may be deployed up to the middle of the "High Visibility" station installation stage which should be equivalent to slightly leading the market while not moving too far ahead of the market. Reaching the High Visibility stage depends on the deployment option chosen.

VIP Station Analysis

The analysis of demographics to determine deployment staging closely examines population data. Population densities in the Census Metropolitan Areas in 2011 are as follows for cities over 50,000 in population:

BC CMAs Over 50,000 Population

Vancouver	2,404,911
Victoria	358,864
Kelowna	188,642
Kamloops	101,577
Nanaimo	101,837
Chilliwack	92,434
Prince George	87,512
Vernon	60,619
Courtney	54,359
TOTAL	**3,450,755**
TOTAL BC POP	**4,584,102**

The CMAs have been broken down into regions for the purpose of developing deployment options. The regions are (in order of hybrid adoption indicators from most to least):

Lower Mainland	(Vancouver, Burnaby, Richmond, Delta, Surrey, Coquitlam)
Island	(Victoria, Saanich, Nanaimo, Courtney)
Okanagan	(Kelowna, Kamloops, Merritt, Vernon, Penticton)
Southeastern BC	(Fernie, Nelson, Cranbrook)
Central BC	(Prince George, Quesnel, Williams Lake)
Northeastern BC	(Fort St John, Dawson Creek, MacKensie)

Northwestern BC (Prince Rupert, Terrace, Smithers, Kitimat)

Breaking the province into these regions comprised of towns and cities which may be easily connected given current EV ranges, provides the basis for the seed networks.

This list order also matches the density of Hybrid Adoption across the province. The Lower Mainland has the most hybrid adoption, followed by the Island, Okanagan, Southeastern BC, Central BC, and then the north of the province. This is further supported by the actual EV adoption data, which, while extremely preliminary, supports this order.

As further information, a list of relevant cities with their populations are as follows:

BC Cities Over 75,000 Population

Vancouver	651,048
Surrey	473,238
Burnaby	229,464
Victoria & Saanich	198,030
Richmond	197,631
Kelowna & West Kelowna	149,254
Abbotsford	139,343
North Vancouver (Dist+C)	139,761
Langley District Municipality	105,747
Coquitlam	127,785
Delta	100,094
Kamloops	87,654
Nanaimo	86,961
Victoria	84,031
Chilliwack	78,898
Maple Ridge	77,402
Prince George	75,828

The goal is to reach as many of these populations as possible as effectively as possible.

Provincial Deployment Indicators

To further analyse and understand how the indicators break down across regions and cities, we summarized the indicators in a table by BC Cities over 75,000 population and then attempted to deploy the 30 stations only by numerical indicators. The resultant table is shown in Figure 4.6.

Figure 4-6 Overlay of Adoption Indicators

BC Cities Over 50,000 Population

	Population (2011)	Hybrid Ownership (2011)	EV Ownership (2011)	EV Dealers (2011)	Number of Stations by Population (2011)	Number of Stations by Hybrid Ownership (2011)	Number of Stations by EV Ownership (2011)	Number of Stations by EV Dealers (2011)	Average of Number of Stations by Indicator
Vancouver	651,048	4819	12	12	6.4	8.4	8.2	4.0	6.7
Surrey	473,238	2023	0	14	4.7	3.5	0.0	4.7	3.2
Burnaby	229,464	904	7	6	2.3	1.6	4.8	2.0	2.7
Richmond	197,631	1283	0	7	1.9	2.2	0.0	2.3	1.6
Kelowna & West Kelowna	149,254	855	0	7	1.5	1.5	0.0	2.3	1.3
Abbotsford	139,343	410	0	4	1.4	0.7	0.0	1.3	0.9
North Vancouver(Dist+C)	139,761	879	4	6	1.4	1.5	2.7	2.0	1.9
Langley District Mun	105,747	323	1	1	1.0	0.6	0.7	0.3	0.7
Coquitlam	127,785	339	3	3	1.3	0.6	2.0	1.0	1.2
Saanich	113,999	94	0	0	1.1	0.2	0.0	0.0	0.3
Delta	100,094	466	0	0	1.0	0.8	0.0	0.0	0.4
Kamloops	87,654	524	0	6	0.9	0.9	0.0	2.0	0.9
Nanaimo	86,961	366	1	5	0.9	0.6	0.7	1.7	1.0
Victoria	84,031	2047	14	8	0.8	3.6	9.5	2.7	4.1
Chilliwack	78,898	261	0	3	0.8	0.5	0.0	1.0	0.6
Maple Ridge	77,402	306	0	2	0.8	0.5	0.0	0.7	0.5
Prince George	75,828	296	0	4	0.7	0.5	0.0	1.3	0.6
New Westminster	67,880	584	0	2	0.7	1.0	0.0	0.7	0.6
Port Coquitlam	57,646	487	2	0	0.6	0.8	1.4	0.0	0.7
Total population in cities over 50000	**3,043,664**	**17266**	**44**	**90**	**30.0**	**30.0**	**30.0**	**30.0**	**30.0**
Total population of BC	**4,584,102**								

Corridors

After deployment of the VIP stations across the province, the next stage of deployment is select Corridors as well as High Visibility stations. In selecting routes and destinations in this stage, the seed network concept is used as well as the indicators to prioritize the location of the seed networks. Corridors must be complete between destinations as there is no point in installing only some stations on a corridor. The High Visibility stations are meant to be installed in locations which are highly visible within a population centre but also in high commercial areas with high traffic volumes. The dense commercial areas ensure that there are activities to do while charging but also ensure that there are likely many reasons for people to come to the area.

Areas which are showing high hybrid adoption, high EV adoption (as much as we can see at this stage) and significant EV dealership numbers will give us an idea of network locations. As well, we would like to reach as much of the BC population as possible.

Options for BC

A table of approaches to developing seed networks in BC with the initial deployment of 30 DC Fast Charging stations follows. These networks include both the initial VIP stations and the Corridor links between them, and in some cases also include High Visibility stations. Six options have been proposed in order to examine a range of possibilities from greatest highway connectivity to intensive regional deployment.

See the table below (Figure 4-13) for further details. It is important to note that the elaboration of these networks has been limited by the planned deployment of 30 stations in the first stage. If more stations were to be considered from the outset, the networks might look different. As a result, it may be helpful to consider phasing beyond the first 30 to understand how each seed network would fill out over time.

The options are as follows:

Option 1 (Figure 4-7): *Maximum long-distance highway connectivity* – the Island, Lower Mainland, and Okanagan are fully connected to each other and regional corridors operate within Central, Southeastern, and Northwestern BC. This includes VIP and Corridor stations.

Due to only having 30 stations, a complete version of this option is not possible but we have outlined the key 30 stations for this phase of the deployment. A full fill out of the option is shown in Figure 4-7a and a table for this option can be found in Appendix B.

Advantages:	More geographic coverage of the province with the networks Highway travel is facilitated
Disadvantages:	Less coverage where uptake is anticipated leaving some stations unlikely to be used Only a few stations in big metropolitan centers meaning less people see them and they are not convenient to where they are needed in the cities Lags predicted market uptake in some areas

Option 2 (Figure 4-8): *Maximum long-distance highway connectivity + high population regions* – the Island, Lower Mainland, and Okanagan are fully connected to each other with some

additional deployment in the Lower Mainland due to population density; regional corridors operate within Central and Southeastern BC. This includes VIP and Corridor stations.

Again, due to only having 30 stations, a complete version of this option is not possible but we have outlined the key 30 stations for this phase of the deployment. A full fill out of the option is shown in Figure 4-8a and a table for this option can be found in Appendix B.

Advantages:	More geographic coverage of the province with the networks Highway travel is facilitated
Disadvantages:	Less coverage where uptake is anticipated leaving some stations unlikely to be used Only one station in big metropolitan centers meaning less people see them and they are not convenient to where they are needed in the cities Lags predicted market uptake in some areas

Option 3 (Figure 4-9): *Regional highway connectivity + high population regions* - the Island, Lower Mainland, and Okanagan are fully connected to each other with the densest population centres receiving multiples stations; regional corridors operate within Southeastern BC. This includes VIP, Corridor, and High Visibility stations.

A few more stations would be required to produce a complete version of this work but we have outlined the key 30 stations for this phase of the deployment. A full fill out of the option is shown in Figure 4-9a and a table for this option can be found in Appendix B.

Advantages:	Stations are centered where population is highest meaning good visibility
Disadvantages:	Not as much geographic coverage Coverage is by population but not by indicators which means the stations are not necessarily where people who are likely to adopt are present Lags predicted market uptake in some areas

Option 4 (Figure 4-10): *Regional highway connectivity + higher population regions* - the Island, Lower Mainland, and Okanagan are fully connected to each other with the densest population centres receiving multiples stations. This includes VIP, Corridor, and High Visibility stations.

Advantages:	Stations are centered where people are likely to adopt EVs More stations are likely to be used more frequently Visibility is high as the stations are in high population areas Leads the market, encouraging EV adoption
Disadvantages:	Not as much geographic coverage

Option 5 (Figure 4-11): *Higher population regions* – the Island and Lower Mainland are fully connected with the densest population centers receiving multiples stations, and the Okanagan region is connected within itself with the densest population centers receiving multiples stations. This includes VIP, Corridor, and High Visibility stations.

Advantages:	Stations are centered where people are likely to adopt EVs More stations are likely to be used more frequently Visibility is high as the stations are in high population areas Leads the market, encouraging EV adoption
Disadvantages:	Less geographic coverage Missing some of the key indicated area in Lower Mainland

	Connectivity between the Lower Mainland and Okanagan not present

Option 6 (Figure 4-12): *Highest population region* - the Island and Lower Mainland are fully connected with the densest population centres receiving multiples stations. This includes VIP, Corridor, and High Visibility stations.

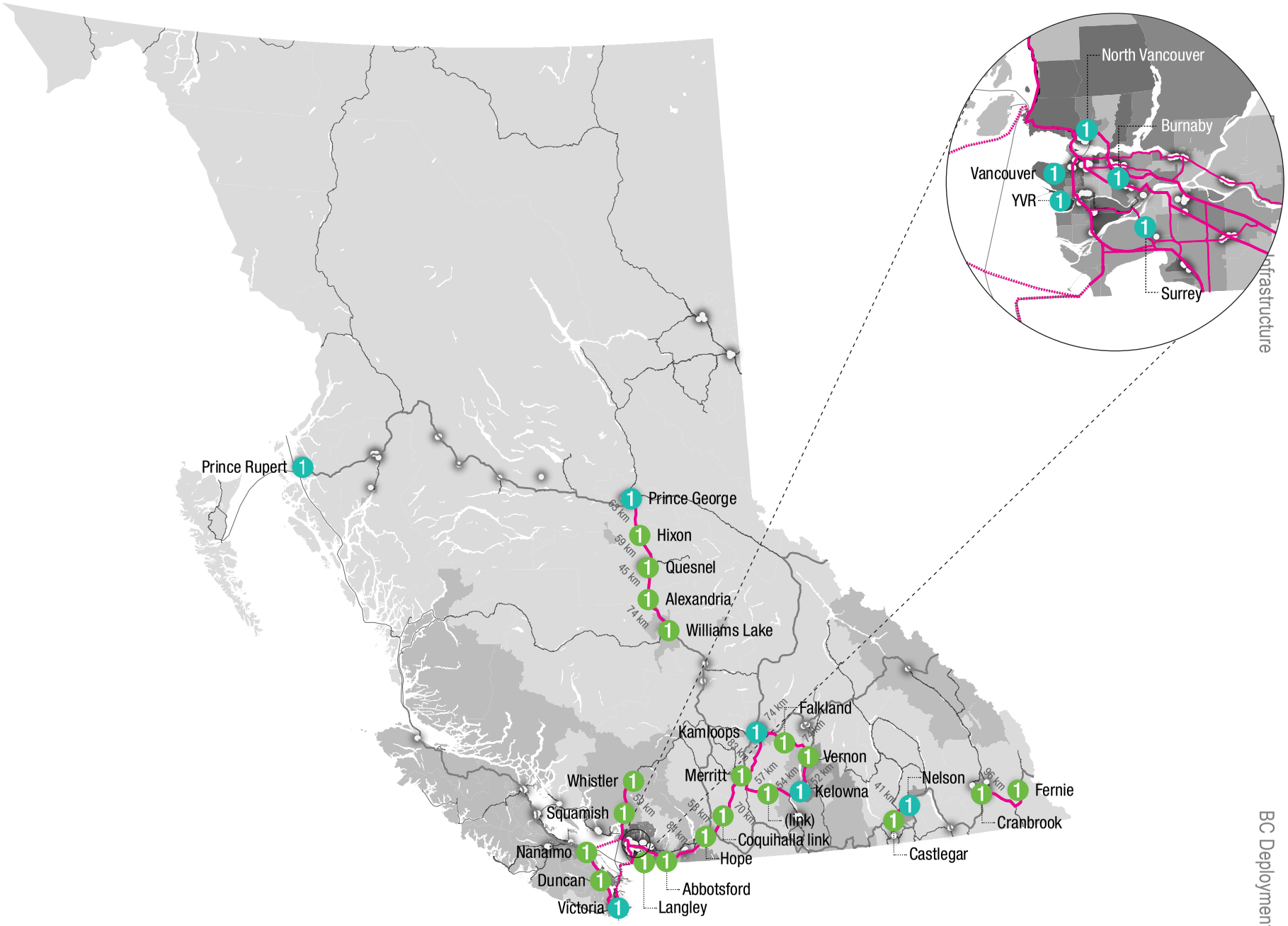
Advantages:	Stations are centered where people are likely to adopt EVs
	More stations are likely to be used more frequently
	Visibility is high as the stations are in high population areas
	Leads the market, encouraging EV adoption
Disadvantages:	More limited geographic coverage

Recommendations for Deployment

In evaluating the options, the criteria for evaluation must be clear. If the criteria for evaluation are related to the encouragement of EV adoption, it follows that options that focus on areas where EV uptake is predicted will be a better choice. There is some debate about the issue: on one hand, spreading the stations across the province's highways seems like it may be a successful way of encouraging people to travel further in their EVs, however it is likely at the early stages that people will travel in gas-fuelled cars for long distances and use EVs for shorter trips closer to home. Some intra-regional travel can be expected and this should be encouraged. There is a discussion to be had that people within a region will use Level 2 chargers if they have travelled some distance from one centre to the next, however the Level 2 chargers cannot always be relied upon to be in the area that the traveler will be going to, and relying on Level 2 charging requires a greater time commitment. In order to properly assess which approach will most effectively guide the installation of the stations, further understanding of the use patterns of the new EV users would be helpful. As such, perhaps the installation of the stations could be guided by the feedback of the users as the stations are installed. Simple surveys on how they use the stations and their futures preferences should provide enough information to guide future station locations.

As a result, we would recommend first installing stations which are key to all options, and which are the most critical (i.e.,VIP), and then carefully gathering feedback from EV users to guide the decision about which option should be further deployed.

Figure 4-7 Option 1



OPTION 1

BC Provincial Deployment of Fast Charging Stations: Phase 1

Scale 1 : 8 000 000 N

1 VIP Station (# stations)

1 Station (# stations)

EV Dealerships

83 km Connecting Highway Distance

Connecting Highway

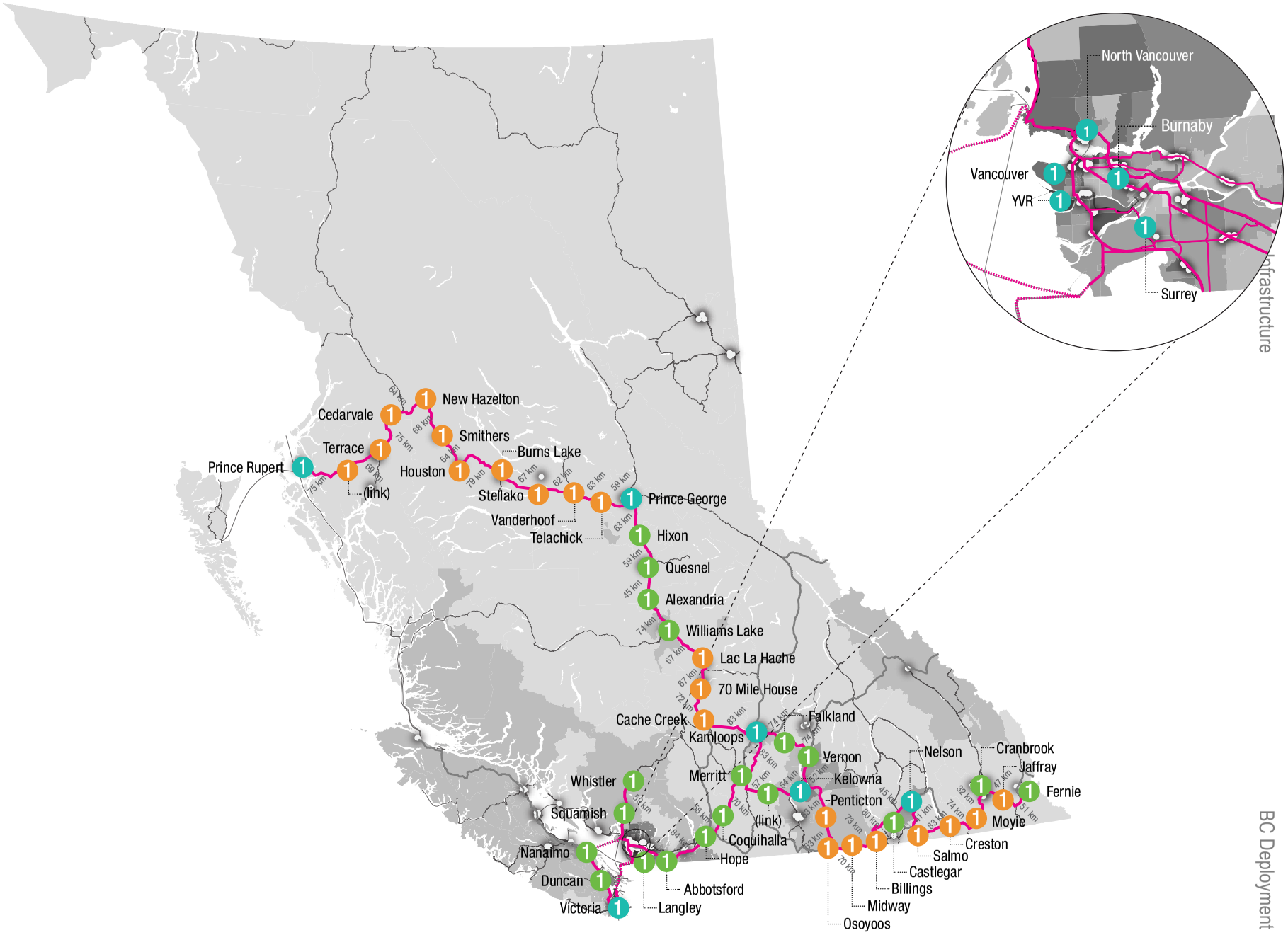
Major Highways

Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area



Infrastructure

BC Deployment

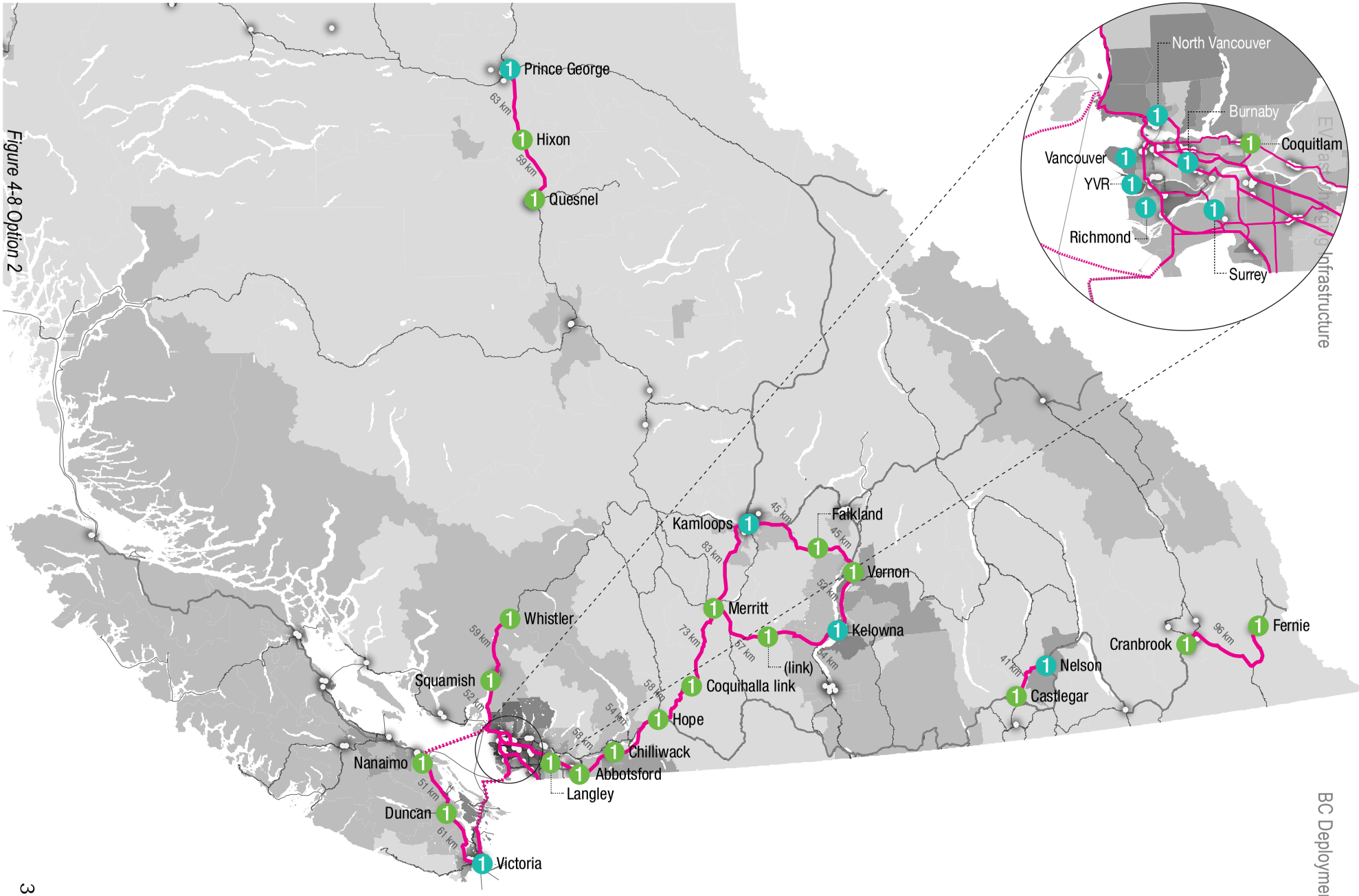
OPTION 1A (ADDITIONAL STATIONS)
BC Provincial Deployment of Fast Charging Stations: Phase 1

Scale 1 : 8 000 000 N

- VIP Station (# stations)
- Station (# stations)
- Additional stations (# stations)
- EV Dealerships
- 83 km Connecting Highway Distance
- Connecting Highway
- Major Highways
- Secondary Highways

Hybrid Adoption:
(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area



OPTION 2

BC Provincial Deployment of Fast Charging Stations: Phase 1

Scale 1 : 4 000 000 N

1 VIP Station (# stations)

1 Station (# stations)

EV Dealerships

83 km Connecting Highway Distance

Connecting Highway

Major Highways

Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area

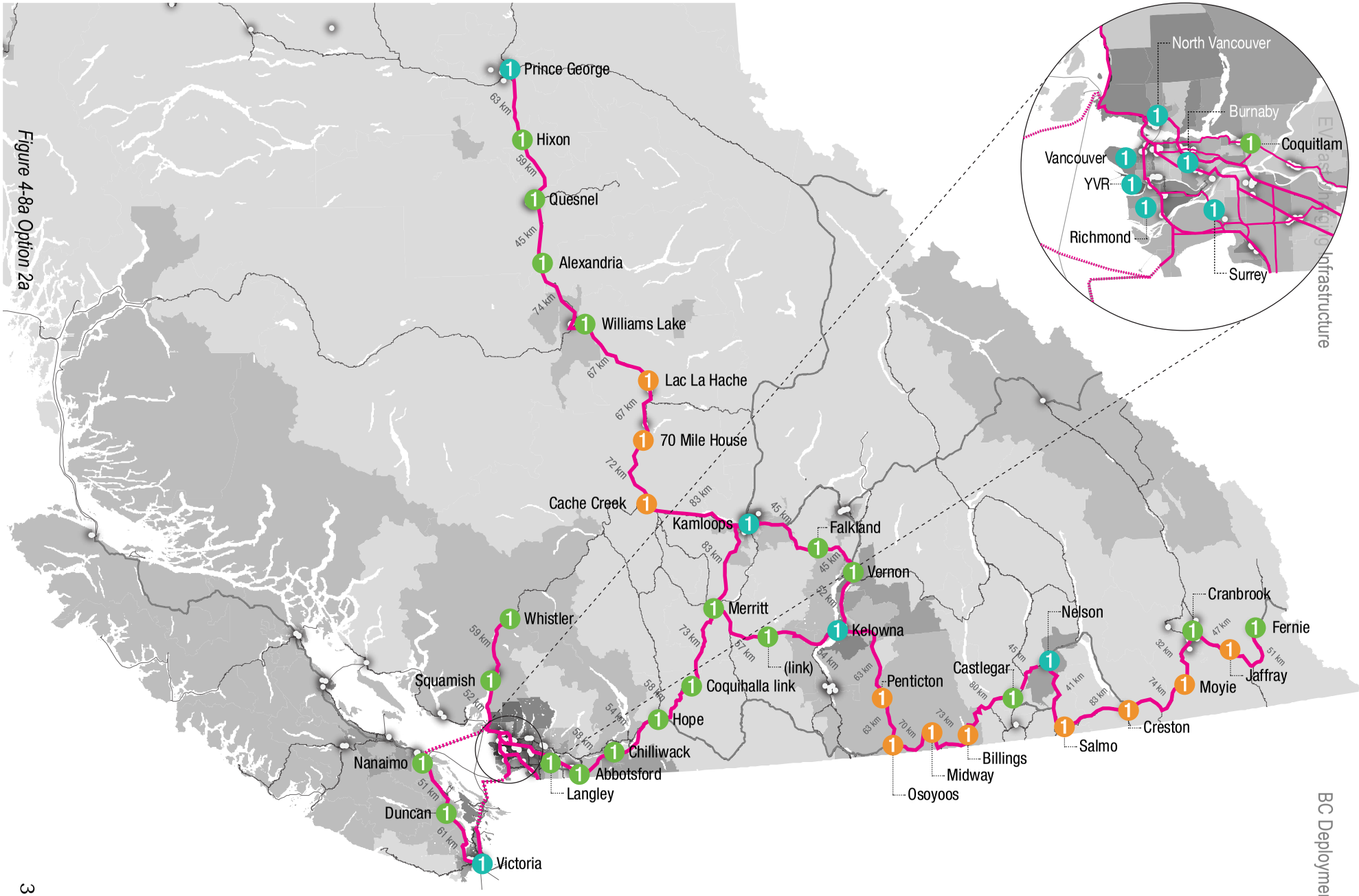
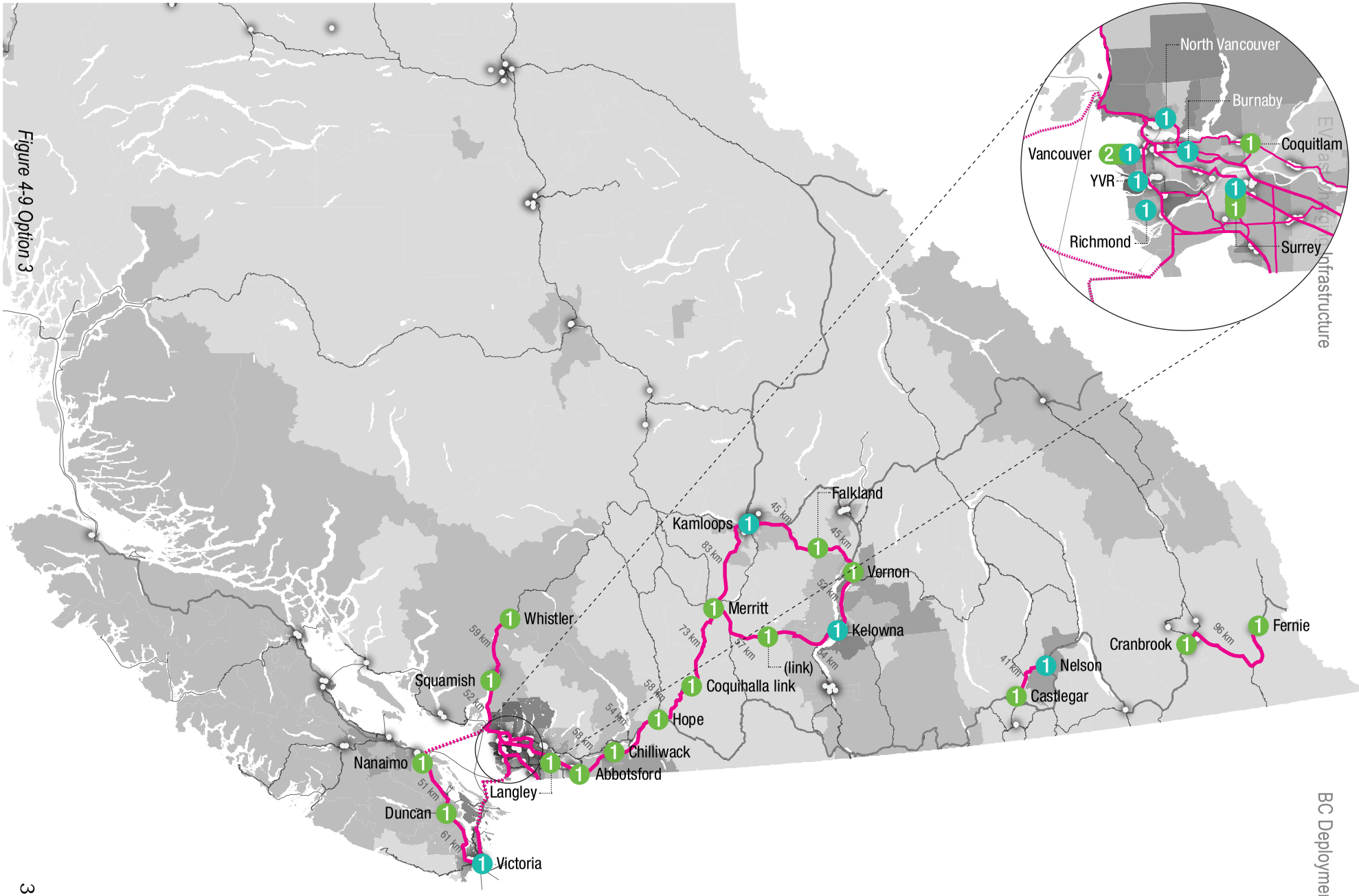


Figure 4-8a Option 2a
Prince George
63 km
Hixon
59 km
Quesnel
45 km
Alexandria
74 km
Williams Lake
67 km
Lac La Hache
67 km
70 Mile House
72 km
Cache Creek
83 km
Kamloops
45 km
Falkland
45 km
Vernon
52 km
Merritt
83 km
Whistler
59 km
73 km
57 km
(link)
64 km
Kelowna
Squamish
52 km
Coquihalla link
58 km
54 km
Hope
58 km
Chilliwack
Abbotsford
Langley
Nanaimo
51 km
Duncan
61 km
Victoria
Penticton
63 km
70 km
Osoyoos
73 km
Midway
Billings
Castlegar
80 km
45 km
Nelson
41 km
Salmo
83 km
Creston
74 km
Moyie
32 km
Cranbrook
47 km
Fernie
51 km
Jaffray
North Vancouver
Burnaby
Coquitlam
Vancouver
YVR
Richmond
Surrey
EV Fast Charging Infrastructure
BC Deployment
35
OPTION 2A (ADDITIONAL STATIONS)
BC Provincial Deployment of Fast Charging Stations: Phase 1
Scale 1 : 4 000 000
N
VIP Station (# stations)
Station (# stations)
Additional stations (# stations)
EV Dealerships
83 km Connecting Highway Distance
Connecting Highway
Major Highways
Secondary Highways
Hybrid Adoption:
(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)
Number of owners per capita x 1000,000 per postal area



OPTION 3

BC Provincial Deployment of Fast Charging Stations: Phase 1

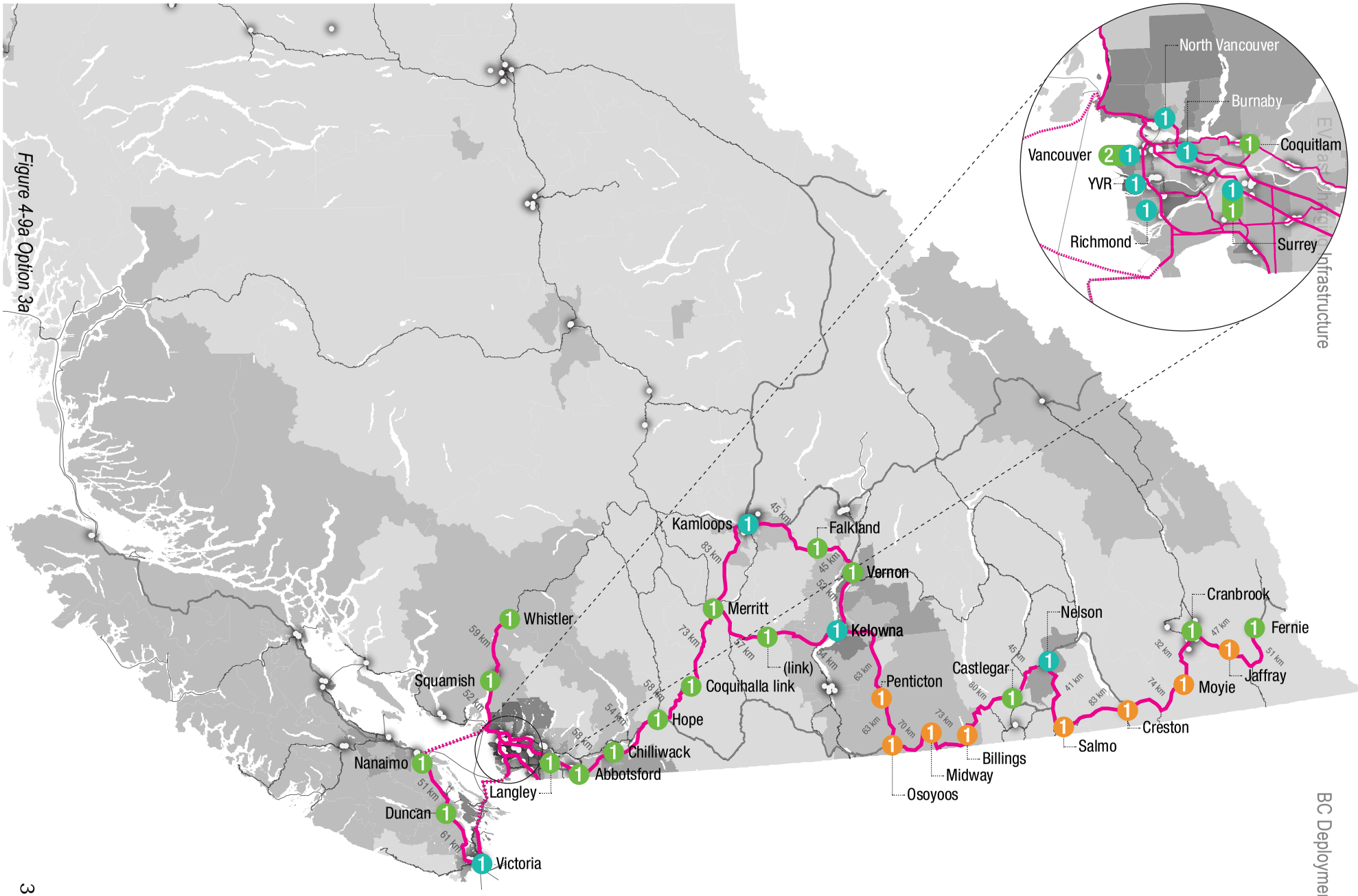
Scale 1 : 4 000 000 N

- VIP Station (# stations)
- Station (# stations)
- EV Dealerships
- 83 km Connecting Highway Distance
- Connecting Highway
- Major Highways
- Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area



OPTION 3A (ADDITIONAL STATIONS)

BC Provincial Deployment of Fast Charging Stations: Phase 1

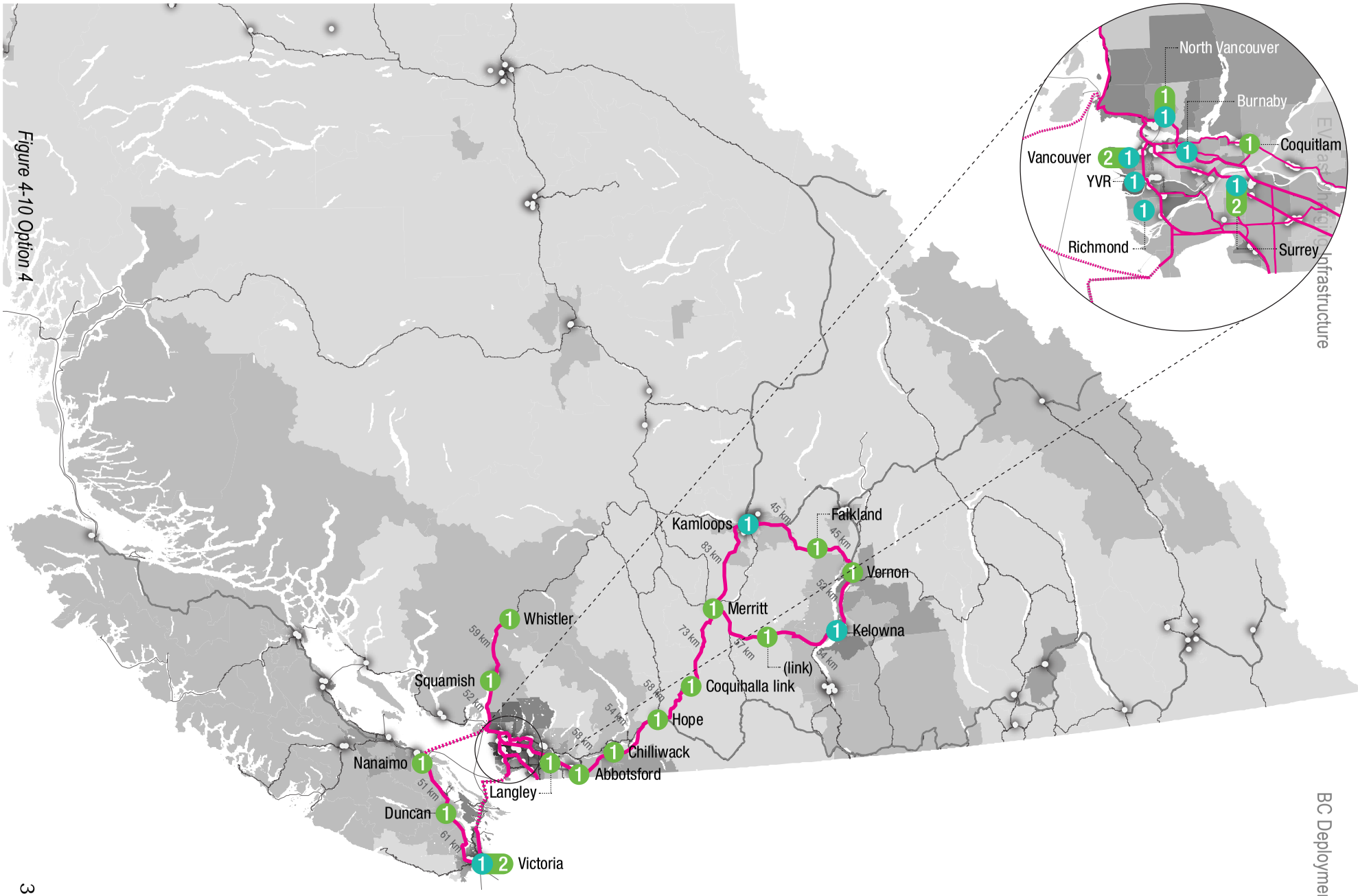
Scale 1 : 4 000 000 N

- VIP Station (# stations)
- Station (# stations)
- Additional stations (# stations)
- EV Dealerships
- 83 km Connecting Highway Distance
- Connecting Highway
- Major Highways
- Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area



OPTION 4

BC Provincial Deployment of Fast Charging Stations: Phase 1

Scale 1 : 4 000 000 N

1 VIP Station (# stations)

1 Station (# stations)

EV Dealerships

83 km Connecting Highway Distance

Connecting Highway

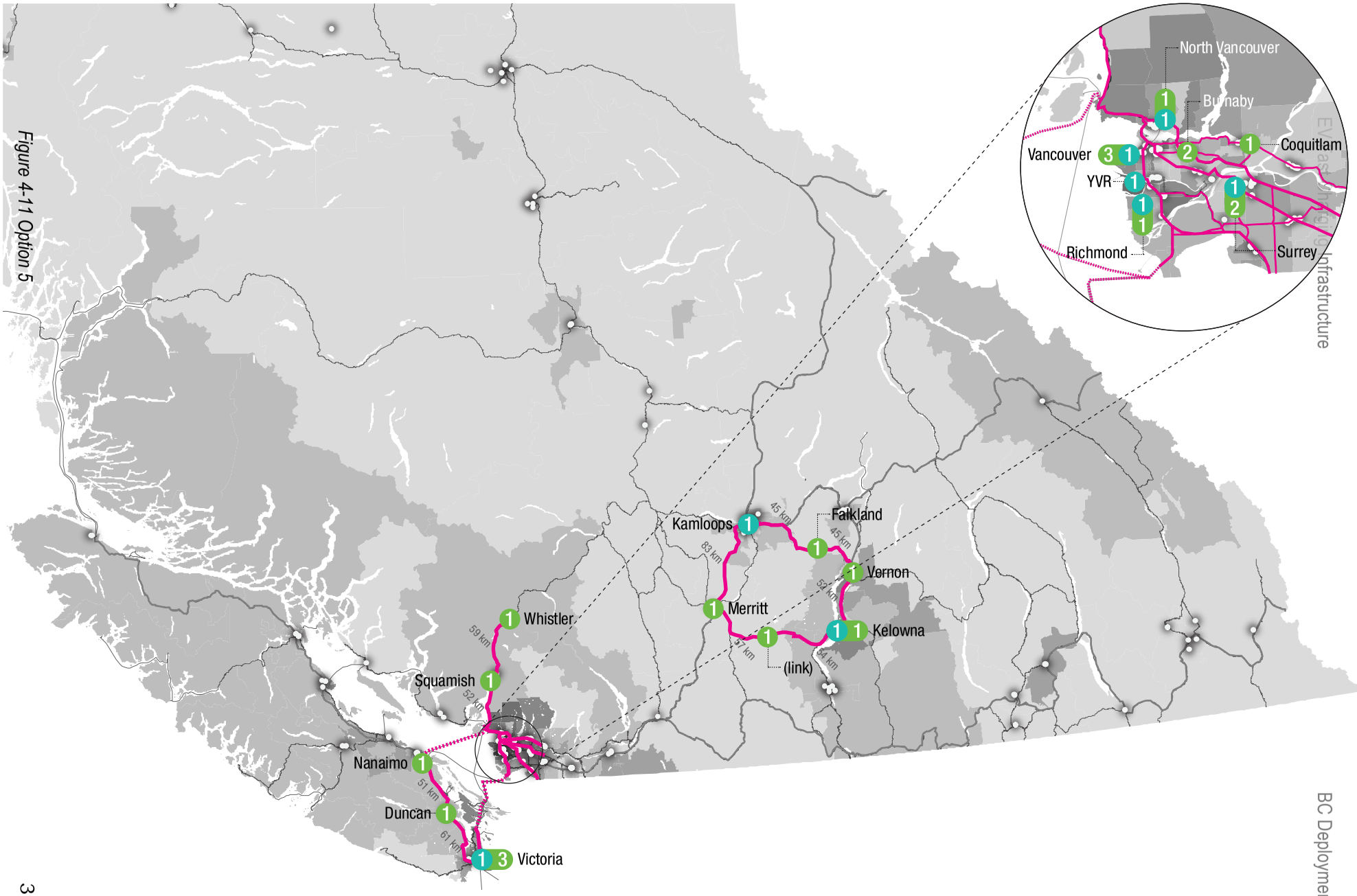
Major Highways

Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area



OPTION 5

BC Provincial Deployment of Fast Charging Stations: Phase 1

Scale 1 : 4 000 000 N

1 VIP Station (# stations)

1 Station (# stations)

EV Dealerships

83 km Connecting Highway Distance

Connecting Highway

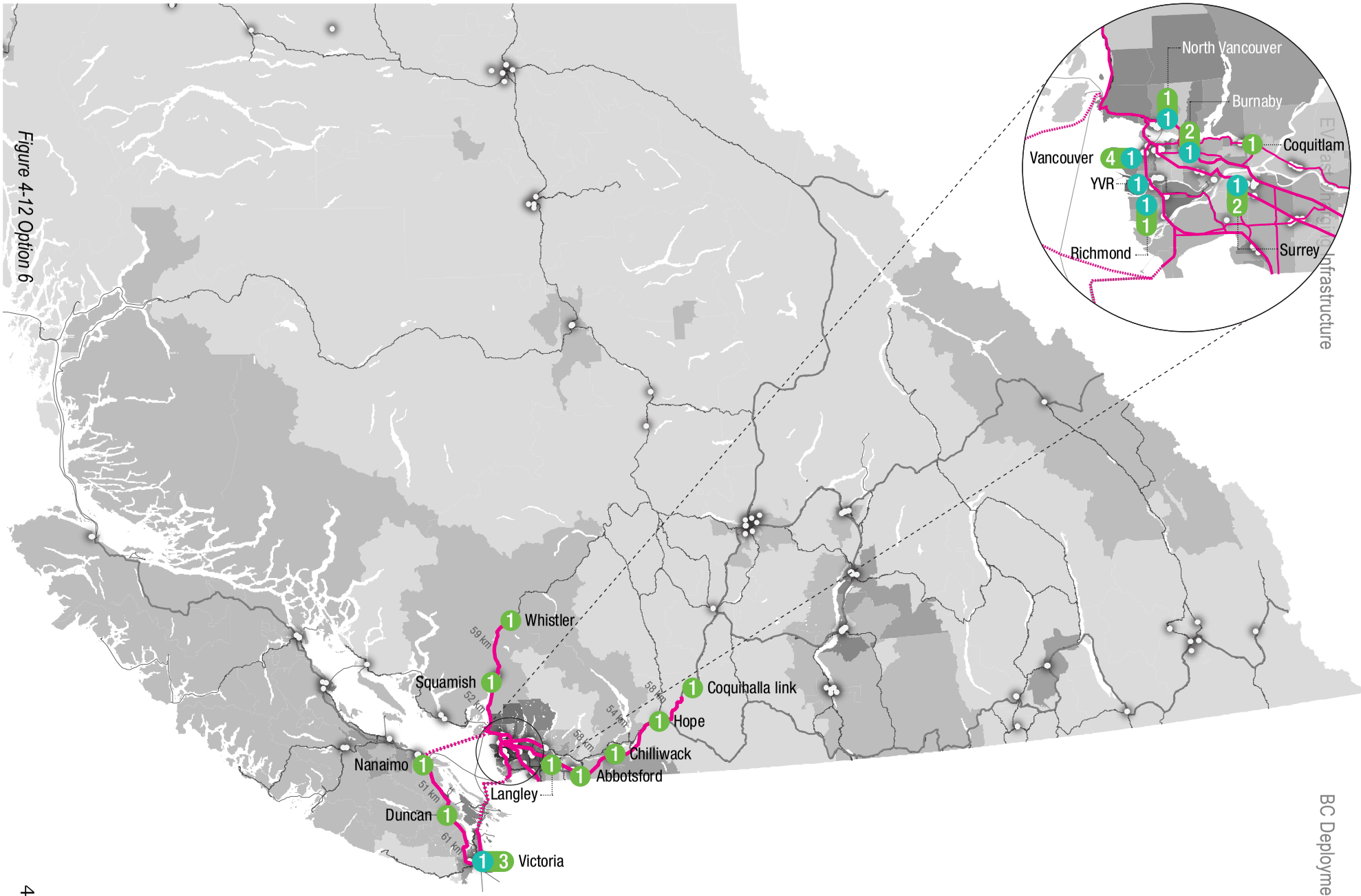
Major Highways

Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area



OPTION 6

BC Provincial Deployment of Fast Charging Stations: Phase 1

Scale 1 : 4 000 000 N

1 VIP Station (# stations)

1 Station (# stations)

EV Dealerships

83 km Connecting Highway Distance

Connecting Highway

Major Highways

Secondary Highways

Hybrid Adoption:

(71- 2888)
(2888 - 4632)
(4632 - 6750)
(6750 - 9502)
(9502 - 13851)
(13851 - 24434)
(24434 - 64285)

Number of owners per capita x 1000,000 per postal area

Figure 4-13 Table of Options

5.

BC Provincial Deployment of Fast Charging Stations – Analysis

Phase 1: 30 Stations

Deployment Option	Goal	Focus
OP1	Reach as many places as possible - priority by indicators	Corridors
OP2	Reach as many places as possible - priority by indicators, elaborated mainland	Corridors
OP3	Move to High Visibility phase by elaborating key cities, population indicators, elaborated mainland	Corridors
OP4	Move to High Visibility phase by elaborating key cities, uptake indicators, elaborated mainland	Corridors
OP5	Move to High Visibility phase by elaborating key cities, uptake indicators, elaborated mainland	Major centres, two key areas, unlinked
OP6	Move to High Visibility phase by elaborating key cities, uptake indicators, elaborated mainland	Major centres, one key area

Area Network	Route	Type	Distance (km)	Location	Deployment Options					
					OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
Lower Mainland	Route 99	○		Whistler	1	1	1	1	1	1
		○	59	Squamish	1	1	1	1	1	1
		✪	52	Vancouver	1	1	3	3	4	5
		✪	11	Richmond		1	1	1	2	2
		✪	26	Surrey	1	1	2	3	3	3
		○	26	—USA border						
	Hwy 1	✪		North Vancouver	1	1	1	2	2	2
		✪	13	Burnaby	1	1	1	1	2	3
		○	17	Coquitlam		1	1	1	1	1
		○	15	Langley	1	1	1	1		1
		○	44	Abbotsford	1	1	1	1		1
		○	31	Chilliwack		1	1	1		1
		○	54	Hope	1	1	1	1		1
	Link to Okanagan (Via Hwy 5, from Hope)	○	58	Coquihalla Rest Stop	1	1	1	1		1
	Vancouver Intl. Airport (From Vancouver)	✪	12	Airport	1	1	1	1	1	1
	Total				**11**	**14**	**17**	**19**	**17**	**24**
Island	Hwy 1	✪		Victoria/Saanich	1	1	1	3	4	4
		○	61	Duncan (link)	1	1	1	1	1	1
		○	51	Nanaimo	1	1	1	1	1	1
	Total				**3**	**3**	**3**	**5**	**6**	**6**

Okanagan	Hwy 5: Kamloops-Merritt	★		Kamloops	1	1	1	1	1	
	Hwy 97c: Merritt-Kelowna	○	83	Merritt	1	1	1	1	1	
	(Coquihalla connector)	○	56.5	Elkhard Road (link)	1	1	1	1	1	
		★	53.5	Kelowna	1	1	1	1	2	
	Hwy 97	○	52	Vernon	1	1	1	1	1	
		○	74	Falkland (link Kamloops-Vernon)	1	1	1	1	1	
	Total				**6**	**6**	**6**	**6**	**7**	
Southeastern BC	Hwy 6	○		Castlegar	1	1	1			
	Hwy 6 & 3/95	★	46	Nelson	1	1	1			
	Hwy 3/93	○	230	Cranbrook	1	1	1			
		○	96	Fernie	1	1	1			
	Total					**4**	**4**	**4**		
Central BC	Hwy 97	★		Prince George	1	1				
		○	63	Hixon (link)	1	1				
		○	59	Quesnel	1	1				
		○	45	Alexandria (link)	1					
		○	74	Williams Lake	1					
	Total				**5**	**3**				
Northwestern	Hwy 16	★		Prince Rupert	1					
	Total				**1**					
NETWORK TOTAL					**30**	**30**	**30**	**30**	**30**	**30**

Legend

★ Very Important Place (VIP) Station
○ High Visibility (HV) Station

Notes

Option 3 - HV stations distributed by population at 1 station for every 200,000 population at High Visibility Stage
Option 4 - HV stations distributed by indicators table breakdown (see report)

5. Site Selection Process

5.1 Audience and Participation for the Site Selection Flowchart

The audience for the Site Selection Flowchart is anticipated to be a range of stakeholders in the project – the flowchart in the first instance is for the Province and BC Hydro to have a consistent, focused and well documented siting approach which can be shared with other stakeholders. The other stakeholders that the Province will need to communicate with include municipalities, other governmental departments, and businesses. This communication will take place on the website and also in person and as such, the flowchart has a description to lead readers through the process if the Province and BC Hydro are not there in person to explain the process.

5.2 Process of Preparing Site Selection Flowchart

Site Visits as an Investigative Method

To assess how a site should be selected and how this process could best be represented in a decision-making flowchart for third party use, our methodology involved visiting locations and attempting to select actual sites at the lot scale within areas which had been identified as desirable target locations in the first step of the research. In order to develop a well-considered decision-making process, we visited a range of sites with varied characteristics such as:

Cluster (city/town) locations

- VIP type site in a downtown core
- High Visibility type site at a high traffic/high property demand area
- High Visibility type site at a high traffic/lower property demand area
- Early Adopter type sites in more suburban areas

Highway locations

- A highway site in a small town
- A highway site at a ferry terminal
- A highway site at an intersection point between highways in a suburban area

Accordingly, we conducted three different sets of site visits: in Vancouver; in the Vancouver to Whistler corridor; and in Nanaimo. Each of these is summarized below.

In the field, we began the process by identifying what particular sites we thought might work at each identified area location and attempted to determine the considerations of the sites as well as their priorities. We subsequently considered how we might frame this in a flowchart.

After compiling the flowchart, we ran the flowchart through a series of meetings with different collaborators and stakeholders in order to test the flowcharts as to the clarity of intent and the flow of the process at large. We anticipate that adjustments will be made to the flowcharts as they are deployed in the first several sitings. After the first few sitings, the flowcharts are meant to work on their own, without attendant explanation or clarification.

Vancouver Site Visits

In Vancouver we evaluated the priority site locations identified in the previous research framework by overlaying maps of commercial, transportation, and demographic characteristics. We began by exploring Very Important Place (VIP) and High Visibility (HV) site areas and then moved on to the Early Adopter site areas.

Very Important Place (VIP) and High Visibility (HV) Sites

We commenced in the downtown core, visiting sites along West Georgia Street between Burrard and Homer Street as we felt that these were both VIP and HV sites. With highly visible and very important sites being located right in the centre of the city, they also turned out to be challenging sites since they were limited by a series of no parking and turn restrictions, as well as a scarcity of available land on which to place the stations. We determined that potential sites directly on West Georgia Street were not feasible due to parking and turn restrictions. However, we did identify sites just off West Georgia Street that were suitable, and with appropriate signage directing EV owners to these sites, they could work reasonably well.

VIP and HV sites were also investigated in the West End at Denman and Davie Streets and along both streets for several blocks from this intersection to determine if there were better potential sites. Given parking and turn restrictions on Denman and Davie at rush hours, it was felt that the triangle of land at Denman and Davie Streets best suited our needs with the fewest restrictions and the greatest visibility.

We also examined several potential sites near the intersection of West Broadway and Granville, another VIP and HV site. Again, given significant parking and turn restrictions at rush hour especially, it was felt that, analogous to the West Georgia sites, locating a block or two away was preferable with clear signage directing EV users to the charge station. Possible locations for the charge station were West 10th Avenue between Fir and Granville Streets, and the gas station at the corner of Hemlock Street and West Broadway.

Early Adopter and Full Functionality Sites

We also explored several neighbourhoods where we anticipate early adopters live and where full functionality sites will be needed in future. The commercial zones on Dunbar Street between West 26th and West 30th Avenues and between West 39th and West 41st Streets were determined to be viable locations, providing on-street charging in walkable areas, and potentially off-street charging at Stong's Super Market on Dunbar Street, the Dunbar Community Centre at West 31st and Dunbar Street and the IGA parking lot at West 41st Avenue and Dunbar Street.

West Vancouver to Whistler Corridor Site Visits

With these site visits, we began the process by working through our developed methodology flowchart, which sets out the sequencing of the questions that must be asked in the EV Fast Charging Station site selection process.

West Vancouver - Very Important Place (VIP) and High Visibility (HV) Sites

West Vancouver offered a siting challenge because the most logical place to site an EV station is at the intersection of Taylor Way and Marine Drive, one of the busiest intersections in the Lower Mainland. We explored a site at Park Royal on this intersection and found it to be suitable

because of its high visibility, but difficulties are posed by turn restrictions and access to the Park Royal parking lots.

We next moved into West Vancouver proper and explored sites between 15th Street and 22nd Street, both chosen because they are through streets that connect to Highway 1. There were excellent possibilities for both on-street and off-street charging stations which could also allow for a first-rate neighbourhood exploration / shopping experience for EV users while their EVs are being charged.

Horseshoe Bay - Very Important Place (VIP) and High Visibility (HV) Sites
We explored Horseshoe Bay at some length and found that a BC Ferries parking lot immediately adjacent to the ferry queue was visible, well signed and easy to access and egress. We also thought that discussions with BC Ferries regarding installing Level 2 chargers on a small portion of their ferries (likely for a fee) are worth having. There will need to be an arrangement with BC Ferries if we choose their Horseshoe Bay parking lot as to precisely how vehicles can reserve a spot in the ferry queue while charging outside of the ferry queuing area.

Whistler - Very Important Place (VIP) and High Visibility (HV) Sites
In Whistler, we met with two municipal managers, and with their advice, decided that there were two locations that met our VIP and HV needs. The first is at the Creekside commercial area on the Sea-to-Sky highway at the beginning of Whistler where an existing gas station and some vacant or underused lots provide great visibility and also ease of access and egress.

The second site is in Whistler Village adjacent to the bus terminal. This site is less visible from the Sea-to-Sky but is located immediately adjacent to the town centre. Additionally, there are 8 – 10 parking spaces controlled by the municipality that can be used to situate the chargers.

The Whistler site visit was particularly worthwhile as we were able to meet with the senior municipal officials responsible for their EV infrastructure planning. Discussions with them were informative and highlighted the utility of the framework we have developed in this report; it is a powerful means to focus both provincial and local attention on a set of critical issues and sequential questions and decisions that must be posed and made in the EV charging station siting process. Using this process across the province and in all communities where EV fast charging stations are to be located provides a strong and coherent framework. It holds the possibility of making more consistent and informed decisions about EV fast charging station locations wherever these decisions are to be made (i.e., in large cities or small; along urban arterials or highway corridors; in large or small downtown cores; or in residential or commercial neighbourhoods).

Nanaimo Site Visits

Nanaimo was selected for visitation due to its central location on Vancouver Island and its gateway function with two ferry terminals that link Vancouver Island with the mainland (Departure Bay linked to Horseshoe Bay and Duke Point linked to Tswawwassen).

Nanaimo's gateway role required that we use both our highway and city and town process flowcharts to identify possible EV fast charging station locations. A unique challenge to Nanaimo is its two gateway ferry terminals and its position astride the Island Highway. Accordingly, we identified two sites that would intercept traffic emanating from both the Departure Bay Ferry

Terminal and the Duke Point Ferry Terminal, as well as traffic moving either north or south along the Island Highway.

The first site (as shown on the attached map) is located south of Nanaimo at the intersection of the Island Highway at 10th Street in Nanaimo at the South Parkway Shopping Mall. This site is highly visible to traffic and has excellent access to traffic moving in both directions. It has the capacity, as a result, to intercept traffic coming from and going to the Duke Point Ferry Terminal as well as both northbound and southbound traffic on the Island Highway.

The second site is located on the Island Highway at Departure Bay Road in, or adjacent to, the Brooks Landing Shopping Centre. This site is ideally suited to intercept traffic coming from and going to the Departure Bay Ferry Terminal as well as serving northbound and southbound traffic on the Island Highway. It is highly visible and there are several sites that are vacant and could readily be the location of a Departure Bay Ferry Terminal oriented site.

5.3 Site Selection Flowcharts

To view the complete highway and town/city site selection flowcharts see Appendix A.

6. Business Model

Summary of EV Fast Charging Business Model work to date (CEATI REPORT No. T112700-0534 EV PUBLIC FAST CHARGING PLANNING FRAMEWORK Section 5):

The business model to be used for the stations must be viewed from different perspectives – the initial level of investment, the transition from subsidized to a working business model, operating model as well as pricing model. Each of these has many factors to take into consideration – social, cultural, economic and political. Ideally the EV charging business would take off and the charging station could become a viable business model unto its own. In the first few years this will not happen so a subsidized model is required. The business model proposed to date considers the technology adoption curve and proposes subsidies until the technology reaches critical mass, at which time subsidies are tapered out and a sustainable business carries on into market maturity.

There are several issues that should be reviewed as a foundation for all of the discussion that follows. Four should be mentioned as being particularly important:

- The fundamental trade-off or contradiction that exists in any business model for a new technology between low or no costs for recharging to attract maximum users and rapid adoption and a pricing system that is sustainable and economically viable so that it will attract and retain businesses to operate the charging stations in the long term;
- The need for the business model to support, and indeed reinforce the brand promised being made by the EV charging station system and the EV technology;
- The need for long-term economic sustainability of the business model to ensure that there will be ample supplies of EV charging stations to meet projected high demand;
- The adoption of innovations and the spread of new technologies are key underlying behaviours critical to any and all business models and plans for EV charging stations and infrastructure.

Trading off Economic Sustainability for Speed of Adoption

This trade-off is inherent in all of the "business models" seen in precedent studies of EV station deployment to date. Some indeed are not business models at all since they provide free charging to EV owners, which is clearly not a viable business approach, but rather a means to encourage EV ownership and use.

The goal for BC is to seek a balance between stimulating EV ownership and use and creating a long-term profitable (i.e. viable and sustainable) business model by looking at short-term stimuli to EV ownership and use through subsidies with a transition to a viable, long-term, profit-based business model that will attract private sector investment for charging stations because they make economic sense and are a good business investment in the long term.

Brand Promises that the Business Model must Achieve and Reinforce

The business model must also be consistent with and reinforce the brand promise. A business model and pricing regime are important elements in branding (i.e. Gucci prices reinforce the brand promise of exclusivity, just as Toyota Yaris pricing reinforces its promise). Accordingly, our business model must be consistent with our key brand promises for EV charging stations in BC. Brand promises were outlined and explained in the CEATI report "CEATI REPORT No.

T112700-0534 EV PUBLIC FAST CHARGING PLANNING FRAMEWORK" in the Branding Section (Section 4).

The Need for Economic Sustainability and Viability of the Business Model

If the business model is not economically sustainable over the long run, then it cannot be considered a successful business model, since we are building a long-term EV charging system for decades to come. The business model can, and likely must, change over time as adoption rates increase and the EV ownership market matures. However, we are building an EV charging system for the long run and thus need to ensure that there will be sufficient charging stations going forward in the appropriate locations to meet future demand. In order to do this, we must have in hand a business model that is profitable in the longer term and thus capable of attracting and retaining a large enough group of private investors and operators to meet this anticipated growing demand well into the future.

The Adoption of Innovation and Diffusion of New Technologies

The adoption and diffusion of innovations in products and services tend to follow a well-defined path as described earlier in this report. This forms the basis of our plan for the staging of stations and relates the business model stages to the staging of the network and the types of stations to be installed.

6.1 Initial level of investment

One of the key question in the business model discussion is whether or not the province/federal government is approaching this station deployment as a long-term value proposition? There are several approaches which may be taken to the business plan and these are summarized below.

Option 1 – high investment for high returns
High quality Fast Charging stations + powerful brands (prestige factor); DC Fast Charging serves as price and quality benchmark relative to Level II

- Advantage: likely to attract investment by private sector owners/operators
- Disadvantage: high upfront capital cost

Option 2 – reduced investment for lesser returns
Mid-market brand and experience

- Advantage: lower upfront capital costs
- Disadvantage: provides lower level of service than premium gas stations
- Disadvantage: fails to bolster prestige of EV owners and station owners/operators

Option 3 – minimal investment for minimal returns
Run as mass-market utility like household electricity, assumes EV owners will seek out the service with little enticement

- Advantage: lowest upfront capital cost
- Disadvantage: little capital value created in the brand or system, unlikely to attract private sector investment

6.2 Transition from subsidy to working business model

When developing a business model for EV charging stations in BC, we have to consider both the end point of having a system that is economically viable and sustainable because it is profitable for independent business people to operate these stations and a transition path and strategy to move from the initial, highly subsidized phases of the EV charging stations project. Considerations in this regard which relate to BC are outlined below:

Phase 1 (through first 30 stations at least) - Fully or heavily subsidized

- Free or highly discounted electricity rates for charging EVs

Other incentives and subsidies, federal/provincial:

- Rebates/tax credits for EV purchase
- Reduced vehicle licensing fees
- Exemption from peak pricing/tolls
- Inclusion in HOV/bus lanes
- Repair + maintenance subsidies/tax credits
- EV charging capacity mandated in new buildings
- Govt procurement of EVs for public fleets
- Investment tax credits/operating subsidies or tax credits for private sector EV station owners
- Below market rents or leases for creating EV charging stations on publicly owned land (including streets)

Other incentives and subsidies, local:

- Parking – preferential and/or discounted
- EV charging capacity mandated in new buildings
- Below market rents or leases for creating EV charging stations on publicly owned land (including streets)

*Public sector subsidies and incentives could encourage or discourage private sector investment depending on how they are employed – this should be examined

Phase 2 - Partially subsidized

- Electricity prices should be increased for all levels of charging infrastructure
- Reduce regulation and increase flexibility to begin to attract private investors and operators

Incentives and subsidies, federal/provincial:

- Rebates/tax credits for EV purchase – maintain at federal level, phase out at provincial level
- Investment tax credits/operating subsidies or tax credits for private sector EV station owners – phase out
- Below market rents or leases for creating EV charging stations on publicly owned land (including streets) – phase out

Incentives and subsidies, local:

- Below market rents or leases for creating EV charging stations on publicly owned land (including streets) – phase out

Phase 3 - Working business model

- Move prices to full cost recovery and profitability (including demand pricing), encouraging private providers to take over the charging infrastructure to operate it profitably over the long term
- Or the public utility continues to operate the charging infrastructure with a full cost recovery model (may be an issue for a regulated utility)
- If utility continues to provide infrastructure (in addition to electricity), it should be at market rates so as not to undercut private investment
- Private owners/operators should be given flexibility to establish a profitable pricing structure and to co-locate with other businesses

6.3 Ownership and Operating Options

Various options exist with regard to who owns and operates the stations – how the business model is deployed. Some of these are outlined below:

1. EV charging stations on government-owned land with operation outsourced to a third party with relevant expertise in operating and maintaining automobile-oriented retail or service – suitable for sites such as curbside, lane, community centres, arenas
    a. Charging station capital costs: BC Hydro, province, federal govt
    b. Land costs: province or local government
    c. Operation: BC Hydro or private third party charging company

2. EV charging stations integrated with existing automobile oriented businesses
    a. Charging station capital costs: BC Hydro, province, federal govt
    b. Land costs: existing automobile-oriented business
    c. Operation: Existing business operator or private third party charging company

3. EV charging stations integrated with existing businesses
    a. Charging station capital costs: BC Hydro, province, federal govt or existing business
    b. Land costs: existing business
    c. Operation: Existing business operator or private third party charging company (third party may be more likely due to existing business's lack of experience with automobile service)
4. EV charging stations as a stand-alone business
    a. Charging station capital costs: BC Hydro, province, federal govt or EV charging company
    b. Land costs: EV charging company
    c. Operation: EV charging company

6.4 Pricing Models

Pricing models that are possible are outlined below:

Free - not a business model but an adoption enhancing device

The first option, free access to EV charging stations, is not a business model at all, since it is unsustainable. However, it is the pricing structure that will be used initially in the project, so it is important to include it here as our starting point.

Fee-based subscription models (these are the class of business models strongly endorsed in the C40 study by Philip and Wiederer (2010)

- Flat monthly or annual subscription fees perhaps based on EV owner estimated usage levels analogous to cell phone contracts
- Flat monthly or annual fee, as above, plus additional fees for usage rates above the contract amount in the chosen subscription–again a variant of cell phone contracts

Non-subscription models

Precedent research showed that subscription models are preferered so far in projects in the US and Europe, but a large variety of pay-as-you-go business models can also be envisioned, a sample of which are discussed here:

- Simple user fees based on levels of service and use, like the current gasoline business model where you pay for the fuel you need, which is priced at a level to provide normal profits for station owners and operators, while covering all operating and capital costs
- Quantity EV charging discounts could also be considered for fleets to encourage fleet use and reflect economies of scale that should be involved in charging EV fleets
- Co-locating activities for additional revenue can also be an integral part of the EV charging station business model, tied to either a subscription or non-subscription business model, with such co-locating activity boosting revenues for the station owner or operator. This would also make the EV charging station more attractive to EV owners, as it would allow the owners to do other shopping or use other services during the 20-30 minutes it takes to charge their EV
- Co-branding for additional revenue is also possible to raise awareness of the EV charging stations such as co-branding with PowerSmart or other green certifications and brands, for example, stations may be made of BC wood, certified by the Forest Stewardship Council. Such co-branding would allow the EV charging stations to build off the credibility of the co-branding partner to attract additional customers or charge premium prices, reflecting the soundness of the charging station brand, which is being reinforced by the co-branding partner's brand.

6.5 Future Business Decisions

Decisions on business models are required in the near future and further discussion will be required. The business climate and government policy decisions will influence these decisions and these climates will begin to form the basis of the business plan.

7. Flexibility of Network Deployment and Next Steps

7.1 Collaboration with Local Authorities Having Jurisdiction

Once the towns/cities and highways have been identified for the first stage of deployment, the process of collaboration with the Local Authorities having jurisdiction in any particular town or city is anticipated to be as follows:

i) Province instigates meeting with identified town/city
ii) Province, BC Hydro and TIPS Lab meet with the municipality to review flowchart
iii) Municipality suggests future meetings and process (perhaps mapping or research is required by the municipality prior to the future meetings)
iv) Future meetings bring stakeholders and Province/BC Hydro/TIPS together to suggest station locations and sites and evaluate these sites based on flowchart; TIPS leads this collaborative process
v) Municipality finalizes station site(s) and makes recommendations to the Province
vi) Province provides approval and BC Hydro installs station(s)

As the flowcharts are used in consultation with the municipalities, the province, and BC Hydro, it is anticipated that they will be refined and further clarification will be added as needed. The first few station placements in cities and towns and on highways will inform the methodology and the authorities and stakeholders involved in the process. The flowcharts will be revised as they are used the first few times and then will be able to stand on their own for the remainder of the station installations.

7.2 Conclusion and Future Research

Once the steps above (Section 7.1) have been carried out, a station must be installed which is in keeping with the 'promise' of an EV Station in the view of the driving public. In order for EVs to be successful, the branding and culture associated with EVs must be developed with a positive market value. As such, branding and design of the stations is key. The design must be economical and functional within public space, which means it must not only be functional from a geometric roadway design perspective but also durable, well lit, easily identifiable, easy to use and ideally a pleasurable place to be. The branding and design considerations should be targeted to the market group that we anticipate will be the first adopters of the EV. Precedents for the market identification and branding have been researched in previous work for BC Hydro and CEATI and can be drawn on for this future work. Likewise, station layout and design have been researched and this information can inform future work. It is anticipated that a 'family' of designs for signage and station canopies/lighting will be developed so that they can be installed fairly simply across a range of station types. Ultimately, this coordinated suite of station designs will work in conjunction with carefully targeted station locations to deliver on the visibility, convenience, and cultural branding key to promoting widespread uptake of electric vehicles throughout the province.

A consideration of the business model and partnering/co-branding options are also required. These large considerations will require future research.

7.3 Future data inclusion and network adjustment

Further data could be collected to inform and refine the work done. This work could include incorporation of information such as:

- Hybrid adoption data on a historical yearly basis (under current production)
- AADT highway information which may be considered for highway staging (currently being mapped)
- Origin-Destination data for the Province (may not exist)
- Further car range and highway distance research to ensure the number of stations is suitable
- Consultation with car co-ops and taxi companies about their EV plans

Appendix A

Site Selection Flow Charts

Fast Charging Stations

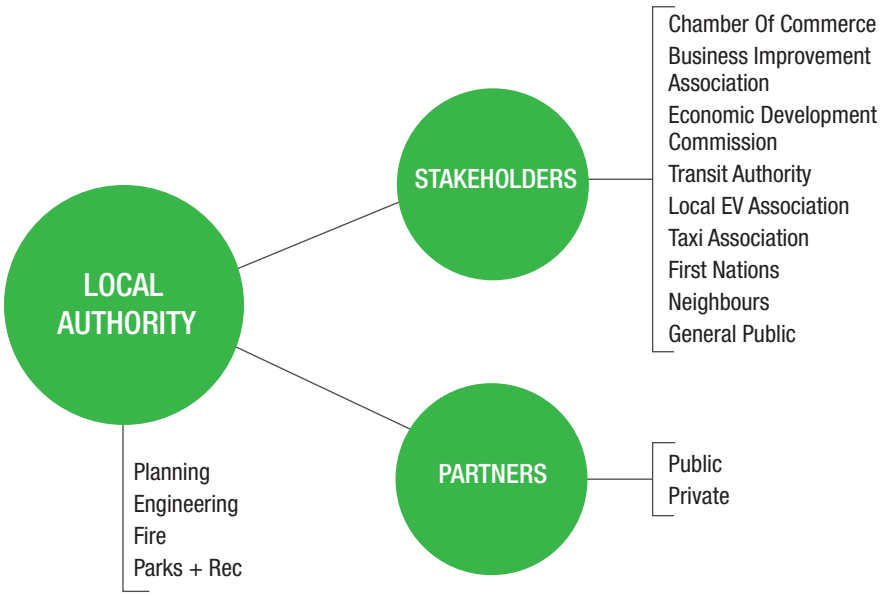
STATION LOCATION PROCESS
CITY & TOWN SCALE

This document will guide you, the Local Authority, through the process of situating Electric Vehicle Fast Charging Stations in your city or town. At certain stages in the process it will be important to consult with Stakeholders and Partners.

The process has been broken down into 7 steps to facilitate your work. The steps start at a large scale and continually eliminate less desirable sites through planning, engineering, economic and social filters to assist you in obtaining a prioritized list of preferred sites.

As you move through the process, be sure to consult the *Guide to the Station Location Process*; it contains definitions and useful information to clarify terminology, processes and considerations.

KEY RELATIONSHIPS

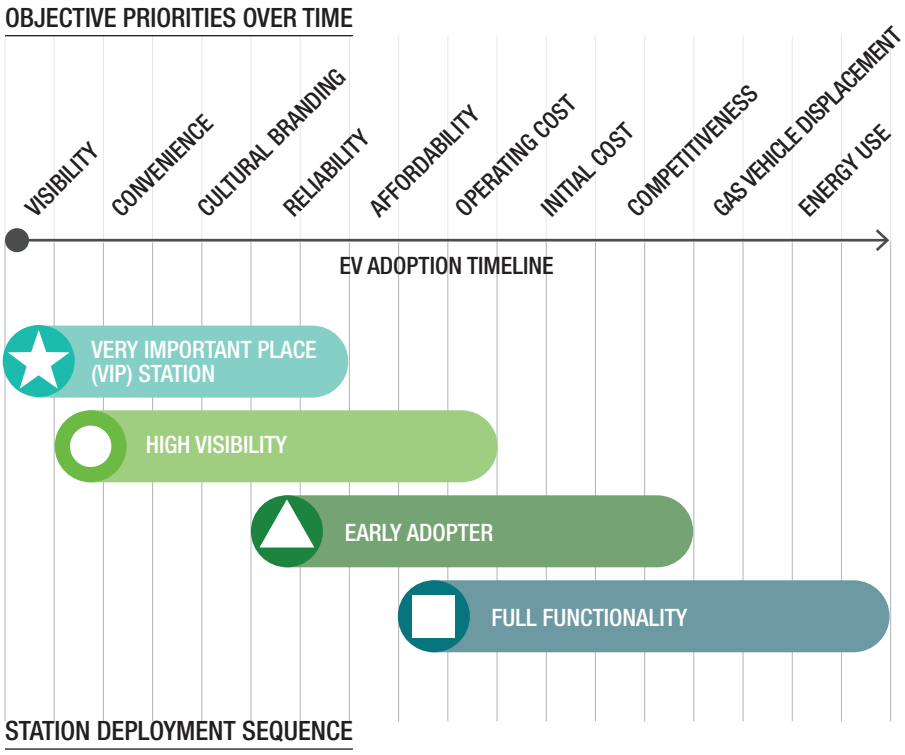


ACTION	OUTCOME
1 REVIEW THE FRAMEWORK	UNDERSTAND PRIORITY OBJECTIVES AND STATION LOCATIONS
2 MAP TARGET LOCATIONS	DETERMINE AREAS WITHIN WHICH TO LOCATE STATIONS
3 CONSIDER THE SITE SCALE	DETERMINE A RANGE OF SITES TO EVALUATE AGAINST CONSTRAINTS
4 EVALUATE CONSTRAINTS	DETERMINE WHETHER THE SITES MEET MINIMUM REQUIREMENTS
5 CONSIDER ECONOMICS	DETERMINE THE ECONOMIC FEASIBILITY OF THE SITES
6 CONSIDER PLANNING	DETERMINE THE PLANNING VIABILITY OF THE SITES
7 EVALUATE DESIRABILITY	DEVELOP A PRIORITIZED LIST OF SITES FOR IMPLEMENTATION

1 REVIEW THE FRAMEWORK

The framework for deploying Electric Vehicle Fast Charging Stations consists of a series of time prioritized objectives and a series of station types. Starting from the left, the foremost concerns upon immediate deployment are Visibility, Convenience, Cultural Branding and Reliability (please see the *Guide to the Station Location Process* for specific definitions).

All Fast Charging Station network deployments should start with Very Important Place (VIP) and High Visibility Stations. Appropriate locations for these stations will be determined through the mapping processes undertaken in Step 2. Again, please see the *Guide to the Station Location Process* for descriptions of the station typologies.



2 MAP TARGET LOCATIONS

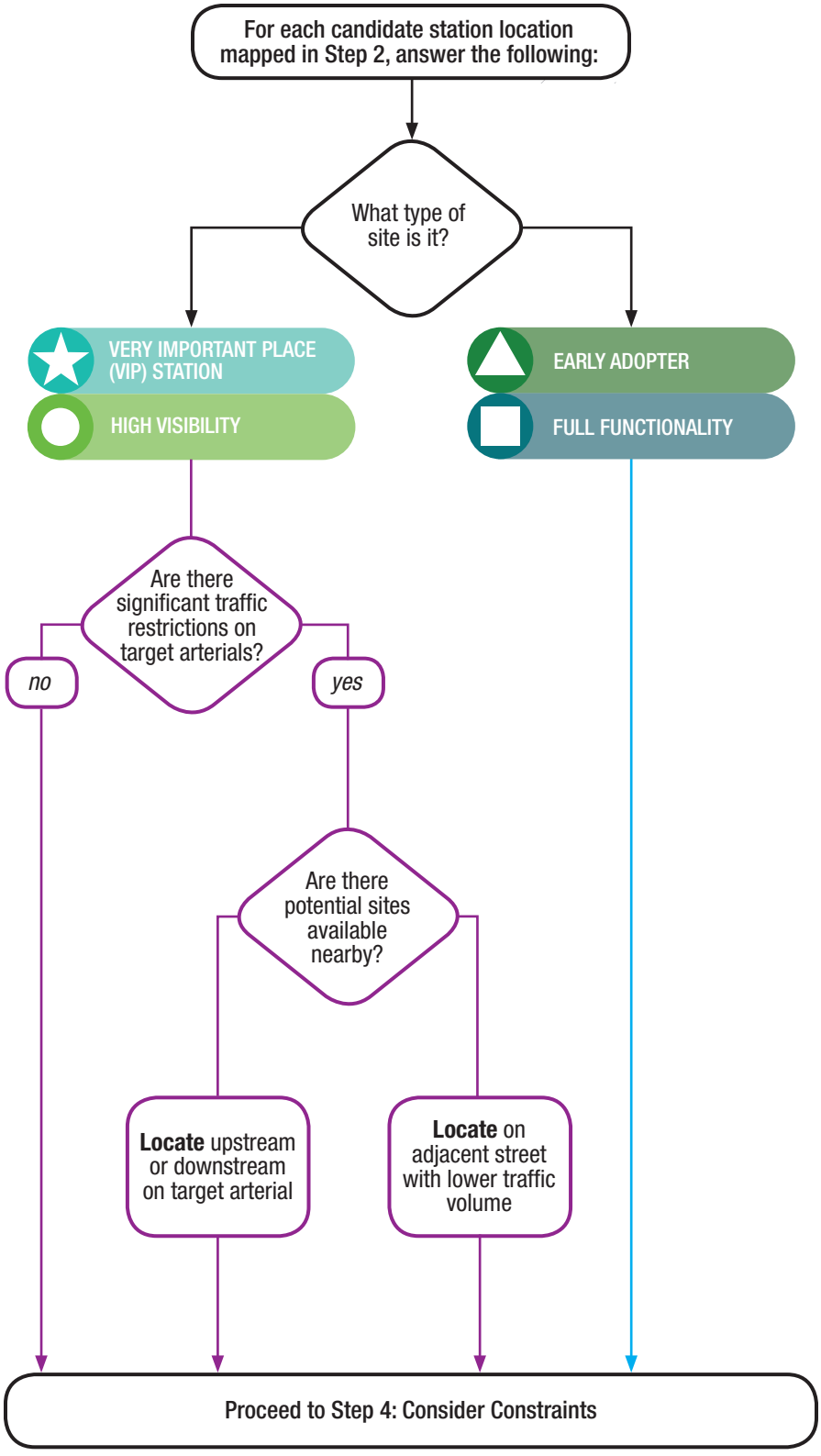
The first step in the Station Location Process is to Map Station Locations. In order for a network of Electric Vehicle Fast Charging Stations to function properly, a series of 4 station types have been identified that work together to meet the goals of the deployment.

Identifying preferred locations for these stations is accomplished by overlaying map data and identifying relevant intersections of the key factors listed to the right. The types should be mapped in order of priority deployment to ensure the end result of a fully functional network. Using the chart at right, identify locations for each station type by evaluating the relevant factors in relation to each other.

TARGET LOCATIONS	MAP OVERLAYS
VERY IMPORTANT PLACE (VIP) STATION	Tourist Attractions Commercial Density
HIGH VISIBILITY	Commercial Density High Traffic Volume
EARLY ADOPTER	Commercial Density High Traffic Volume Hybrid Ownership Density
FULL FUNCTIONALITY	Commercial Density High Traffic Volume Population Density

3 CONSIDER THE SITE SCALE

Once target locations have been identified for the deployment of Fast Charging Stations, use this flow chart to determine the finer grained location or site. In this step of the process the urban context is considered.



4 EVALUATE CONSTRAINTS

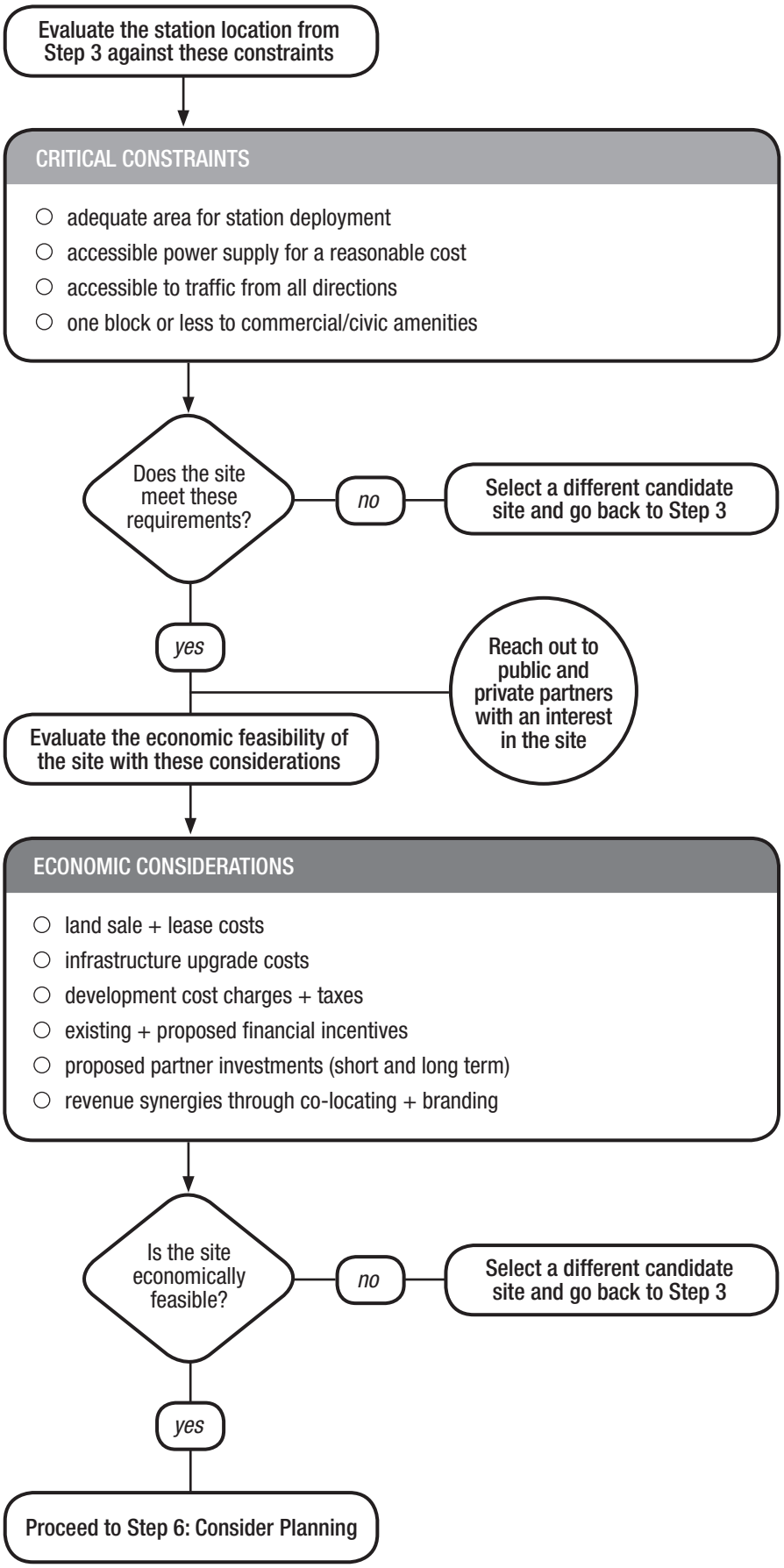
With a more defined site selected for the station, consider this series of critical constraints required for a functional station. It is vital that a candidate site meet all of the constraints in the flowchart at right in order to be a suitable location.

If a target site does not meet the constraints, select a new site and return to Step 3 to determine a new location.

5 CONSIDER ECONOMICS

If the site meets all of the Critical Constraints, gauge the economic feasibility of the site using the considerations in the chart at right.

If a candidate site is not economically feasible, select a new a site and return to Step 3 to determine a new location.



6 CONSIDER PLANNING

Once the site has met all of the Critical Constraints and been identified as economically feasible, Planning Considerations must be taken in account.

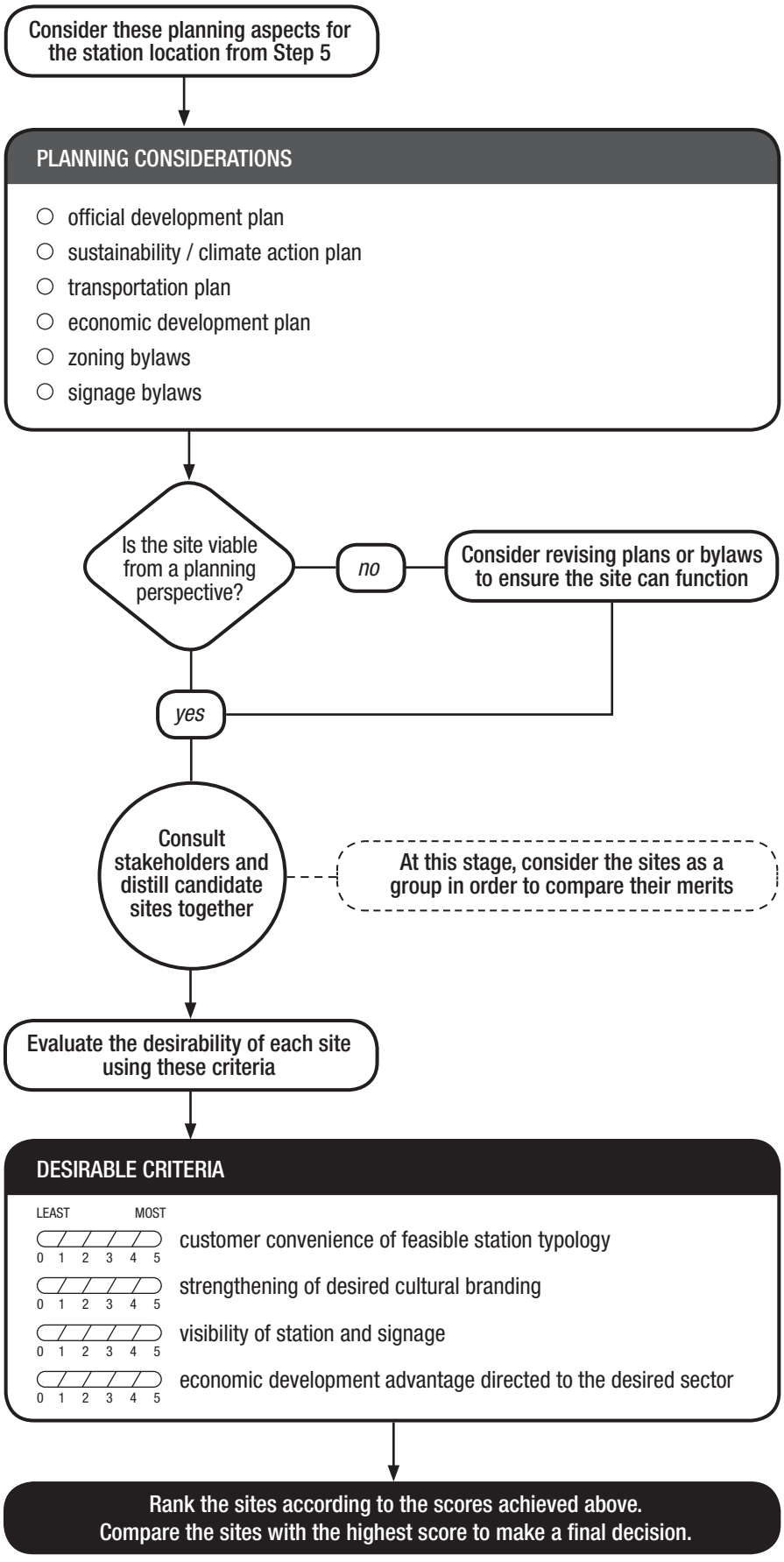
If the site is viable from a planning perspective, proceed to the final step to Evaluate Desirability. If the site is not considered viable consider revising plans or bylaws to ensure the site can function.

7 EVALUATE DESIRABILITY

Once a site has been specifically located and meets all of the constraints and considerations, it must be evaluated according to its desirability in order to place it in a priority ranking among all of your candidate sites.

At this stage it is important to consider public and private partnerships that may allow the site to benefit from a productive relationship. Gather stakeholder input and consider the site using the criteria at right.

Score the candidate sites based on the Desirable Criteria. Rank the sites according to the scores they attain and compare those with the highest scores to reach final decisions on implementation.



GUIDE TO THE STATION LOCATION PROCESS

1 REVIEW THE FRAMEWORK

OBJECTIVES

The objectives for the public EV fast charging station network were derived through a planning and business lens, over a range of scales from the micro-urban scale of a parking space to the global scale of emissions reductions. These objectives attempt to address the concerns of all stakeholders, though some objectives may be more important to individual stakeholders over the course of the network deployment. For the framework, the objectives have been prioritized over the course of deployment in the following order:

Visibility
Increase the public awareness and market profile of EVs, establish high-impact branding and contribute positive urban design in station locations.

Convenience
Provide service in obvious, well-signed locations, ensure short wait times, and provide a simple user interface .

Cultural branding
Position EVs as progressive, green, politically aware, and innovative, building on their ability to decrease GHG emissions and their appeal as a new technology.

Reliability
Provide robust maintenance and service support, prioritize consistency across different types of fast-charging stations.

Affordability (Consumer)
Maintain competitive rates through early phases of adoption, i.e. rates may fluctuate to remain competitive with gas prices.

Operating cost (Utility or Service Provider)
Minimize operating costs through vandal-resistant design, simple user interface, preferring automated stations over manned stations

Initial Cost (Utility, Service Provider, or Land Owner)
Minimize installation costs through pre-fabricated or mass-customized units and standardized installation methods, work with financial institutions to provide favourable terms.

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Work towards financial performance on highly valuable urban land, prioritize deployment as an add-on to existing business, consider locating stations on under-utilized or under-performing sites.

Displacement of gas vehicles
Ensure network robustness so that EVs are a clear alternative to gas vehicles rather than an additional mode of transport, increase market share to at least 15% of total vehicles to have a measurable impact on the purchase of gas vehicles.

Energy use
Continue to increase EV market share to magnify the impact of EVs which are one-to-one more efficient than gas vehicles, promote efficient driving patterns through network deployment, reduce the need for single occupant vehicles (SOVs) with emphasis on other forms of electrified transport, i.e. buses, streetcars, light rail.

STATION TYPES

The general approach to locating stations and the phasing of stations has been considered as a tiered network that will serve evolving objectives over time. At the beginning of the process, the main goal is to enhance visibility of the EV charging stations to introduce public confidence, reduce range anxiety, and show support for the EV. After this first phase, more objectives come into play to bolster consumer confidence through the reliability and affordability of the network. As the continuing good faith of early adopters will be crucial to promoting ongoing adoption, it may be important to prioritize stations that serve high concentrations of early adopters. As the network matures, full functionality, distributed throughout a cluster, will become the goal. These four types of stations have been designated Stage 1: Very Important Place Stations, Stage 2: High Visibility Stations, Stage 3: Early Adopter Stations, and Stage 4: Full Functionality Stations. Each type has a more specialized social function that is linked to the stage of EV adoption, and it enables a priority staging of the network. Ultimately, the four types of stations will work together to form a complete network.

Very Important Place (VIP) Stations
The placement of VIP stations emphasizes the first three objectives.

- Visibility - raising the profile of the electric car
- Convenience - demonstrating that electric cars are simple to run and recharge
- Cultural Branding - to showcase the lifestyle brand of the electric car, increasing mass appeal and accelerating consumer desire

This does not preclude VIP stations from addressing the additional objectives that will unfold over time.

High Visibility Stations

In terms of phased introduction, high visibility stations would overlap with the tail end of VIP station deployment. As a result, they also play a large role in cultural branding, upping the profile of electric cars as a "must have" technology. They also emphasize the next three objectives, which will become more important over the course of electric vehicle adoption.

- Reliability - demonstrating that both the vehicles themselves and the infrastructure can be counted on for availability and smooth operation
- Affordability - demonstrating that an affordable fee-for-charging model makes the cars competitive
- Operating Cost - as infrastructure starts to be adopted by the private sector, showing that it has the potential to be an economically viable business

Early Adopter Station

To cover gaps in high visibility station coverage in areas with high early adoption of electric vehicles. In this sense, early adopter stations are the first stage of the last phase, "full functionality", which aims to provide a mature network. Early adopter stations would emphasize the objectives at the tail end of high visibility stations (affordability, operating cost) while beginning to address the next objective.

- Initial cost - as adoption intensifies and technology evolves, the initial cost of installing fast-charging stations should decrease. This dovetails with intensive adoption among "early adopters"

Full Functionality Station

To achieve a mature fast-charging network with full coverage, such that vehicle owners would not need to give a second thought to their ability to charge when away from obvious home or office slow-charging locations. This dovetails with "early majority" and "late majority" adopters who are increasingly risk averse in their adoption of new technology. Over time, full functionality stations would address the final three long term objectives.

- Financial competitiveness - with widespread adoption and maturing business models, fast-charging infrastructure operators should be able to engage in this business profitably. At this point, risk averse operators would be convinced to take part in the market along with the risk averse consumers.
- Displacement of Gas Vehicles - widespread adoption would start to have a measurable impact on the car market, displacing gas vehicles and reducing greenhouse gas emissions (if clean electricity is used) due to electric vehicle's proven convenience, reliability, cost savings, and environmental benefits
- Energy Use - urban impact of electric vehicle infrastructure would start to take shape as a place-based strategy emphasizes lower overall vehicle use

This stage will likely be the most difficult in which to identify distinct station locations. As a first step, stations are proposed to be located in the commercial areas nearest the major entrances and exits to urban areas, with one station near each major city access point. All major gateways to the city such as airports and ferry terminals were also considered to require a station in order to facilitate use by taxis or other drivers dropping off or picking up people at that point. It is anticipated that these kinds of trips will require a charge at the "gateway" facility prior to a return trip. In completing the functional network, priority was given to commercial areas rather than highway off ramps or bridges, because the importance of supplementary activities was deemed to outweigh proximity to exits.

2 MAP TARGET LOCATIONS

METHODOLOGIES FOR MAPPING EACH STATION TYPE

Very Important Place (VIP) Stations

- Identify and map high profile city locations–i.e. significant public spaces, prominent tourist attractions, city-defining places and objects
- Identify and map existing charging stations (if any)
- Locate VIP stations strategically in relation to existing charging stations in the most prominent locations mapped above

High Visibility Stations

- Identify and map high activity and high visibility locations including areas with high commercial activity and areas with high traffic volume
- Identify and map existing charging stations
- Locate high visibility stations at the most prominent intersections of commercial activity and traffic.
- Locate them in relation to VIP stations, considering the distance between stations to provide the widest coverage with the least resources

Early Adopter Station

- Identify and map hybrid ownership per capita and population density
- Locate stations in areas of high population density and high hybrid ownership which are not already covered with high visibility stations as the first priority
- Locate stations in areas of lower population density and high hybrid ownership as the second priority

Full Functionality Station

- Include the following maps from previous station location phases: high to medium commercial activity, high traffic volume, and population density
- In addition, identify and map major gateways to the city, i.e. airports, freeways, ports
- Identify and map gas stations
- Identify and map public parkades
- Locate stations strategically in relation to existing VIP, high visibility, and early adopter stations to provide a mature network

3 CONSIDER THE SITE SCALE

TRAFFIC CHALLENGES

Due to Very Important Place (VIP) Stations and High Visibility Stations demanding close proximity to busy intersections, traffic restrictions can require the re-siting of the station. If traffic restrictions prohibit the viability of a station at the epicenter of activity, consider two alternatives for siting the station as closely as possible to the hub.

Upstream/Downstream

This siting strategy moves the station either up or down one of the main arterials of the intersection. The movement should be within a short number of blocks of the intersection itself to maintain visibility. More visible signage may be required to reinforce cultural branding where a station moves further away from the intersection.

Adjacent Street

This siting strategy moves the station to a proximate adjacent street with a lower traffic volume. A suitable adjacent street will still have a higher than normal volume of traffic and maintain strong connections of visibility to the main arterial. More visible signage may be required to reinforce cultural branding where a station moves further away from the intersection.

STATION TYPE CATEGORIES

Unlike a gas station, the EV charging station can take many forms, however, in order to be recognizable, the station must have a coherent design component that is consistently discernible to the public in any form that it takes. In other words, a design “language” must be developed in order to communicate to the vehicle owners. In the case of a gas station, the spatial arrangement is always recognizable: it is on a corner, it has a large canopy, it has a consistent scale and signage. Since an EV charging station may be curbside, may be attached to a gas station or other business, or may be a stand-alone entity, it must be recognizable in all its forms.

Public right of way - i.e. curbside, lane

The public right of way is envisioned as taking over several public parking stalls and could involve curb shaping or pavement marking that highlights the station’s location and special status in the city. The charging station shown in the following image has lighting designed into the stall as well as solar panels to operate the charging station. Light or another indication of functionality or the amount of charge could be included to add an element of dynamic information and interaction. Activities while charging at this type of station are provided by the urban context and not integrated with the station itself.

Civic amenity - i.e. library, community centre, neighbourhood house

With a civic amenity, a charging station could be a stand-alone post or could include a canopy. There is sufficient parking at many civic amenities such that stations could easily be integrated. Activities while charging would likely relate to the civic amenity to which the station is attached, but it is possible that in an urban area, other nearby commercial activities could play a role. Again, since the station is a public amenity, it would not integrate a commercial business.

Businesses that directly serve cars - i.e. gas stations, Canadian Tire Auto Parts, mechanics

The design of a station that integrates with a gas station or other auto service type business faces a few challenges: first it must be at a safe distance from the gas pumps, and secondly it must differentiate itself from the existing gas station. The operation of the EV charging station will be independent of the gas station and must be identifiable for what it is. Integration with an existing gas station has the advantage of sharing the commercial services attached to the gas station. While this may not be truly suitable for someone waiting 20 minutes, it does provide some activity or amenity while charging.

Businesses with parking out front - ranging from small strip mall to big box

Any business willing to forgo some parking spots for an EV station could host an EV station in their parking area. The business would need to be able to accommodate charging bays, charging infrastructure, and perhaps some queuing space, as well as signage to indicate the station’s presence. Spatially it may not be that recognizable as a station, so additional signage may be necessary. Protection from the elements in terms of a canopy would be desirable, and this feature would also help identify the station for wayfinding purposes.

Parkade - general or office

The design of a charging station in a parkade does not so much require design of the space but design of signage and a branded presence to indicate to the public the existence of the charging station and the appropriate entrance. As important as the signage on the exterior of the parkade is, the interior signage will direct the driver to the charging stations within the parkade. Shelter from the elements is provided by the parkade itself so a canopy is not a prime consideration. Lighting and safety considerations are important but are usually considered in the design of the parkade itself.

Attached to any kind of business

As the EV market evolves, charging stations might be attached to any form of business. Similarly to the designs for auto-oriented businesses, the challenge is in differentiating the brand and making the charging station recognizable as such. Considerations in terms of comfort and convenience

while charging, as well as the activities while charging, are key. Ideally, the business should provide an activity that lasts approximately as long as the time required for a fast charge. If the business provides a longer term activity, it might make more sense for the charging station to be a level 1 or 2 type.

Charging station with other business or co-locating business

The charging station in a mature EV market could take the role of a prime attraction with related activities integrated into and around the station. The station could be integrated with other green or progressive businesses that tie into the branding or else activities that might generate electricity. Activities such as a fitness centre, a "green" grocery store, a farmer's market, or a sustainable coffee shop could be integrated into the "image" of the EV brand. In outlying areas where there are no existing activities adjacent to the station, the captive audience of the EV charging station may provide enough of a market to make other businesses worthwhile.

4 EVALUATE CONSTRAINTS

CRITICAL CONSTRAINTS

These constraints are an important first filter; if a candidate site fails to meet even one of these, it can't be considered further. Though the goal is to arrive at a black and white answer for each constraint, there is some grey area which is addressed here. First, adequate area will depend on the size of station desired. The smallest area required to accommodate two cars side-by-side is Xm x Xm, and the smallest area required to accommodate two cars in a linear arrangement is Xm x Xm. Second, the power supply required to serve a fast charging station is an X volt transformer. Typically, any large building will have this type of supply. Consult with your local utility to determine the distance to this type of supply and an estimated cost to bring the supply to the desired site. Third, 'accessible to traffic from all directions' may include having to make several turns from a given direction, as long as a vehicle can in fact reach the destination site. Lastly, given the time required for charging, it is important to have access to commercial / civic amenities nearby so that EV users don't perceive that time is wasted while charging.

5 CONSIDER ECONOMICS

ECONOMIC FEASIBILITY

After considering critical constraints, considering economic feasibility will be the next most important step. At this stage it will be critical to reach out to potential partners, both public and private, who may have a stake in the site, to determine whether a partnership with them might go forward. For example, if the parking lot of a particular business has been identified as a preferred site, but the business has no interest in working with the municipality on this project, the site should be rejected. Furthermore, evaluating economic considerations will be most productive when compared against a defined budget. However, even if a budget has not yet been defined, it may be helpful to examine these economic considerations to evaluate multiple candidate sites against each other.

6 CONSIDER PLANNING

PLANNING VIABILITY

Planning considerations are unique, in that as the local authority, you are in the position to alter or amend plans and bylaws after reviewing them. For example, while the zoning bylaw may not currently permit the proposed mix of uses, you may make an amendment to the zoning bylaw with a general exception for an electric vehicle charging station. While you most likely have an official development plan, a sustainability or climate action plan, and a transportation plan in place which address general greenhouse gas emission reduction goals, your transportation plan may not yet address the electrification of transportation. In this case, it would be preferable to develop a general outline of an electrification of transportation plan, which considering level I and level II charging as well as fast charging in a comprehensive network. If this is not yet feasible, fast charging can be considered on its own.

7 EVALUATE DESIRABILITY

COMPARING AND RANKING SITES

After reviewing planning and economic considerations, it will be necessary to make some qualitative judgments when comparing candidate sites. At this point, a scale is introduced to allow for the weighting of multiple criteria. Depending on the area available at a given site, various station typologies may be feasible. For example, if the site is curbside, you may not be able to construct a canopy to cover EV users while charging given vehicle clearances necessary in a right-of-way. However, if the site is located in a parking lot or attached to a business, a canopy may be feasible. Choices like this may have a major impact on EV users' initial perceptions of the technology and should be carefully considered. Desired cultural branding presents another grey area, however as a municipality you should be aware that attaching charging stations to various types of businesses or amenities could have significant implications for the branding, especially related to sustainability. It may be beneficial to attach the charging station to a business which is already perceived as 'green.' In the same vein, charging station siting can have a major impact on economic development. For example, if a charging station is located near local businesses, it may help them thrive, whereas a charging station located amongst chain development will have a very different impact on the local economy. When it comes to visibility, two equally valid approaches can be considered. On one hand, the station itself may be located to be highly visible from a major right-of-way. On the other hand, highly visible signage might be planted beside the right-of-way, directing people to a station that is less immediately visible. In the end, all of these factors will require some degree of judgment call. Ultimately, as the municipality, you should determine which sites which have made it this far in the process will be most beneficial to your desired direction of growth and development.

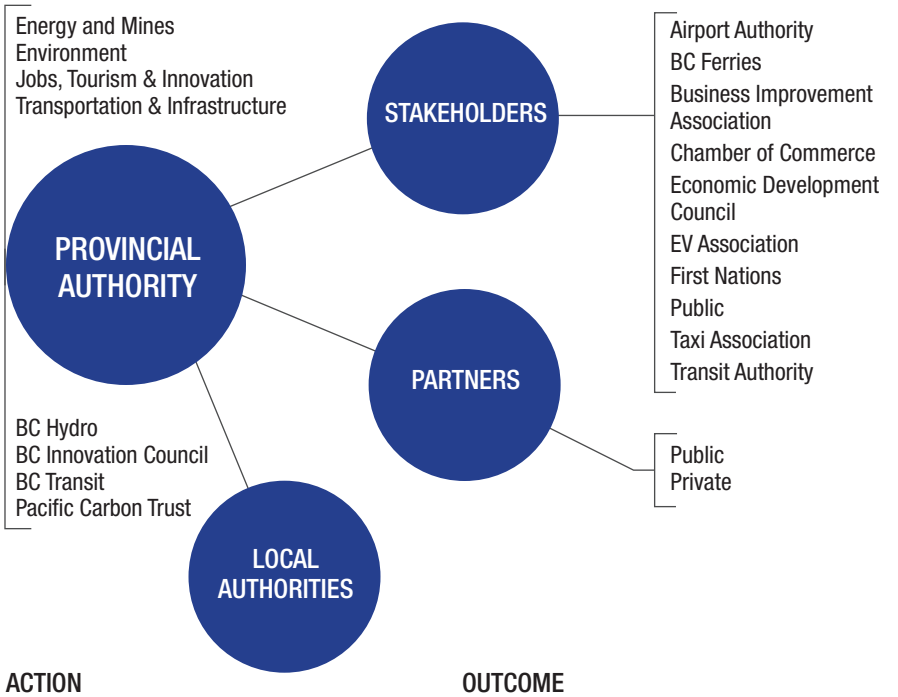
STATION LOCATION PROCESS
HIGHWAY SCALE

This document will guide you, the Provincial Authority, through the process of situating Electric Vehicle Fast Charging Stations throughout your jurisdiction. At certain stages in the process it will be important to consult with Local Authorities, Stakeholders and Partners.

The process has been broken down into 7 steps to facilitate your work. The steps start at a large scale and continually refine through more detailed considerations to assist you in obtaining a prioritized list of station sites.

As you move through the process, be sure to consult the *Guide to the Station Location Process*; it contains definitions and useful information to clarify terminology, processes and considerations.

KEY RELATIONSHIPS



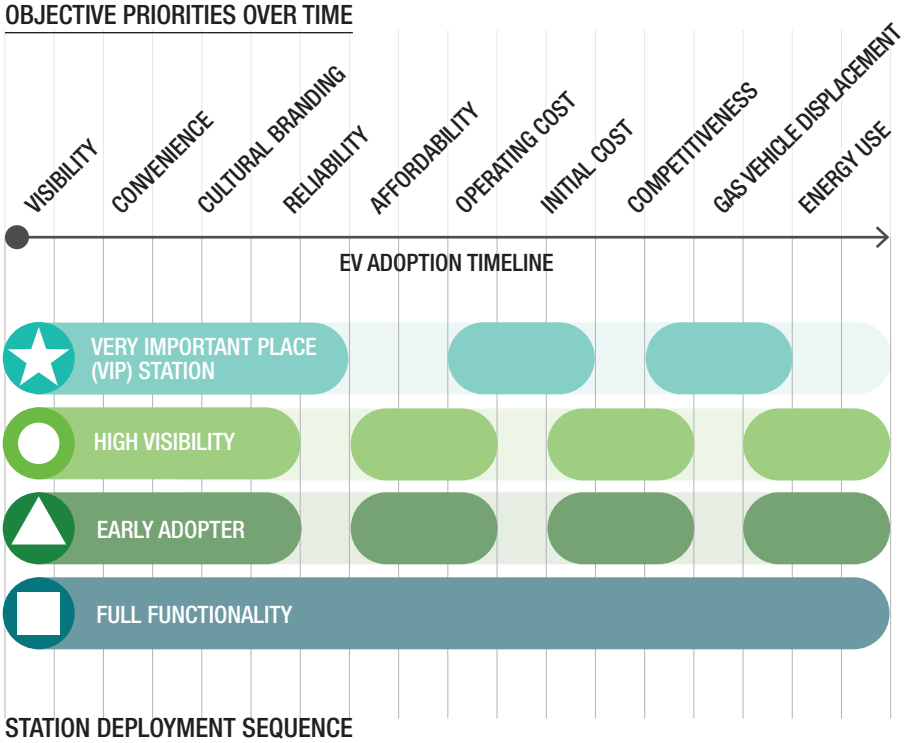
ACTION	OUTCOME
1 REVIEW THE FRAMEWORK	UNDERSTAND PRIORITY OBJECTIVES AND STATION TYPOLOGIES
2 MAP TARGET LOCATIONS	DETERMINE SITE AREAS WITHIN WHICH TO LOCATE STATIONS
3 CONSIDER THE SITE SCALE	DETERMINE A RANGE OF SITES TO EVALUATE WITH CONSTRAINTS
4 EVALUATE CONSTRAINTS	DETERMINE WHETHER THE SITES MEETS MINIMUM REQUIREMENTS
5 CONSIDER ECONOMICS	DETERMINE THE ECONOMIC FEASIBILITY OF THE SITES
6 CONSIDER PLANNING	DETERMINE THE PLANNING VIABILITY OF THE SITES
7 EVALUATE DESIRABILITY	DEVELOP A LIST OF PRIORITIZED SITES FOR IMPLEMENTATION

1 REVIEW THE FRAMEWORK

The framework for deploying Electric Vehicle Fast Charging Stations consists of a series of time prioritized objectives and a series of station typologies. Starting from the left, the foremost concerns upon immediate deployment are Visibility, Convenience, Cultural Branding and Reliability (please see the *Guide to the Station Location Process* for specific definitions).

If electric vehicle range is not accommodated along highways, the vehicles become useless. As a result, the "full functionality" phase is critical for corridors and must be introduced immediately. The prioritized objectives are relevant but more of them must be addressed at once.

OBJECTIVE PRIORITIES OVER TIME



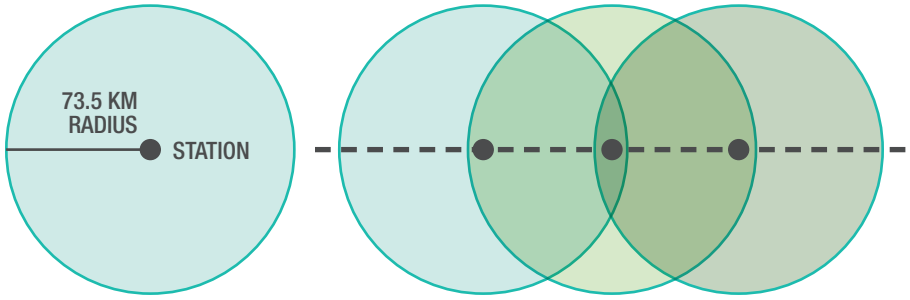
STATION DEPLOYMENT SEQUENCE

2 MAP TARGET LOCATIONS

The first step in the Station Location Process is to Map Station Locations. In order for a highway network of Electric Vehicle Fast Charging Stations to function properly, the range of the vehicles themselves must be taken into account.

Using a range of 73.5 km, plot stations along the highway such that the ranges overlap (please see the *Guide to the Station Location Process* for information on range determination). Stations should be located to meet not only the range requirements of the vehicles but also the expectations of a highway driver.

RANGE MAPPING

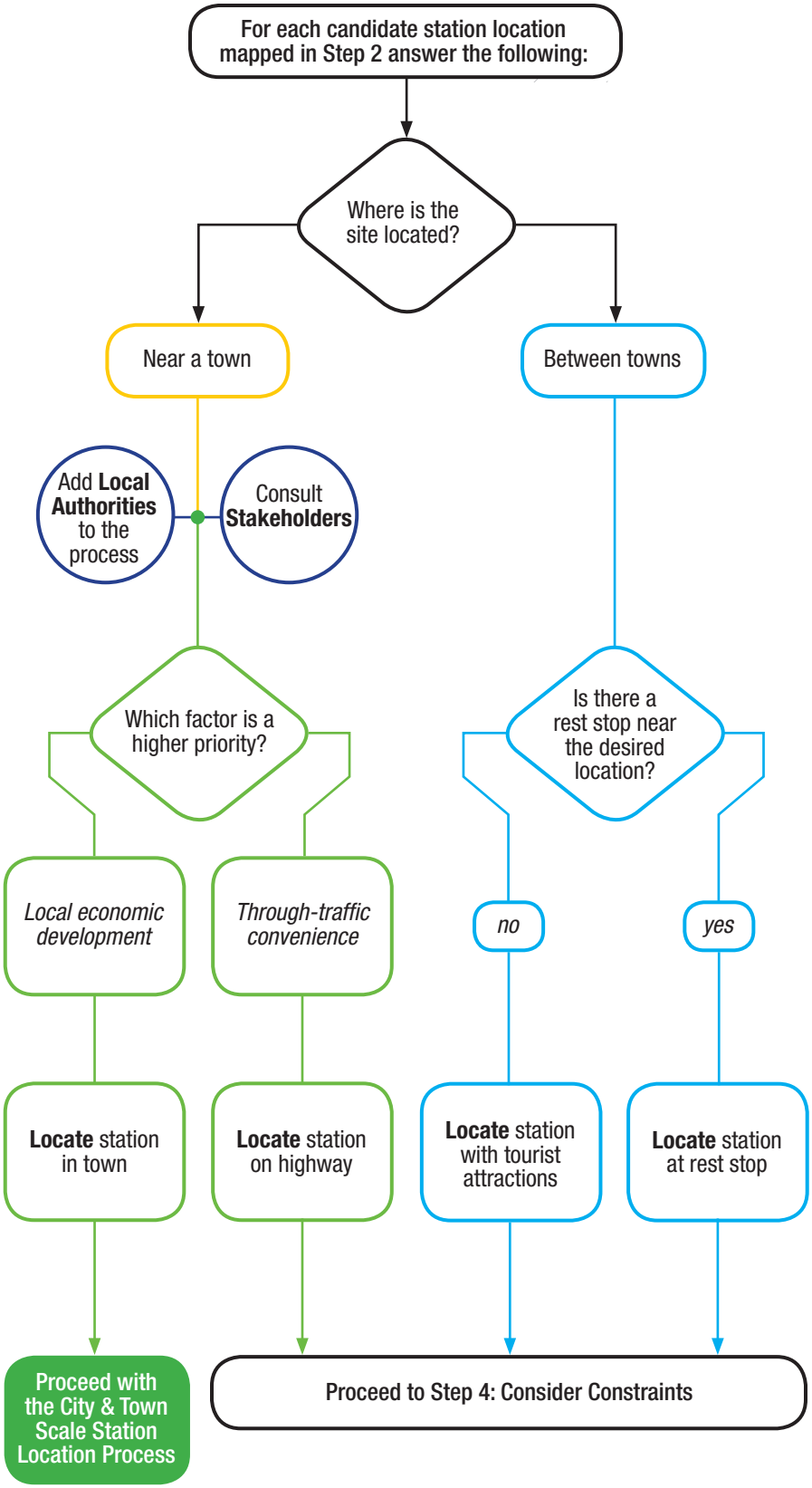


Example of a single station plotting

Stations plotted along a route such that each 73.5 Km radius overlaps with the station before and after

3 CONSIDER THE SITE SCALE

Once target locations have been identified for the deployment of Fast Charging Stations, use this flow chart to determine the finer grained location or site.



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If a candidate site does not meet the constraints, select a new site and return to Step 3 to determine a new location. Resubmit new sites in this flowchart of constraints until a potential site is deemed appropriate for desirability evaluation.

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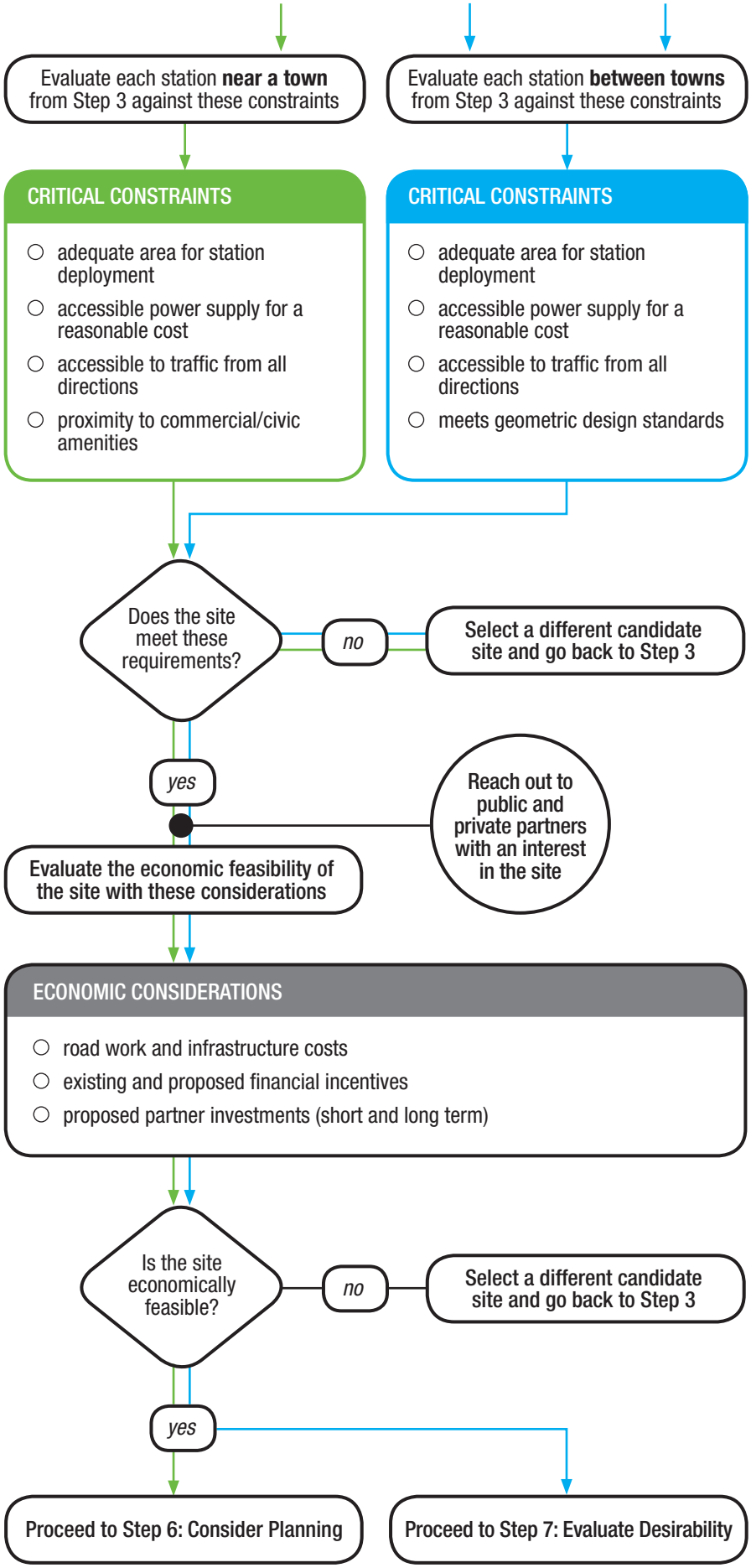

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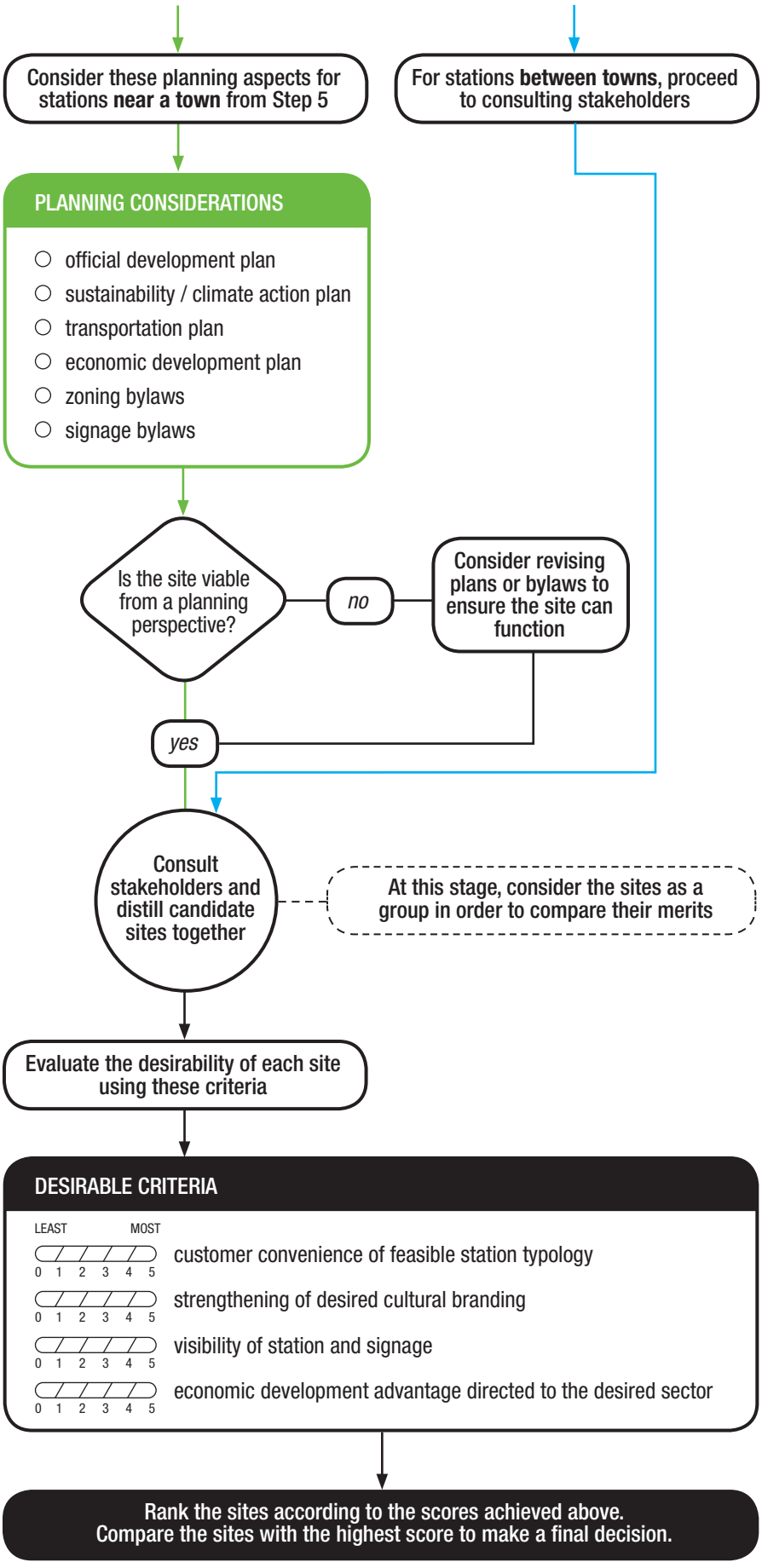

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Minimize operating costs through vandal-resistant design, simple user interface, preferring automated stations over manned stations

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STATION TYPES

Highways have been designated as corridors for the purposes of this framework to help describe the nature of the infrastructure they will require. The defining characteristic of corridors is the relationship between distance covered and the range of available electric vehicles. If electric vehicle range is not accommodated along corridors, the vehicles become useless. As a result, the “full functionality” phase is critical for corridors and must be introduced earlier than in the cluster context, where home and office charging will be widely available. The prioritized objectives are still relevant here, but more of them must be addressed at once.

Corridor Staging
As mentioned above, the “full functionality” phase would be the first to be introduced along corridors, if possible in conjunction with “early adopters”, in order to make intercity travel viable as early as possible. “VIP” and “high visibility” stations still have an important role to play here, though it would be qualitatively different than in the cluster context. Within a corridor, VIP and high visibility stations could double as full functionality stations, at the same time promoting the uniqueness of a given location. Electric vehicle charging infrastructure has the potential to have an impact in the urban and interurban context in distinct opposition to the impact gas stations have historically had. Where gas stations have led to sprawl and homogenous highway-side development, promoting the convenience of the strip as their main attraction, electric vehicle infrastructure could be largely place-based, tying into the unique identities and attractions of small towns or the outlying areas of large cities. This would help bolster the “cultural branding” objective by helping local economies and repositioning autonomous road travel as a positive influence.

Very Important Place (VIP) Stations

The placement of VIP stations emphasizes the first three objectives.

– Visibility - raising the profile of the electric car
– Convenience - demonstrating that electric cars are simple to run and recharge
– Cultural Branding - to showcase the lifestyle brand of the electric car, increasing mass appeal and accelerating consumer desire

This does not preclude VIP stations from addressing the additional objectives that will unfold over time.

High Visibility Stations

In terms of phased introduction, high visibility stations would overlap with the tail end of VIP station deployment. As a result, they also play a large role in cultural branding, upping the profile of electric cars as a "must have" technology. They also emphasize the next three objectives, which will become more important over the course of electric vehicle adoption.

– Reliability - demonstrating that both the vehicles themselves and the infrastructure can be counted on for availability and smooth operation
– Affordability - demonstrating that an affordable fee-for-charging model makes the cars competitive
– Operating Cost - as infrastructure starts to be adopted by the private sector, showing that it has the potential to be an economically viable business

Early Adopter Station

To cover gaps in high visibility station coverage in areas with high early adoption of electric vehicles. In this sense, early adopter stations are the first stage of the last phase, "full functionality", which aims to provide a mature network. Early adopter stations would emphasize the objectives at the tail end of high visibility stations (affordability, operating cost) while beginning to address the next objective.

– Initial cost - as adoption intensifies and technology evolves, the initial cost of installing fast-charging stations should decrease. This dovetails with intensive adoption among "early adopters"

Full Functionality Station

To achieve a mature fast-charging network with full coverage, such that vehicle owners would not need to give a second thought to their ability to charge when away from obvious home or office slow-charging locations. This dovetails with "early majority" and "late majority" adopters who are increasingly risk averse in their adoption of new technology. Over time, basic functionality stations would address the final three long term objectives.

– Financial competitiveness - with widespread adoption and maturing business models, fast-charging infrastructure operators should be able to engage in this business profitably. At this point, risk averse operators would be convinced to take part in the market along with the risk averse consumers.
– Displacement of Gas Vehicles - widespread adoption would start to have a measurable impact on the car market, displacing gas vehicles and reducing greenhouse gas emissions (if clean electricity is used) due to electric vehicle's proven convenience, reliability, cost savings, and environmental benefits
– Energy Use - the urban impact of electric vehicle infrastructure would start to take shape as a place-based strategy emphasizes lower overall vehicle use

2 MAP TARGET LOCATIONS

ELECTRIC VEHICLE RANGE MAPPING

In order to identify a realistic range to be applied to corridor maps, an extensive analysis was conducted of available and projected electric vehicles. The manufacturers' estimated ranges as well as the EPA values that should be applied to those estimates were evaluated. From the analysis that follows, it was concluded that a range of 73.5 km would be realistic to consider in the corridor context. The analysis first surveyed all electric cars on the market and then narrowed the study to those that would be available in the geographic region being considered (British Columbia). Only cars that are highway worthy were considered. Highway worthy is defined by the following conditions: vehicle speed of greater than 100km/h, vehicle range (given by the manufacturer) of greater than 100km per charge, and four seats. The distances claimed by the manufacturers, however, need to be modified based on the types of ranges achieved in EPA tests, which more closely reflect real-world performance.

This was accomplished using the EPA rating figures which are already available for the Nissan Leaf. The EPA test projects a range of 73 miles / 117.5 km for the Nissan Leaf, while Nissan claims 100 miles / 160 km. The EPA figures are based on a detailed 5-cycle test which includes city, highway, high speed, air conditioning, and cold temperature. Cars may achieve better performance than the EPA figures suggest, however, the conservative estimate is appropriate for range mapping.

From this study, we conclude that the real range for the Nissan Leaf is 73.44% (117.5 km / 160 km) of the nominal range given by Nissan. Applying this percentage to the car with the lowest range in the overview, the Blade Electron which has a nominal range of 100km, a minimum range for commercially available, highway worthy cars of 73.5 km (100km x 0.7344) is derived. This translates to the maximum feasible distance to be allowed between highway charging stations. Though future advances in battery technology are likely to allow a greater range, this fairly frequent recommended spacing will help to comprehensively serve a more saturated market in the future.

3 CONSIDER THE SITE SCALE

HIGHWAY SITUATIONS

When locating stations on the highway there will be two specific situations to consider: locating near a town or between a town.

Near a town

If a station is to be located near a town it is necessary to add Local Authorities and Stakeholders to the process as critical decisions need to be made that do not fall solely within the jurisdiction of the larger authority. For example, will the station be located on the highway itself, preferencing through traffic convenience, or within the town, preferencing the potential to stimulate local economic development? These decisions need to be undertaken in consultation with the various stakeholders.

Between towns

For station locations that are not near to a town it is possible for an existing highway rest stop to be used as the site. These rest stops typically have existing infrastructure that complements the program of the charging station and may have an available power supply. If a rest stop is not present, efforts should be made to locate the station at a significant point of interest or tourist attraction. Both the charging station and the attraction can benefit from the increased volume of traffic through the site as well as increased visibility and exposure.

STATION TYPE CATEGORIES

Unlike a gas station, the EV charging station can take many forms, however, in order to be recognizable, the station must have a coherent design component that is consistently discernible to the public in any form that it takes. In other words, a design "language" must be developed in order to communicate to the vehicle owners. In the case of a gas station, the spatial arrangement is always recognizable: it is on a corner, it has a large canopy, it has a consistent scale and signage. Since an EV charging station may be curbside, may be attached to a gas station or other business, or may be a stand-alone entity, it must be recognizable in all its forms.

Charging station with other business or co-locating business

The charging station in a mature EV market could take the role of a prime attraction with related activities integrated into and around the station. The station could be integrated with other green or progressive businesses that tie into the branding or else activities that might generate electricity. Activities such as a fitness centre, a "green" grocery store, a farmer's market, or a sustainable coffee shop could be integrated into the "image" of the EV brand. In outlying areas where there are no existing activities adjacent to the station, the captive audience of the EV charging station may provide enough of a market to make other businesses worthwhile.

Rest stop

The charging station in this case is envisioned for a highway rest stop location. Rest stops in BC are typically on crown land and operated by the Ministry of Transportation. As a result, commercial activities would likely be absent. The station would only consist of the charging unit, a canopy for weather protection, and seating–all of which are integrated in the design option shown in the following figures. Supplementary activities that could be considered include viewing or nature interpretation in cases where the rest stop is at a view point or other point of interest on the highway.

Stand-alone highway station

The stand-alone highway station or station for more suburban sites would be a charging station with built-in amenities similar to current highway gas stations with services. Stores or restaurants with playgrounds would likely be the co-locating activities seeking to capitalize on the captive audience.

4 EVALUATE CONSTRAINTS

CRITICAL CONSTRAINTS

These constraints are an important first filter; if a candidate site fails to meet even one of these, it can't be considered further. Though the goal is to arrive at a black and white answer for each constraint, there is some grey area which is addressed here. First, adequate area will depend on the size of station desired. The smallest area required to accommodate two cars side-by-side is Xm x Xm, and the smallest area required to accommodate two cars in a linear arrangement is Xm x Xm. Second, the power supply required to serve a fast charging station is an X volt transformer. Typically, any large building will have this type of supply. Consult with your local utility to determine the distance to this type of supply and an estimated cost to bring the supply to the desired site. Third, 'accessible to traffic from all directions' may include having to make several turns from a given direction, or in the case of a highway, exiting and changing direction via an overpass, as long as a vehicle can in fact reach the destination site. Avoiding this minor inconvenience would mean doubling up on charging stations to serve both directions, which is not a feasible option given resource constraints in early deployment phases. Fourth, given the time required for charging, it is important to have access to commercial /civic amenities nearby whenever

possible, so that EV users don't perceive that time is wasted while charging. When working on a highway site, that proximity is not likely achievable, though views or historic attractions may provide a diversion while charging. Lastly, for a highway site, 'geometric design standards' provided by the Ministry of Transportation should be consulted to ensure that turning radiuses and related constraints can be accommodated on the candidate site.

5 CONSIDER ECONOMICS

ECONOMIC FEASIBILITY

After considering critical constraints, considering economic feasibility will be the next most important step. At this stage it will be critical to reach out to potential partners, both public and private, who may have a stake in the site, to determine whether a partnership with them might go forward. For example, if the parking lot of a particular business has been identified as a preferred site, but the business has no interest in working with the authority on this project, the site should be rejected. Furthermore, evaluating economic considerations will be most productive when compared against a defined budget. However, even if a budget has not yet been defined, it may be helpful to examine these economic considerations to evaluate multiple candidate sites against each other.

6 CONSIDER PLANNING

PLANNING VIABILITY

Planning considerations are unique, in that as the local authority, you are in the position to alter or amend plans and bylaws after reviewing them. For example, while the zoning bylaw may not currently permit the proposed mix of uses, you may make an amendment to the zoning bylaw with a general exception for an electric vehicle charging station. While you most likely have an official development plan, a sustainability or climate action plan, and a transportation plan in place which address general greenhouse gas emission reduction goals, your transportation plan may not yet address the electrification of transportation. In this case, it would be preferable to develop a general outline of an electrification of transportation plan, which considers level I and level II charging as well as fast charging in a comprehensive network. If this is not yet feasible, fast charging can be considered on its own.

7 EVALUATE DESIRABILITY

NOTES WOULD GO HERE

After reviewing planning and economic considerations, it will be necessary to make some qualitative judgments when comparing candidate sites. At this point, a scale is introduced to allow for the weighting of multiple criteria. Depending on the area available at a given site, various station typologies may be feasible. For example, if the site is curbside, you may not be able to construct a canopy to cover EV users while charging given vehicle clearances necessary in a right-of-way. However, if the site is located in a parking lot or attached to a business, a canopy may be feasible. Choices like this may have a major impact on EV users' initial perceptions of the technology and should be carefully considered. Desired cultural branding presents another grey area, however as a municipality you should be aware that attaching charging stations to various types of businesses or amenities could have significant implications for the branding, especially related to sustainability. It may be beneficial to attach the charging station to a business which is already perceived as 'green.' In the same vein, charging station siting can have a major impact on economic development. For example, if a charging station is located near local businesses, it may help them thrive, whereas a charging station located amongst chain development will have a very different impact on the local economy. When it comes to visibility, two equally valid approaches can be considered. On one hand, the station itself may be located to be highly visible from a major right-of-way. On the other hand, highly visible signage might be planted beside the right-of-way, directing people to a station that is less immediately visible. In the end, all of these factors will require some degree of judgment call. Ultimately, as the municipality, you should determine which sites which have made it this far in the process will be most beneficial to your desired direction of growth and development.

Appendix B

Matrix of Alternate Options

Fast Charging Stations

BC Provincial Deployment of Fast Charging Stations – Analysis

Phase 1: 30 Stations

Deployment Option	Goal	Focus
OP1	Reach as many places as possible - priority by indicators	Corridors
OP2	Reach as many places as possible - priority by indicators, elaborated mainland	Corridors
OP3	Move to High Visibility phase by elaborating key cities, population indicators, elaborated mainland	Corridors
OP4	Move to High Visibility phase by elaborating key cities, uptake indicators, elaborated mainland	Corridors
OP5	Move to High Visibility phase by elaborating key cities, uptake indicators, elaborated mainland	Major centres, two key areas, unlinked
OP6	Move to High Visibility phase by elaborating key cities, uptake indicators, elaborated mainland	Major centres, one key area

Area Network	Route	Type	Distance (km)	Location	Deployment Options					
					OP1	OP2	OP3	OP4	OP5	OP6
Lower Mainland	Route 99	○		Whistler	1	1	1	1	1	1
		○	59	Squamish	1	1	1	1	1	1
		✪	52	Vancouver	1	1	3	3	4	5
		✪	11	Richmond		1	1	1	2	2
		✪	26	Surrey	1	1	2	3	3	3
		○	26	—USA border						
	Hwy 1	✪		North Vancouver	1	1	1	2	2	2
		✪	13	Burnaby	1	1	1	1	2	3
		○	17	Coquitlam		1	1	1	1	1
		○	15	Langley	1	1	1	1		1
		○	44	Abbotsford	1	1	1	1		1
		○	31	Chilliwack		1	1	1		1
		○	54	Hope	1	1	1	1		1
	Link to Okanagan (Via Hwy 5, from Hope)	○	58	Coquihalla Rest Stop	1	1	1	1		1
	Vancouver Intl. Airport (From Vancouver)	✪	12	Airport	1	1	1	1	1	1
	Total				**11**	**14**	**17**	**19**	**17**	**24**
Island	Hwy 1	✪		Victoria/Saanich	1	1	1	3	4	4
		○	61	Duncan (link)	1	1	1	1	1	1
		○	51	Nanaimo	1	1	1	1	1	1
	Total				**3**	**3**	**3**	**5**	**6**	**6**
Okanagan	Hwy 5: Kamloops-Merritt	✪		Kamloops	1	1	1	1	1	
	Hwy 97c: Merritt-Kelowna	○	**83**	Merritt	1	1	1	1	1	
	(Coquihalla connector)	○	56.5	Elkhard Road (link)	1	1	1	1	1	
		✪	53.5	Kelowna	1	1	1	1	2	
	Hwy 97	○	52	Vernon	1	1	1	1	1	
		○	74	Falkland (link Kamloops-Vernon)	1	1	1	1	1	
	Total				**6**	**6**	**6**	**6**	**7**	

Southeastern BC	Hwy 97	○	63	Penticton	1	1	1			
	Hwy 3		63	Osoyoos	1	1	1			
			70	Midway	1	1	1			
			73	Billings	1	1	1			
		○	80	Castlegar	1	1	1			
	Hwy 6	☆	45	Nelson	1	1	1			
			41	Salmo	1	1	1			
	Hwy 3		**83**	Creston	1	1	1			
			74	Moyie	1	1	1			
		○	32	Cranbrook	1	1	1			
			47	Jaffray	1	1	1			
		○	51	Fernie	1	1	1			
	Total				**12**	**12**	**12**			
Central BC	Hwy 97	☆		Prince George	1	1				
		○	63	Hixon (link)	1	1				
		○	59	Quesnel	1	1				
		○	45	Alexandria (link)	1	1				
		○	74	Williams Lake	1	1				
			67	Lac La Hache	1	1				
			67	70 Mile House	1	1				
			72	Cache Creek	1	1				
	Hwy 1		83	(distance to Kamloops for checking)						
	Total				**8**	**8**				
Northwestern	Hwy 16	☆		Prince Rupert	1					
			75	Skeena River Ecological Reserve (near)	1					
			69	Terrace	1					
			75	Cedarvale	1					
			64	New Hazelton	1					
			68	Smithers	1					
			64	Houston	1					
			79	Burns Lake	1					
			67	Stellako	1					
			62	Vanderhoof	1					
			63	Telachick	1					
			40	(distance to Prince george for check)						
	Total				**11**					
NETWORK TOTAL					**51**	**43**	**38**	**30**	**30**	**30**

Legend

☆ Very Important Place (VIP) Station
○ High Visibility (HV) Station

Notes

Option 3 - HV stations distributed by population at 1 station for every 200,000 population at High Visibility Stage
Option 4 - HV stations distributed by indicator flowchart (see report)