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Assessing charging infrastructure needs in Québec

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This working paper assesses the electric vehicle charging infrastructure required in Québec province through 2035 and provides a specific focus on Montréal. The analysis focuses on light-duty vehicles including passenger cars, taxis, private-hire vehicles, and light commercial vehicles. The geographic scope covers 17 administrative regions and results are presented at the provincial and regional levels. The focus on Montréal provides results at the Greater Montréal, administrative region, and city levels. The results show that Québec currently has 27% and 12% of the public charging infrastructure needed by 2025 and 2030. The report also summarizes programs and investments from Hydro-Québec and the provincial government that promote charging infrastructure development in Québec.

Introduction

Québec is leading the electric vehicle transition in Canada: it is home to more than 45% of Canada's electric vehicles, but only 23% of Canada's overall car fleet. The province passed the mark of 100,000 electric vehicles on its roads in April 2021. In the 2030 Plan for a Green Economy, published in 2020, Québec set a goal of having 1.5 million light-duty electric vehicles on its roads in 2030, which would represent about 30% of the light-duty fleet.[1] To achieve this target, Québec has implemented many measures to spur electric vehicle uptake including offering financial incentives, establishing charging infrastructure deployment programs, creating electric vehicle consumer awareness initiatives, and setting a 2035 government target of ending sales of new fossil fuel passenger cars and light commercial vehicles. The Government of Canada also requires

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1 Government of Québec, "2030 Plan for a Green Economy," March 11, 2021, https://www.quebec.ca/en/government/policies-orientations/plan-green-economy/.

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that all new light-duty cars and passenger trucks be zero-emission by 2035, accelerating Canada's previous goal of 100% sales by 2040. Québec's pursuit of transportation electrification is part of a larger strategy to promote climate resiliency and energy savings through increased use of domestic clean energy; indeed, more than 99.7% of Québec's electricity is produced from renewable sources.[2]

In order to reach its ambitious transport electrification goals, Québec will require significant expansion of its public and private charging infrastructure network. The objective of this study is to assess the electric vehicle charging infrastructure needed in Québec's 17 administrative regions by 2035 to support future electric vehicle uptake. We provide a detailed analysis of Greater Montréal, the Montréal administrative region (Montréal Island), and Montréal city, which account for 48%, 24%, and 21% of Québec's population, respectively.[3] This study complements an analysis made by Dunsky on electric vehicle uptake in Greater Montréal and the related charging infrastructure needed up to 2030.[4] While the Dunsky analysis only reports public chargers at the Greater Montréal level, the present analysis provides detailed results by charger type (both public and private) and location and extends to 2035. A comparison between this study and the Dunsky one can be found in Table A 9 of the Annex.

Three categories of vehicles comprise the analysis: passenger cars (company and private), light commercial vehicles, and taxis (including private-hire vehicles). The model takes into account vehicle purchase trends, charging behavior up to December 2020, and the 2035 target of 100% zero-emission vehicle sales, interpreted as 100% BEV sales, for passenger cars and light commercial vehicles. Results are provided at the regional level for six charging categories: private home, depot (for light commercial vehicles), private workplace, public AC normal (including residential and destination), public fast urban, and fast highway corridor. Based on the results of the modeling and the analysis, the study recommends policies to support the deployment of charging infrastructure. Throughout this report, normal charging refers to chargers providing power less than or equal to 11 kW in alternating current (AC). Fast charging refers to charger providing power greater than 25 kW using direct current (DC) electricity.

Market characterization of vehicles and charging

Electric vehicle market

The development of the electric vehicle market, battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs) in Québec has grown steadily since 2010, with a significant acceleration since 2018. Figure 1 below displays the cumulative BEV (dark blue) and PHEV (light blue) sales up to 2020 (left axis) along with new EV sales share (red line and right axis). Yellow dashes refer to the left axis and display the cumulative new EV sales in Greater Montréal. Based on electric vehicle sales through 2020, there were approximately 51,300 BEVs and 40,800 PHEVs on Québec roads at the end of 2020, with 27,000 of the BEVs and 18,000 of the PHEVs found in Greater Montréal.[5]

2 Government of Québec, "2030 Plan for a Green Economy," March 11, 2021.

3 Greater Montréal is composed of the Montréal administrative region, Laval, Longueuil, the Northern Ring, and the Southern Ring. A map can be found in Figure A 2 of the Annex.

4 Dunsky Expertise en énergie, "Diagnostic et modélisation de l'évolution du marché des véhicules électriques 2013-2030", Montréal QC: Dunsky, May 21, 2021, available on-demand.

5 AVÉQ, "Actualités - AVÉQ - Association Des Véhicules Électriques Du Québec," March 31, 2021, https://www.aveq.ca/actualiteacutes/pret-a-publier-statistiques-saaq-aveq-sur-lelectromobilite-au-quebec-en-date-du-31-mars-2021-infographie.

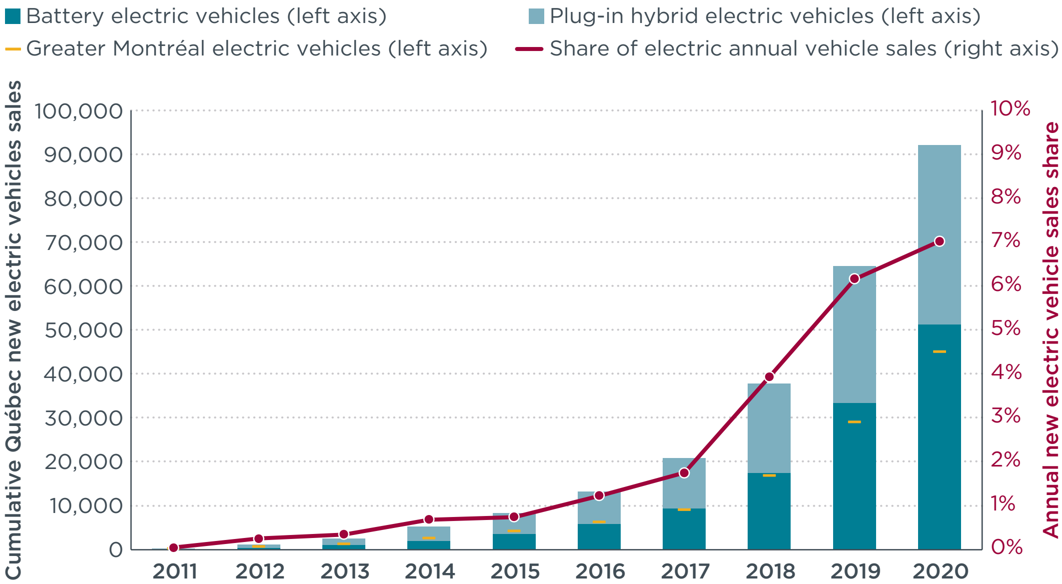

Figure 1. Cumulative new light-duty EV sales in Québec (left axis and blue bars) and in Greater Montréal (yellow dashes) and annual new EV sales share (right axis and line) from 2011 to 2020

In 2020 passenger EVs accounted for approximately 7% of the passenger vehicle sales. On the other hand, EVs represent only slightly more than 1.3% of the total light-duty vehicle stock. Electric vehicles are unevenly distributed across Québec with urban regions, especially the Montréal metropolitan region (also called Greater Montréal), accounting for close to 50% of cumulative EV sales. Figure 2 below displays the EV sales share for Québec's 17 administrative regions and for Greater Montréal in the upper right corner. As shown, the southwestern part of Québec, mostly urban, is leading EV sales. The map key with the name of every region and subdivision is provided in Figure A 1 and Figure A 2 of the Annex.

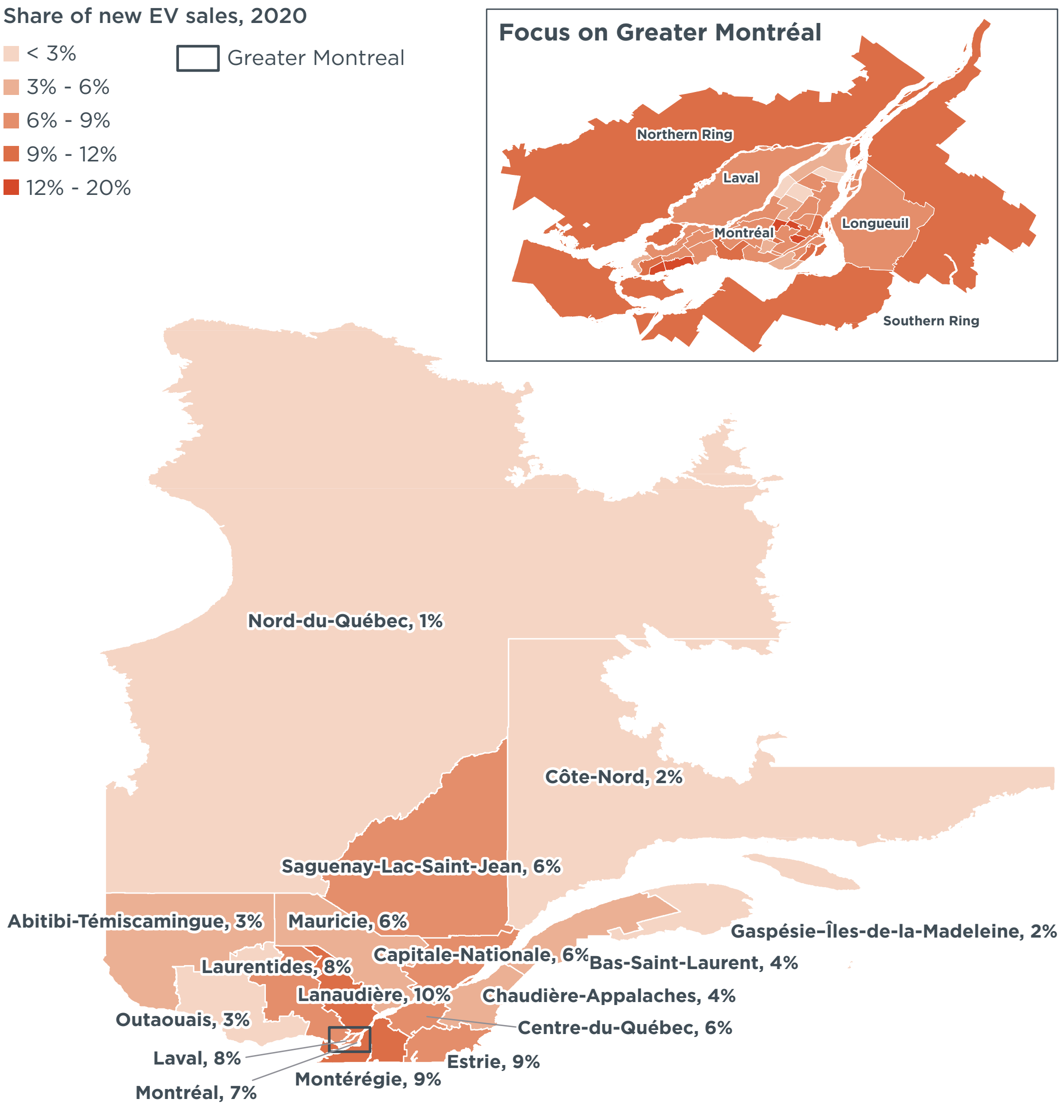

Figure 2. 2020 new EV sales share in Québec province with a focus on Greater Montréal in the upper right corner

For reference, the average EV sales share for the province was 7%, and 5 regions had new EV sales shares above this average: Estrie, Lanaudière, Laurentides, Laval, and Montérégie. At a more granular level, while Greater Montréal reached an EV sales share slightly above 8%, three municipalities and one district surpassed 12%: Baie d'Urfé, Mont-Royal, Westmount, and Outremont.

Electric vehicle policies in place

Financial subsidies. In 2012, the Québec government launched its "Roulez Vert" (Drive Green) program to spur EV uptake in the province. The program provides subsidies of up to $8,000 to individuals, companies, and municipalities for the purchase of a new EV, and since 2017, up to $4,000 for the purchase of secondhand EVs.[6] (All dollar amounts in this paper are Canadian dollars unless specified otherwise.) Roulez Vert also

6 Government of Québec, "Accueil | vehiculeselectriques.gouv.qc.ca." Véhicules électriques – Gouvernement du Québec, April 2021, https://vehiculeselectriques.gouv.qc.ca.

subsidizes deployment of private charging infrastructure, which will be discussed in the next section. In addition to the Québec-specific $8,000 subsidy, individuals can benefit from an additional $5,000 federal government subsidy on new EVs.

Zero-Emission Vehicle (ZEV) standards. In addition to financial subsidies, and following the example of leading ZEV markets like California and China, Québec adopted a ZEV standard which came into force in January 2018.[7] This mandate requires manufacturers to meet credit-based requirements, not direct market-share targets. The ZEV percentage credit requirement is applied to the manufacturer's production volume to obtain the number of credits required for compliance in a given year. Since 2018, auto manufacturers have been required to earn credits to meet targets that gradually increase over the years, up to 22% in 2025. For example, if a manufacturer sells or leases 30,000 new cars in Québec in 2025, it will have to earn 6,600 credits in that year (30,000 multiplied by 22%). Similar to the standard in California and other U.S. states, each ZEV sold can earn up to 4 credits, with the value calculated based on the type of vehicle and the electric range. In its 2030 Plan for a Green Economy, Québec has pledged to strengthen this standard in the coming years.

Consumer awareness. The "Roulons électrique" promotion and awareness campaign started in 2018, led by Équiterre with the support of Québec government.[8] They organized many events to allow individuals to test drive electric vehicles, developed a platform for gathering information on EVs, shared multiple guides for current and potential EV buyers, and published a series of videos promoting EVs. AVÉQ, the Québec electric vehicle association and a partner of this campaign, supports transport electrification and promotes consumer awareness in Québec by providing objective information to current and future electric car users.

Charging infrastructure network

Québec has a well-developed charging ecosystem with 5,689 public normal chargers and 690 fast chargers as of December 31st 2020.[9] Hydro-Québec, a state-owned public utility that manages the generation, transmission, and distribution of electricity, plays a major role in charging infrastructure rollout and operates the largest public charging infrastructure network in Québec, The Electric Circuit. It consists of more than 3,100 public charging stations, including 466 fast-charge stations (mostly 50kW and some 100kW chargers), across the province as of mid-2021 (with additional stations in Eastern Ontario).[10]

Many programs exist in Canada and in Québec specifically to fund charging infrastructure deployment. At the federal level, the Zero-Emission Vehicle Infrastructure Program (ZEVIP) is a 5-year, $280 million program that targets public destination, on-street, workplace, and multi-unit dwellings for charger deployment. The subsidies range from $5,000 per connector for a normal AC Level 2 charger to $75,000 for a fast charger delivering 100kW or more.[11] The following two subsections describe some Québec-specific programs.

7 Government of Québec, "Zero-Emission Vehicles (ZEV) Standard," 2018. https://www.environnement.gouv.qc.ca/changementsclimatiques/vze/index-en.htm#types-vehicules.

8 Équiterre, "Roulons électrique," accessed November 17, 2021, https://www.roulonselectrique.ca/fr/.

9 Interview with Transports Québec, September 2021.

10 Circuit electrique, "The Electric Circuit," Hydro-Québec, accessed July 21, 2021. https://lecircuitelectrique.com/en/.

11 Natural Resources Canada, "Zero Emission Vehicle Infrastructure Program," Natural Resources Canada, April 16, 2019, https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876.

Support for private charging

The government of Québec provides subsidies for public and private chargers alike. Private individuals can get a $600 subsidy for the purchase and installation of a home charger, and multi-unit dwelling owners and companies can get up to $5,000 per connector. This program has funded 43,036 home chargers through December 2020. [12]

The Québec government has also supported workplace charging since 2014 through its "Roulez Vert" (Drive Green) program. Until mid-2019, companies had to offer free EV charging to their employees if the firm took advantage of the government support. In 2021, the government covers 50% of the purchase and installation cost for a workplace charger, up to $5,000 per charger; the maximum amount a company can apply for per year is $25,000.[13] The program has funded 4,559 workplace chargers through September 2020.

While plugging in at home or at work generally covers 90% of private passenger EV charging needs, the remaining 10% is covered by public charging using normal and fast chargers.[14] These sectors have primarily been planned and implemented by Hydro-Québec through the programs described below.

Public normal charging network

Hydro-Québec has launched a grant program for the purchase and installation of curbside charging stations, offering municipalities up to $24,000 (before taxes) per station (composed of 2 chargers). This program is intended to fund 4,500 curbside chargers through 2028.[15] To be eligible for the grant, curbside chargers must be used for overnight charging in districts where EV owners do not have access to private home charging, or as daytime destination charging in business districts or near shops.

Public fast charging network

Until 2017, Hydro-Québec relied on a model of even public-private cost sharing to develop Québec's fast charging network; however, this model proved ineffective as the network was not consistently profitable and did not expand fast enough to meet user demand.[16] In response, in 2018, the Québec government passed Bill 184, which became a law to promote the establishment of a fast charging network as a public service for electric vehicles, mandating that Hydro-Québec be responsible for the deployment of a fast charging network as a public service.[17] The law modified the energy management law to take into account the revenues needed by Hydro-Québec to operate a public charging infrastructure network for the following 10 years (until 2028) when setting

12 Government of Québec, "Données statistiques| vehiculeselectriques.gouv.qc.ca" Véhicules électriques—Gouvernement du Québec, accessed August 22, 2021. http://vehiculeselectriques.gouv.qc.ca/rabais/statistiques/infographie-programme-roulez-electrique.asp and Québec. "État de l'énergie au Québec 2021—Un bilan éclairant à l'égard des enjeux globaux," accessed August 9, 2021. https://www.Québec.ca/nouvelles/actualites/details/etat-de-lenergie-au-Québec-2021-un-bilan-eclairant-a-legard-des-enjeux-globaux.

13 Government of Québec, "Remboursement pour une borne au travail | Programme Roulez vert," Véhicules électriques—Gouvernement du Québec, January 1, 2021, https://vehiculeselectriques.gouv.qc.ca/rabais/travail/programme-remboursement-borne-recharge-travail.asp.

14 Hydro-Québec, "Durée et lieux de recharge d'une auto électrique," accessed August 20, 2021. https://www.hydroQuébec.com/electrification-transport/voitures-electriques/recharge.html.

15 Circuit electrique, "4,500-Charging Station Grant Program," The Electric Circuit, May 27, 2021. https://lecircuitelectrique.com/en/4500-program/.

16 Personal communication with Hydro-Québec, September 2021.

17 Québec Official Publisher, Bill 184 (2018, chapter 25), National Assembly, "An Act to promote the establishment of a public fast-charging service for electric vehicles", June 15 2018, http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=5&file=2018C25A.PDF; Régie de l'énergie Québec, "HQD - Demande Relative à l'établissement d'un Service Public de Recharge Rapide Pour Véhicules Électriques," 2018, http://publicsde.regie-energie.qc.ca/_layouts/publicsite/ProjectPhaseDetail.aspx?ProjectID=473&phase=1&Provenance=B&generate=true.

energy prices for consumers. This law also allowed the government to set the charging rates, taking into account installation and operating costs.

Prompted by the new law, Hydro-Québec will, through 2030, add 2,500 fast chargers purchased from the manufacturers AddEnergie and ABB, companies that won the public tender. Hydro-Québec estimates that each BEV sold results in an additional $300 per year in electricity consumption (both at home and in public), revenue that can be used to finance deployment of fast chargers.[18] Under this law, profits related to EV home charging are dedicated to deployment of the fast-charging network with the goal of limiting electricity price increases for all Hydro-Québec customers.

Following the adoption of this law, Hydro-Québec's strategy has been to install at least 160 new fast chargers per year, selecting locations based on site merits and accessibility, as shown in Figure 3 below.[19]

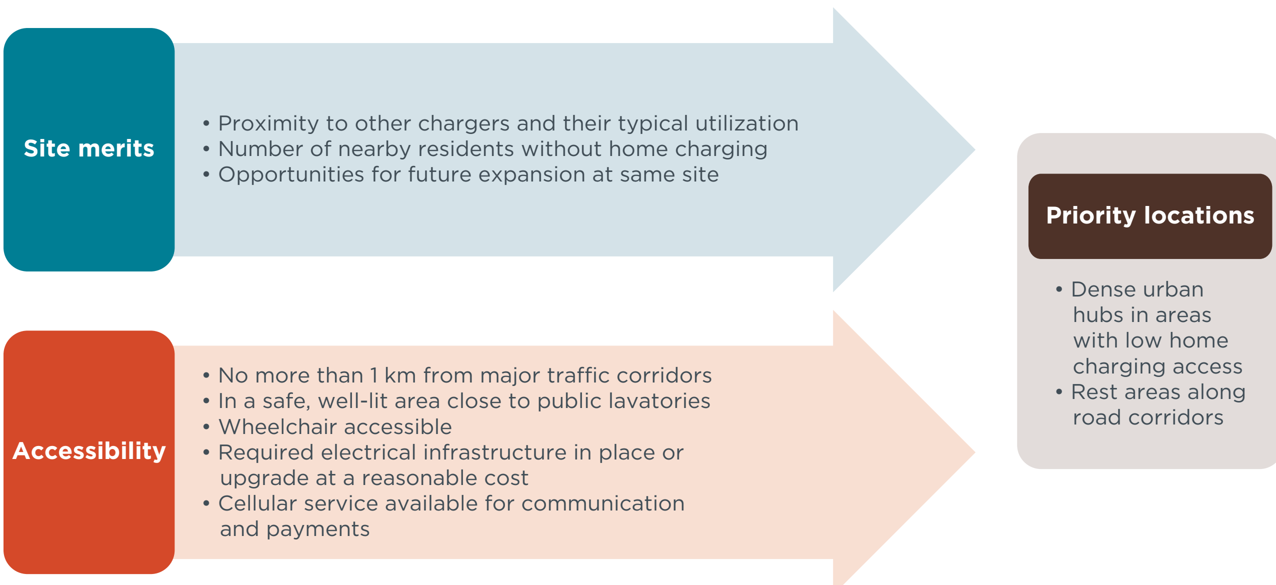

Figure 3. Hydro-Québec fast charging deployment strategy

Vehicle charging infrastructure scenarios

The core objective of this analysis is to calculate the amount of charging infrastructure required to support future electric vehicle uptake in each of the regions of Québec and the subdivisions of the Montréal metropolitan region. This section provides the key modeling steps and data inputs to identify how many and what type of chargers will be needed in each of the 17 administrative regions of Québec and Greater Montréal divisions up to 2035. The modeling takes into account observed charging trends and data through 2020 and adjusts parameters in future years to account for expected changes in vehicle technology, home charging availability, and kilometers traveled. The estimates for private home, private depot, workplace, public AC normal, public fast urban, and public fast highway charging requirements for each region and division are

18 AVEQ, "Le projet de loi n 184 – Position officielle AVÈQ", May 31, 2018, https://www.aveq.ca/actualiteacutes/le-projet-de-loi-n184-position-officielle-aveq.

19 Circuit électrique, "Fast-Charge Station Deployment Strategy." The Electric Circuit, October 2020, https://lecircuitelectrique.com/en/deployment-strategy/.

based on characteristics such as population density, number of driving commuters, access to workplace charging, dedicated parking spot accessibility, and housing type. The aforementioned parameters and characteristics also depend on the vehicle type: passenger cars, light commercial vehicles, and taxis (including private-hire vehicles).

Overview of methodology

The methodology used to assess charging needs in Québec up to 2035 is similar to the methodology for a related study focused on France and is described in more detail in that paper.[20] A table summarizing the main data inputs and assumptions is provided in Table A 3 of the Annex. An overview of the modeling approach and steps is provided in Figure 4 below. The blue rectangles represent the model steps and begin at the top left. The yellow trapezoids indicate the data inputs and assumptions between the model steps and the grey ovals explain the question that is analyzed at each step. The top left rectangle shows that the model starts with projections of vehicle sales and stock. The following step allocates this stock to driver groups depending on the type of car (BEV vs PHEV), home charging availability, commuting status (car commuter vs. non car commuter), and accessibility to workplace charging. After this, the daily energy required is forecasted for each charging group. Finally, this electricity demand is apportioned by location and translated into number of chargers according to charger utilization and power.

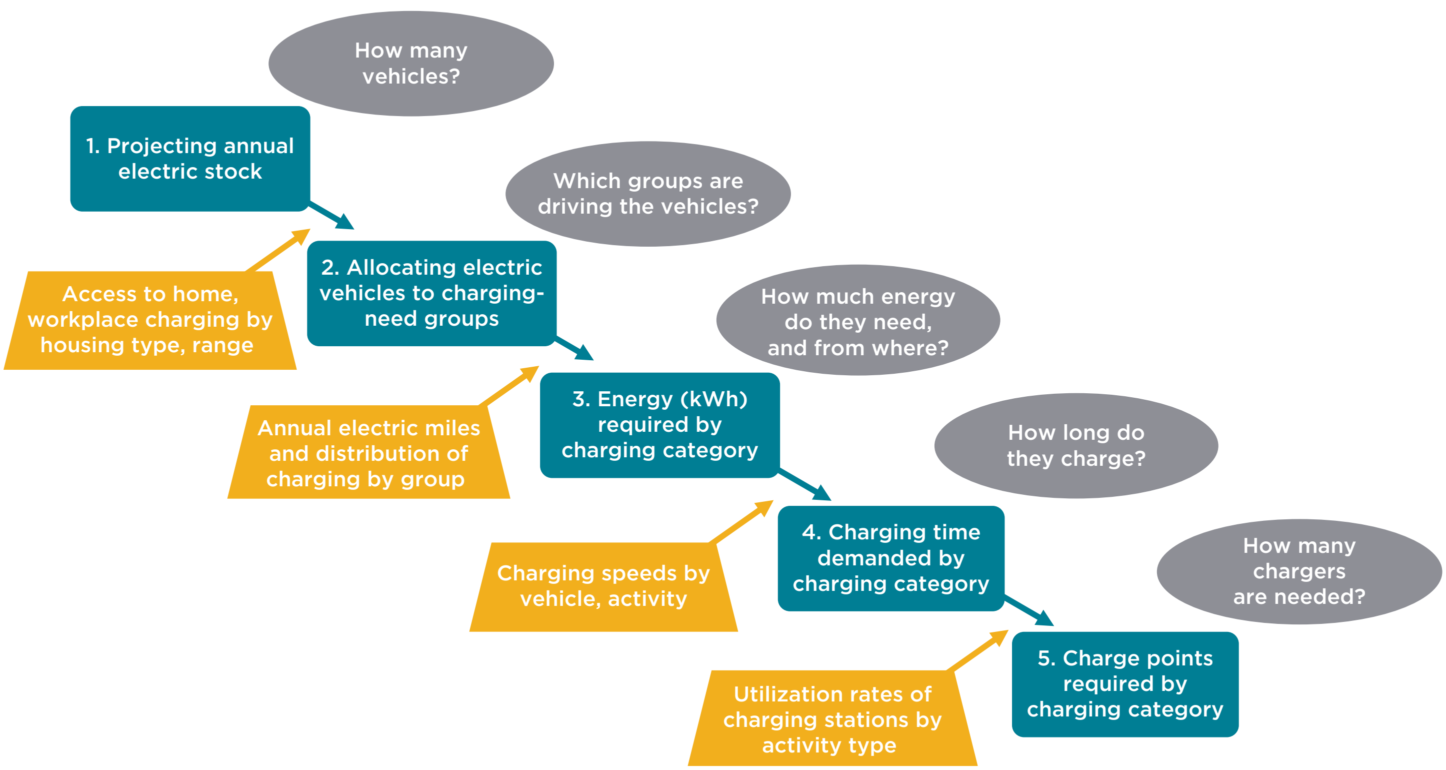

Figure 4. Summary of key modeling steps to assess charging needs based on electric vehicle uptake

The results in this paper are presented by charging category. Three types of private chargers are common:

20 Marie Rajon Bernard, Dale Hall, Nic Lutsey. *Charging infrastructure to support the electric mobility transition in France*, (ICCT: Washington, DC, 2021), https://theicct.org/publications/france-evs-infrastructure-transition-nov21.

» *private home chargers,* typically found in homes or apartment complexes
» *depot chargers,* which are clustered at sites that service a number of light commercial vehicles
» *private workplace chargers*, which are available exclusively to employees at a workplace. For EV owners without access to home charging, including many living in Montréal, workplace charging can provide a convenient, dependable, and low-cost charging option.

Beyond private charging, a dense and reliable public charging network is key to inspiring confidence that charging will be available and to convincing reluctant drivers to switch to an EV. Fast urban charging will be particularly important. Public charging takes several forms:

» *public AC normal chargers* are of particular importance to EV owners who lack access to home charging, usually people living in dense urban cores like Montréal
» *public fast urban chargers* are heavily used by high-mileage fleets like taxis and professional vans. They are also important for EV owners without access to home charging.
» *public fast highway chargers* are used to quickly charge during longer trips.

The yellow trapezoids of Figure 4 represent data inputs, which are drawn from many sources and other analytical research. The main sources for each data domain, and the variables informed by the data, are shown in Table 1 below. The sources and their use are further described in the sections below.

Table 1. Data sources for key variables

Data domain	Variable	Source
Population	Population	2016 Canada census[a]
Housing	Number of houses and apartments in each region and Montréal subdivisions	2016 Census and Ville de Montréal[b]
Passenger car, taxi, and light commercial vehicle sales and stock	New registrations and total stock of vehicles, including internal combustion engine vehicles, battery electric vehicle (BEVs) and plug-in hybrid electric vehicles (PHEVs).	AVÈQ[c]; Canada statistics[d]; Québec government[e]; and CMM[f]
Existing charging infrastructure	Counts of AC normal and DC fast chargers per region and in Montréal subdivisions	AVÈQ[c]; Individual interview[g]
Charging behavior	Observed share of charging in different settings, and public chargers' usage	Previous ICCT studies[h]; Individual interviews[j]
Annual kilometers driven	Differentiated by region and commuting status	Dunsky report[i]; Individual interviews[j]
Vehicle information	Battery energy, charging acceptance rate	Canada 2021 fuel consumption guide[k] and previous ICCT studies[h]

[a] Government of Canada, Statistics Canada, "Census Profile, 2016 Census," February 8, 2017, https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E.

[b] Ville de Montréal.,"Ville de Montréal - Montréal en statistiques – Habitation," web page, Ville de Montréal, accessed August 9, 2021, http://ville.Montréal.qc.ca/portal/page?_pageid=6897,67885745&_dad=portal&_schema=PORTAL.

[c] AVÉQ, "Actualités - AVÉQ - Association Des Véhicules Électriques Du Québec," March 31, 2021, https://www.aveq.ca/actualiteacutes/pret-a-publier-statistiques-saaq-aveq-sur-lelectromobilite-au-Québec-en-date-du-31-mars-2021-infographie.

[d] Government of Canada, "New Motor Vehicle Registrations," Statistics Canada, May 26, 2021, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101.

[e] Government of Québec, "Banque de données des statistiques officielles," November 12, 2020, https://bdso.gouv.qc.ca/pls/ken/ken213_afich_tabl.page_tabl?p_iden_tran=REPERJA6WV6166536384148d06kR&p_lang=1&p_m_o=SAAQ&p_id_ss_domn=718&p_id_raprt=3372#tri_age=1&tri_tertr=17.

[f] CMM, "Grand Montréal En Statistiques," Communauté métropolitaine de Montréal, 2021, http://observatoire.cmm.qc.ca/index.php?id=1048&no_cache=1&t=4&st=149&i=1837&p=2019&e=2&no_cache=1.

[g] Interview with Transport Québec, September 2021

[h] Bauer, Gordon, Chih-Wei Hsu, Michael Nicholas, and Nic Lutsey, "Charging up America: Assessing the Growing Need for U.S. Charging Infrastructure through 2030," (ICCT: Washington, DC, July, 2021), https://theicct.org/publications/charging-up-america-jul2021.

[i] Dunsky report

[j] Interviews with officials from Québec ministry of energy and natural resources and ministry of Environment and fight against climate change and Hydro-Québec, September 2021.

[k] Natural Resources Canada. "Guide de consummation de carburant 2021," https://www.rncan.gc.ca/sites/nrcan/files/oee/pdf/transports/outils/consommation-carburant/Guide%20de%20consommation%20de%20carburant%202021.pdf#page=43.

Québec electric vehicle market scenario

The first modeling step is to forecast electric vehicle sales as a percentage of annual passenger car sales. This modeling aligns with the target of 100% zero-emission new vehicle sales in 2035, as defined by Québec's Plan for a Green Economy. EV stock is estimated based on sales and vehicle turnover, taking into account Québec average vehicle retirement age; cars are also redistributed within the province through the second-hand market. The model uses each region's 2020 new EV sales share as an input and then increases this share over the years to reach 100% BEV sales in 2035, following a logistic growth curve. This modeling is in line with Québec's 2030 Plan for a Green Economy, which aims to have 1.5 million EVs on Québec roads in 2030, representing 30% of the light-duty vehicle stock. Our modeling also takes into account an accelerated transition in Montréal to integrate some of the city's 2020-2030 Climate Plan goals, including implementation of a zero-emission zone in the city center in 2030.[21]

21 Montréal, Ville de. "Montréal Climate Plan: Objective Carbon-Neutral by 2050." Accessed August 9, 2021. https://Montréal.ca/en/articles/Montréal-climate-plan-objective-carbon-neutral-2050-7613.

This study's projections for electric vehicle stock are shown in Figure 5 below. The blue bars (left axis) of the figure display the projected increase in number of EVs on Québec roads up to 2035, with light blue representing PHEVs and dark blue BEVs. The red and green lines (right axis) show the projected EV share of new sales (in red) and total vehicle stock (green) from 2020 to 2035 at the provincial level. The modeling aligns with Québec's goal of having 1.5 million EVs in 2030, and 30% electric vehicle stock in 2030; these goals are indicated with purple and yellow crosses. The 2016 goal of having 600,000 vehicles on Québec roads in 2026 is also indicated. The model accounts for a slight delay in the attainment of the 2026 goal due to the effect of COVID-19 on vehicle sales, including supply chain issues.

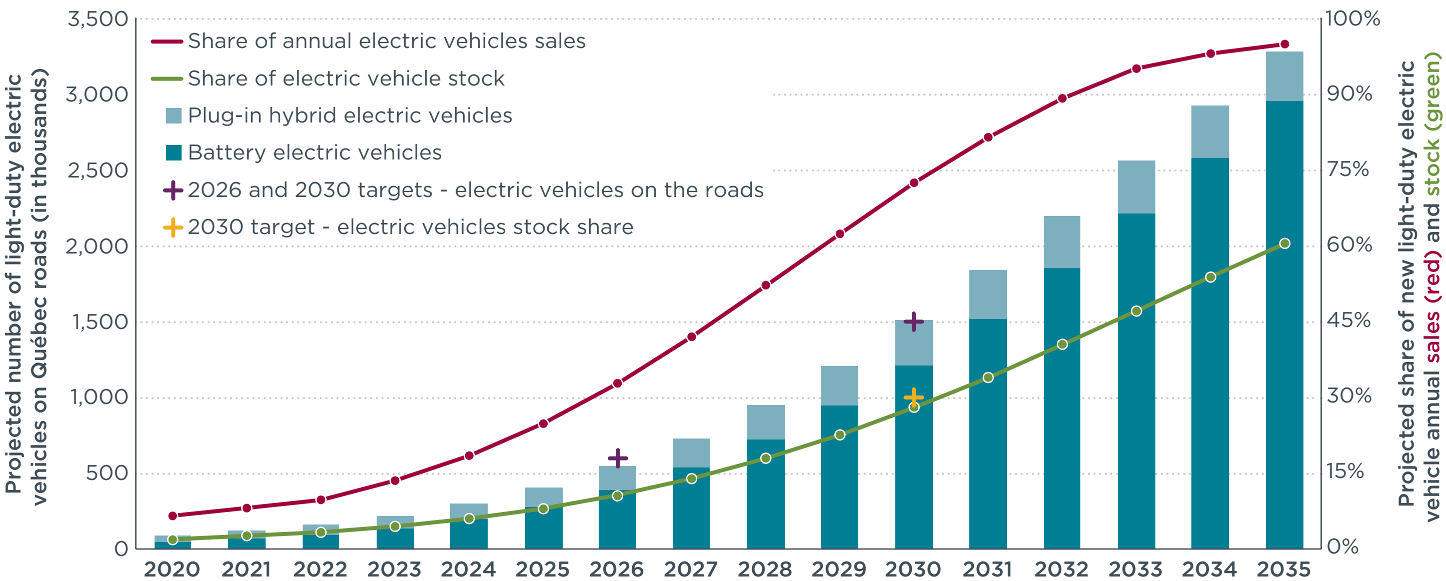

Figure 5. Number of light-duty electric vehicles on Québec roads (left axis and blue bars) and new EV sales share (right axis and red line)

The number of new car registrations dropped in 2020 due to the global pandemic. The study assumes that registrations will rebound to 2019 levels by 2023 to account for effects of the pandemic on consumer behavior and supply chain issues such as semiconductor shortages. After 2023, total car registrations are assumed to remain constant through 2035 as other policies encourage alternative transportation modes. In Montréal, sales are expected to decrease by 1% per year from 2023 to 2030 because of Montréal's ambition to shift 25% of solo auto journeys to less carbon-intensive modes of transportation. To reflect the redistribution of vehicles after the conclusion of a lease or resale, conventional and electric passenger vehicle registrations per capita were compared to passenger vehicle stock per capita and redistributed proportionally after a period of five years. Areas where new vehicle registrations per capita were proportionally higher than vehicle stock per capita would see their vehicles redistributed to areas that had lower new registrations compared to their stock.

The methodology outlined in the paragraphs above is applied to passenger and light commercial vehicles. For taxis and ride-hailing vehicles, also called private-hire vehicles, the entire fleet is assumed to be 40% electric (80% BEV and 20% PHEV) in 2030 and 100% BEV as soon as 2035, aligning with the Québec Plan for a Green Economy.

Allocation of electric vehicles to charging need groups

The second modeling step is the allocation of the electric vehicle stock to charging need groups, each with distinct charging behaviors. For private passenger cars, four factors are considered: EV type (BEV or PHEV), commuting status (driving to work or not), workplace charging access, and home charging access.

EV type influences the number of electric kilometers driven per day, the efficiency of the car (kilometers per kilowatt-hour [kWh]), and charging acceptance rate for AC normal and fast chargers (power in kilowatts [kW]). EV type for all vehicle categories is based on the mix of BEVs and PHEVs in each region in 2020; we assume a linear shift toward BEVs to reach 100% BEV sales in 2035. *Commuting status* is important to determine the number of kilometers driven and access to workplace charging. *Workplace* and *home charging* access influence the magnitude of workplace, home, and public charging needed.

This results in 12 charging needs groups. For light commercial vehicles, two factors are considered: the EV type (BEV or PHEV), and the parking location type (at home or at the depot). It is assumed that one-third of the LCV fleet is owned by private individuals or individual companies like electricians, plumbers, or other artisans parking their vehicles at home. Finally, for taxis and private-hire vehicles two factors are taken into consideration: EV type and home charging access.

The type of housing is used to estimate home charging availability. Based on census data, housing type is divided into 6 categories: detached houses, attached houses, apartments in high-rise, mid-rise, and low-rise buildings, and other housing types (including mobile homes, campers, boats, etc.). It is assumed that attached and detached house dwellers own more vehicles on average than residents of other housing types. Based on previous ICCT studies and a survey from the National Renewable Energy Laboratory (NREL), it is further assumed that in 2035, when EVs have reached mass adoption, access to home charging will be available to 89% of EV owners in detached homes, 70% in attached homes, 26% in low-rise buildings, 19% in mid-rise buildings, 29% in high-rise buildings, and 59% in other housing types.[22] These shares are slightly higher in 2020 to account for higher EV uptake in dwellings with home charging access in early years.

Commuting status is based on the 2016 Canada census. Among EVs used for commuting, it is assumed that in 2020 between 30% and 35% of them have access to workplace charging, with this proportion rising to between 35% and 40% in 2035 as workplace charging becomes more common. These assumptions are based on 2020 data available on the number of subsidized workplace chargers at the provincial level.[23] While the COVID-19 pandemic may have a long-lasting impact on teleworking and therefore the number of car commuters, this was not included in this analysis due to the high uncertainty and lack of data.

22 Yanbo Ge, Christina Simeone, Andrew Duvall, and Eric Wood, *There's No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future of Electric Vehicle Charging Infrastructure*, (National Renewable Energy Laboratory, October 2021), https://www.nrel.gov/docs/fy22osti/81065.pdf.

23 Government of Québec. "État de l'énergie au Québec 2021—Un bilan éclairant à l'égard des enjeux globaux." Accessed August 9, 2021. https://www.Québec.ca/nouvelles/actualites/details/etat-de-lenergie-au-Québec-2021-un-bilan-eclairant-a-legard-des-enjeux-globaux.

Energy required by charging category

For the third modeling step, we determine the total energy that each driver group will use and allocate it to the different charging locations: private home, private depot, workplace, public AC normal, fast urban, and fast highway chargers. The characteristics of the twelve groups previously mentioned are meant to represent averages and each group is heterogeneous, with greatly varying individual-level vehicle specifications, driving patterns, and charging behavior. For example, not every driver with workplace charging plugs in at work. Furthermore, some PHEV drivers have access to charging at home or work, but never plug in, preferring instead to drive nearly exclusively using fuel. The assumptions driving the energy requirements for each passenger car driver group are outlined in Table A 4 in the Annex.

The energy need allocation for each driver group is based on previous ICCT studies and personal interviews with Hydro-Québec and the Québec government on their charging infrastructure deployment strategies.[24] The annual passenger electric vehicle kilometers driven is derived from a provincial average of 18,000 km per year,[25] with the assumption that non-commuters drive 75% as many kilometers as commuters. The kilometers driven vary from region to region and per user type. These assumptions differ for Montréal region, for which non-commuters are assumed to drive about 60% of commuters' kilometers based on a 2018 Montréal origin destination survey.[26] The share of kilometers powered by electricity for PHEVs is based on an ICCT study of real-world usage of PHEVs.[27] Different assumptions are made for light commercial vehicles and taxis. They are assumed to drive 70 km and 190 km per working day (about 305 days per year), respectively, on average.[28]

The electric kilometers are converted into energy based on vehicle efficiency. Passenger BEVs and PHEVs (including taxis) have efficiencies of 4.3 and 4.2 kilometers per kilowatt-hours (km/kWh) respectively and light commercial BEVs and PHEVs have efficiencies of 2.7 and 2.6 km/kWh respectively. This is based on an ICCT study focused on the United States and on the Canadian guide on vehicle consumption and emissions, accounting for lower efficiency during cold winter months.[29] As technology improves, we estimate the per-km energy needed for each vehicle category to decline by roughly 1% per year.[30] An additional assumption is made about chargers' efficiency. It is assumed that 90% of the electricity fed into the charger is passed on to the electric vehicle.

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24 Marie Rajon Bernard, Dale Hall, and Nic Lutsey, *Charging infrastructure to support the electric mobility transition in France*, (ICCT: Washington, DC, November, 2021).

25 Personal communication, Québec environment ministry and Hydro-Québec, September 2021.

26 ARTM, "Enquête Origine-Destination 2018 – ARTM," accessed August 20, 2021, https://www.artm.Québec/planification/enqueteod/.

27 Plötz, Patrick, Cornelius Moll, Yaoming Li, Georg Bieker, and Peter Mock, "Real-World Usage of Plug-in Hybrid Electric Vehicles: Fuel Consumption, Electric Driving, and CO_2 Emissions," (ICCT: Washington, DC, September 27, 2020), https://theicct.org/publications/phev-real-world-usage-sept2020.

28 Government of Québec, "2030 Plan for a Green Economy," March 11, 2021; "État de l'énergie au Québec 2021 - Un bilan éclairant à l'égard des enjeux globaux," accessed August 9, 2021.

29 Gordon Bauer, Chih-Wei Hsu, Michael Nicholas, and Nic Lutsey, "Charging up America: Assessing the Growing Need for U.S. Charging Infrastructure through 2030," https://theicct.org/publications/charging-up-america-jul2021;
Ressources naturelles Canada, "Guide de consummation de carburant 2021", 2021, https://www.rncan.gc.ca/sites/nrcan/files/oee/pdf/transports/outils/consommation-carburant/Guide%20de%20consommation%20de%20carburant%202021.pdf#page=43.

30 Gordon Bauer, Chih-Wei Hsu, Michael Nicholas, and Nic Lutsey, "Charging up America: Assessing the Growing Need for U.S. Charging Infrastructure through 2030," (ICCT: Washington, DC, July 2021), https://theicct.org/publications/charging-up-america-jul2021.

Charging time demanded by charging category

The fourth modeling step estimates the average charger power and vehicle power accepted. The average rate of power draw is the same for all vehicle categories (passenger and light commercial vehicles) and increases over time to reflect technology improvements in the vehicles and greater availability, and profitability, of higher-power charging. Table 2 displays the average rate of power draw for different chargers over the years. These wattages take into account a decrease in charging power during cold winter months.[31]

The power ratings in Table 2 represent the average experienced charging speed for all electric vehicles across all the province's chargers of a certain category in a given year. This average power is lower than the rated maximum power of a charger because of different vehicle acceptance rates and variations in power over the charge cycle (e.g., power typically decreases as the battery approaches 100% charge). Additionally, the rated maximum power of chargers varies within each category. For example, urban fast chargers range from 25kW stations to 350kW or more with some 50kW, 100kW, or 150kW chargers and one hub can provide chargers with a variety of maximum rated power. These charging and vehicle power acceptance assumptions are used for all the vehicle types, assuming technologies will evolve similarly across the various electric vehicle applications.

Table 2. Average rate of power draw for different chargers and vehicles, 2020–2035

	BEV – AC normal charger	PHEV – AC normal charger	Urban fast charger	Corridor highway charger
2020	6.4 kW	3.3 kW	24 kW	60 kW
2030	8 kW	4.6 kW	80 kW	115 kW
2035	9.6 kW	5.3 kW	110 kW	145 kW

Charger utilization and number of chargers

Public chargers. The final step is the calculation of the number of chargers of various types across the regions. To do this, the hours per day of active power drawn from the different stations are forecasted and then multiplied by the charger output power in kW determined at the previous step to obtain the daily energy available in kWh. Finally, the energy required for the EVs determined at step 3 is divided by the energy provided by each charger to determine the number of outlets needed.

The model reflects increasing utilization in hours per day with increasing electric vehicle penetration for both public AC normal and fast chargers as shown in other studies. This results in different hours per day of active power drawn across regions, with higher usage in mature EV markets. Based on data from Hydro-Québec, we classify regions into 3 groups: high, middle, and low charger utilization. [32] Table 3 displays the composition of each group and the accompanying assumptions for 2020 and 2035 charger utilization.

31 Juuso Lindgren and Peter D. Lund, "Effect of extreme temperatures on battery charging and performance of electric vehicles", *Journal of Power Sources* 328, 2016, http://dx.doi.org/10.1016/j.jpowsour.2016.07.038.

32 Interviews with Hydro-Québec, July, August, and September 2021.

Table 3. Average estimated daily utilization per region for 2020 and 2035 based on the utilization group

Utilization group	Region	Normal AC charger utilization per day (in hours)		DC Fast charger utilization per day (in hours)	
		2020	2035	2020	2035
Low utilization	Abitibi-Témiscamingue	1.3	5.2	1.1	4
	Côte-Nord	1.3	5.2	1.1	4
	Gaspésie–Îles-de-la-Madeleine	1.3	5.2	1.1	4
	Nord-du-Québec	1.3	5.2	1.1	4
	Saguenay–Lac-Saint-Jean	1.3	5.2	1.1	4
Mid utilization	Bas-Saint-Laurent	1.6	5.6	1.3	4.5
	Estrie	1.6	5.6	1.3	4.5
	Outaouais	1.6	5.6	1.3	4.5
High utilization	Capitale-Nationale	1.9	6	1.5	5
	Centre-du-Québec	1.9	6	1.5	5
	Chaudière-Appalaches	1.9	6	1.5	5
	Lanaudière	1.9	6	1.5	5
	Laurentides	1.9	6	1.5	5
	Laval	1.9	6	1.5	5
	Mauricie	1.9	6	1.5	5
	Montérégie	1.9	6	1.5	5
	Montréal	1.9	6	1.5	5
Québec province		1.84	5.88	1.46	4.85

Based on the methodology of similar studies and adapting to the Québécois context, the average increasing usage of normal charging as a function of electric vehicles stock share can be represented by the following equation:

$$\textit{Average daily hours of normal chargers' usage} = a \times \ln(\textit{EV stock share}) + b$$

The a and b coefficient vary from region to region based on both utilization groups and EV market penetration. The "a" coefficient represents the rate at which the utilization will increase, and the "b" coefficient represents the maximum usage assumed once the EV stock share reaches 100%. Using a natural log (ln) function prevents the number of hours from rising past a practical threshold at high market penetrations, but also allows for a rapid increase in utilization in the nascent stages of an electric vehicle market. The daily usage varies in each region; as a result, utilization is typically higher than the national average in larger urbanized areas where there is a higher concentration of EVs and chargers, allowing for more frequent and convenient matches between EV trips and charger locations.

A similar model is used to account for increasing usage of fast chargers represented by the following equation:

$$\textit{Average daily hours of fast charger usage} = c \times \ln(\textit{BEV stock share}) + d$$

Similar to AC normal chargers, the daily usage varies in each region depending on the market's maturity represented by the BEV stock share, and on the charger utilization group. Only BEVs are considered since PHEVs do not use fast chargers.

Fast corridor highway chargers. While the methodology presented in Figure 4 above is applied at the regional level for workplace, public AC normal, and urban fast chargers, fast corridor highway chargers experience similar utilization across the province. The number of highway corridor chargers is calculated at the provincial level and then split among highways and national roads based on the average daily passenger car traffic. It is further split per region, based on the length of the roads in each region.

The utilization assumptions described above for public chargers are applied for all vehicle types: passenger cars, light commercial vehicles, and taxis. However, other categories of charging are calculated in different ways.

Workplace chargers. Workplace charging can take place either at private chargers reserved for employees or at public chargers near one's place of work (e.g., at parking garages or shopping centers). In this analysis, a third of charging while working takes place at public chargers. For workplace chargers, utilization remains at 5 hours per workday through 2035.

Depot chargers. The analysis assumes that employers take a straightforward approach for depot charging for professional vans, installing one charger per two BEVs and one charger per four PHEVs. This can be accomplished either through power-sharing and smart charging across charging ports, or by charging vehicles in shifts. Overnight charging allows these vehicles to receive the majority of their daily charging needs.

Private home chargers. The number of home chargers is determined by the number of EV drivers with access to home charging, as described in the housing section above. In this analysis, every BEV with access to home charging receives its own charger, but in cases where multiple PHEVs are in one household, they may share a charger.

Finally, chargers used by light commercial vehicles are calculated differently for the Montréal administrative region. The previously described methodologies are applied at the regional level and chargers are then further split by districts and cities based on different criteria. Depot chargers are allocated proportionally based on the share and size of van-owning businesses in each area.[33] Normal AC and fast urban chargers are based on the share of both population and retail stores in the area.

Results

The following section presents our results for the total number of EVs, the energy demand, and the resulting number of public and private chargers needed. These results are presented at two different levels: the provincial level with its 17 administrative regions and the Montréal city level with its 19 districts. Further results at the Greater Montréal level are provided in the Annex.

Results at the provincial level

Summary of overall Québec results

Table 4 summarizes our 2025, 2030, and 2035 charging results, alongside data for 2020 for reference. As described above, the total number of EVs in this scenario increases from close to 100,000 at the end of 2020 to slightly above 1.5 million in 2030. Charging infrastructure across all home, workplace, and public types increases substantially to

33 Ville de Montréal. "Profil sectoriel: Agglomération de Montréal SCIAN 41 Commerce de gros", accessed August 19th 2021, http://ville.Montréal.qc.ca/pls/portal/docs/PAGE/MTL_STATS_FR/MEDIA/DOCUMENTS/COMMERCE%20DE%20GROS_2019.PDF.

support this growing EV population. We estimate Québec will need 94,600 non-home chargers in 2030, about 11 times the approximately 9,000 such chargers at the end of 2020. We estimate a need for 52,000 public chargers in 2030, 8 times the number installed in 2020.

Table 4. Summary of key analysis results at the provincial level for 2020, 2025, 2030, and 2035

Area	Variable	2020	2025	2030	2035
Electric vehicles (including battery-electric and plug-in hybrid electric vehicles)	Total EV population (thousands)	92	409	1,512	3,283
	Total BEV population (thousands)	51	282	1,217	2,959
	Total passenger EV population (in thousands, excluding light commercial vehicles)	88	393	1,430	3,072
	EV share of new light-duty vehicle sales	7%	25%	73%	100%
	EV share of Québec light-duty vehicle population	2%	9%	29%	62%
EV owner characteristics	Home charging access share	85%	82%	79%	78%
	Commuter share of EV owners	70%	64%	58%	58%
	Workplace charging access share among EV commuters	34%	36%	38%	39%
	Home charging share of energy demand	73%	68%	64%	62%
	Home charging share of energy demand for passenger cars	74%	71%	68%	66%
	Work and depot charging share of energy demand	5%	7%	9%	10%
Number of chargers	Private home chargers (thousands)	76	303	1,081	2,381
	Private workplace chargers (thousands)	2	8	24	44
	Depot chargers (thousands)	0.2	3	19	57
	Public normal chargers (thousands)	6	21	46	69
	Public fast urban chargers (thousands)	0.7 (total urban and highway fast chargers)	2.4	4.9	7.8
	Public fast highway chargers (thousands)		0.6	1.4	2.1
EV charger dynamics	EVs per public charger	14	17	29	42
	EVs per non-home charger	11	12	16	18
	BEV per fast charger	74	95	194	300

Electric vehicle energy demand

Figure 6 presents the total energy demand for charging in gigawatt-hours (GWh) per year for each EV charging setting from 2020 to 2035, including public and private stations. The figure includes charging needs for passenger cars, light commercial vehicles, and taxis. Energy demand from EV charging grows substantially, from an estimated 340 gigawatt-hours (GWh) of electricity in 2020 to 1,550 GWh in 2025, and 5,790 GWh in 2030. As indicated, in 2030, 1,550 GWh, or 27% of the overall EV charging energy, is from public charging. For context, the total electricity produced in Québec in 2019 was 212 terawatt-hours (TWh)[34], about 15% of which was exported,

34 Total electricity consumption per capita in Québec is higher compared to other markets due to the presence of electricity-intensive industries and the widespread use of electricity to heat homes, both a result of the plentiful and inexpensive hydropower produced in the province.

so EV charging demand in 2030 and 2035 would amount to only 2.7% and 6.1% (respectively) of the electricity produced.[35]

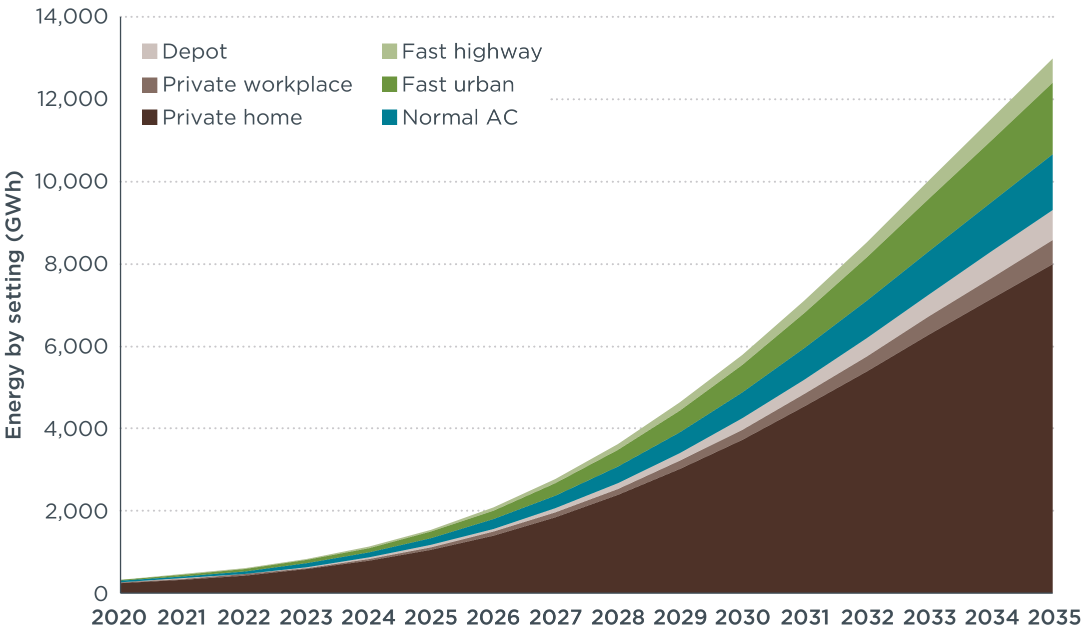

Figure 6. Energy demand (GWh) from electric vehicle charging per charging setting over the years

The figure clearly illustrates the large share of home charging. Indeed, home charging is (and is likely to remain) the cheapest and most convenient form of EV charging when it is available. As shown in Table 4, in 2030, 73% of EV charging energy will come from home, private workplace, and depot charging. While private home electricity is forecast to increase in absolute terms, its share among all electricity needed decreases due to a reduction in home charging availability as EVs reach mass adoption. Indeed, while in 2020 85% of EV owners in this analysis have access to home charging,[36] this share decreases to 79% in 2030. At a more granular level, only 38% of Montréal city EV drivers are forecast to have access to home charging in 2030. When focusing on this city, the projected 210,600 EVs will consume approximately 570 GWh of electricity in 2030: 206 GWh from home charging, 300 GWh from public charging, and the remaining 64 GWh from private work and depot.

Number of chargers

Total non-home chargers. The estimated total number of non-residential chargers, including private work and depot (brown) and public (blue and green) is provided for Québec province, below. Figure A 3 in the Annex provides detailed results for each of the 17 administrative regions. The hashed blue and green bars correspond to the number of public chargers and the hashed brown to the estimated number of workplace chargers as of end of 2020. In 2030, an estimated 94,600 non-home chargers will be needed of which 52,000 would be public chargers and the remaining 42,600 would be split between 23,700 private workplace and 18,900 depot chargers.

35 Government of Canada, Canada Energy Regulator, "NEB – Provincial and Territorial Energy Profiles – Québec," July 19, 2021, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-Québec.html;
Québec, "État de l'énergie au Québec 2021 - Un bilan éclairant à l'égard des enjeux globaux."

36 AVÈQ. "Sondage 2021 auprès des members de l'AVEQ", June 30th 2021, https://www.aveq.ca/actualiteacutes/sondage-2021-aupres-des-membres-de-laveq.

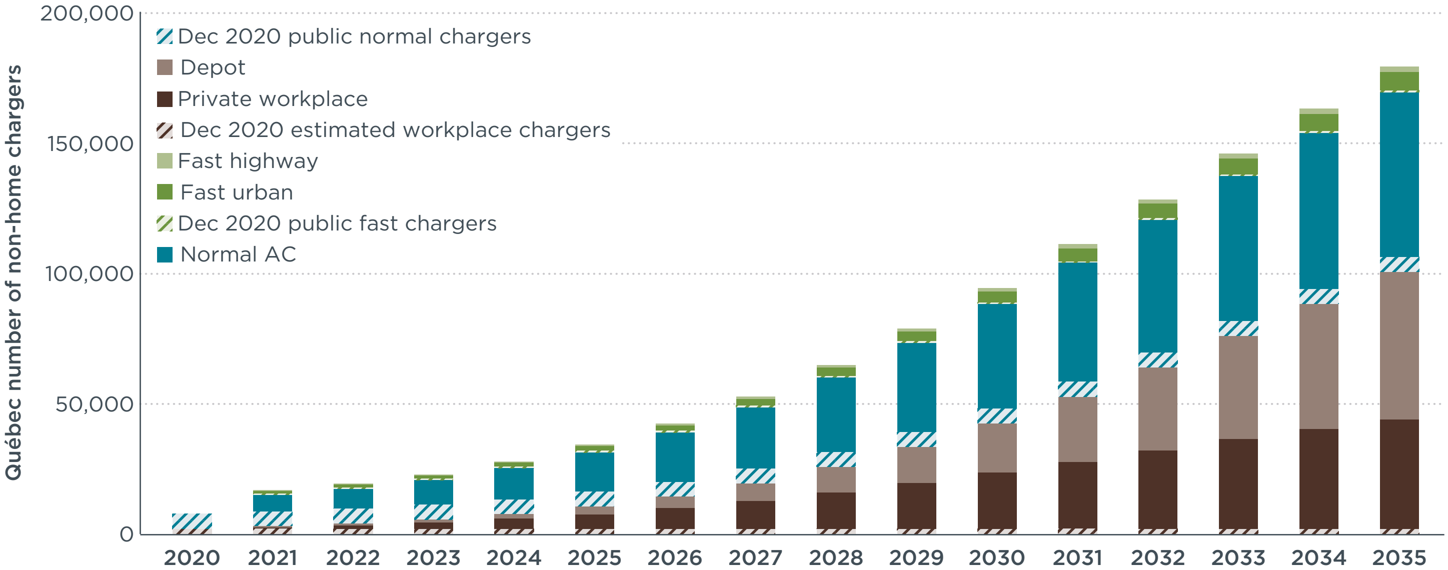

Figure 7. Total number of non-home chargers up to 2035

As more electric light commercial vehicles become available, the number of depot chargers grows from a negligible number in 2020 to 18,900 in 2030, accounting for 20% of all non-residential chargers. Depending on the regions, the number of non-home chargers needed is multiplied by between 1.9 and 2.9 between 2020 and 2025 and 2.3 and 4.2 between 2025 and 2030 for most regions. A more efficient use of the public infrastructure network leads to a need for 1.7 to 2.4 times more non-home chargers between 2030 and 2035.

Also not shown here but in Figure A 3 in the Annex, the three regions with the highest number of non-home chargers are also the three most populous ones. Montréal, the most populous region, needs a total of 20,100 non-home chargers in 2030, the highest need of all regions. It is followed by Montérégie with 19,200 and Capitale-Nationale with 9,390 non-home chargers in 2030. At the other end of the spectrum, Nord-du-Québec, Gaspésie-Îles-de-la-Madeleine, and Côte-Nord will require the lowest number of non-home chargers with 290, 830, and 960 units respectively in 2030. Table A 5 in the Annex provides the detailed forecast number of chargers per region and per category for 2025, 2030, and 2035.

Public chargers. Figure 8 displays the number of public normal (left, blue) and public fast (right, green) chargers needed in Québec by 2030. Specific forecasts for the number of chargers for each region can be found in the Annex in Figure A 3. Hashed colors indicate the amount of charging built through 2020. At the provincial level, as of the end of 2020, 27%, 12% and 8% of the forecast 2025, 2030, and 2035 public charging infrastructure is already in place. As indicated in these graphs, we forecast that Montréal region will need the highest number of both normal and fast chargers in 2030 with 10,100 and 1,370 units respectively. At the other end of the spectrum, Nord-du-Québec will need the lowest number of normal and fast chargers with 105 and 45 units respectively. Most fast chargers in Nord-du-Québec are located along highways and national roads, few are in towns or residential areas.

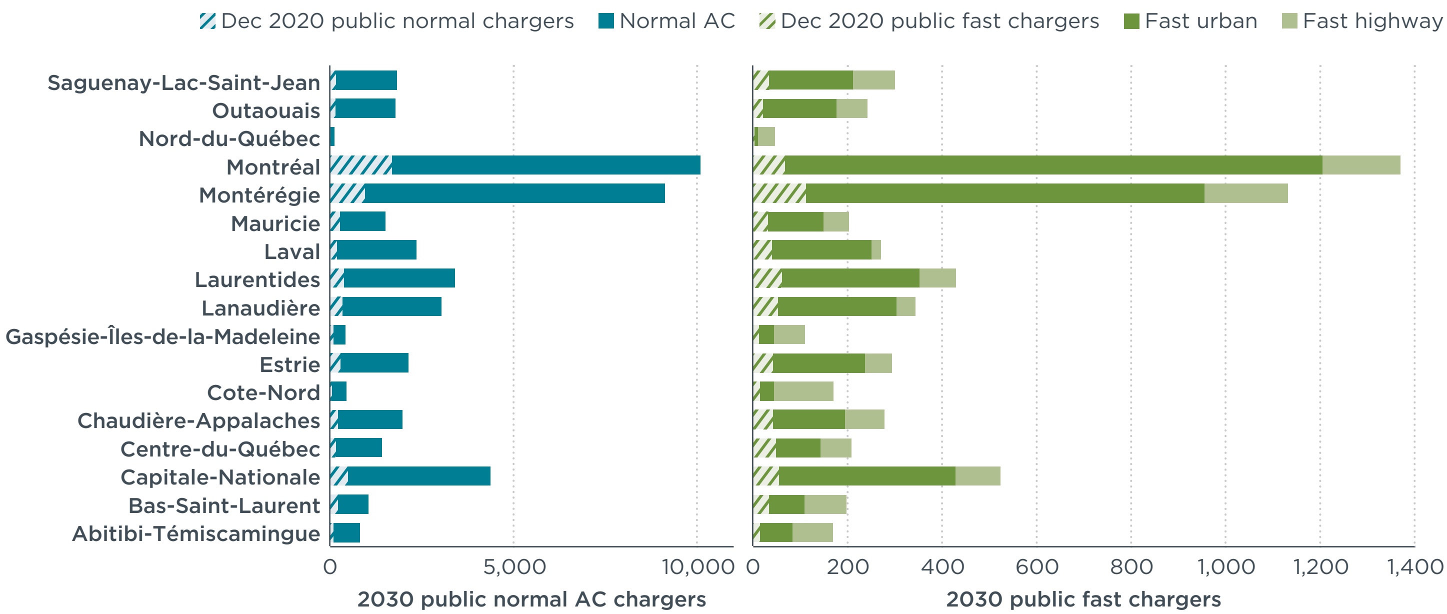

Figure 8. Estimated number of public normal (left and blue) and fast (right and green) chargers in 2030 per administrative region

Overall, we forecast a need for around 45,700 normal and 6,300 fast chargers (4,900 in urban areas and 1,400 along highways) by 2030 at the provincial level. The need for 6,300 fast chargers exceeds the Québec government mandate that 2,500 fast chargers be installed by Hydro-Québec by 2030, meaning that further efforts might be needed, with commitments from the private sector for example. Public fast highway chargers will also be important as EVs become mainstream and are used for all travel needs. Our modeling forecasts an increase in fast highway chargers through 2035, reaching 610 in 2025, 1,400 in 2030, and 2,100 in 2035. Table A 8 in the Annex provides a detailed breakdown per highway and national roads.

Figure 9 displays the share of 2030 public charging infrastructure already in place through 2020 for the regions of Québec, as well as an inset for Greater Montréal. Regions in dark blue are closer to meeting their 2030 projected charging needs while those in light blue have further to go. Across all of Québec, there were just under 6,000 normal and 700 fast chargers installed through 2020. This indicates a need to multiply the number of normal chargers by 8 and that of fast chargers by 9 by 2030. The share of 2030 infrastructure in place as of 2020 in Montréal is only shown at the city and rest of the island levels due to a lack of data accuracy for 2020 charging infrastructure in place at the borough and district levels.

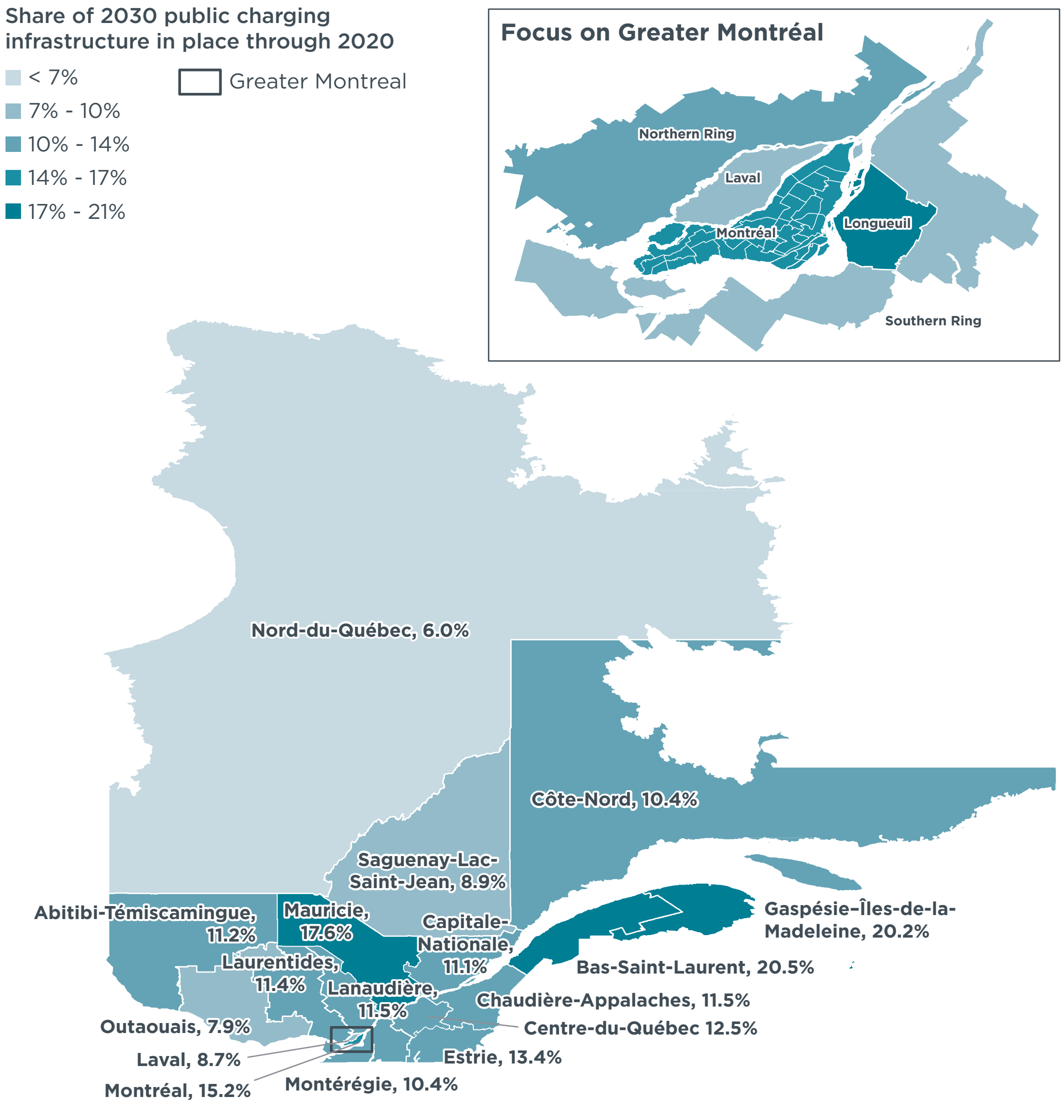

Figure 9. Share of 2030 public charging infrastructure already in place through 2020

As demonstrated in the figure, the share of charging in place varies by region. As of 2020, 12% of Québec's 2030 overall requirement for public charging infrastructure is already in place. For fast charging infrastructure, 11% of 2030 needs were in place at the end of 2020 while close to 12.5% of the normal charging infrastructure was in place. At the regional level, four regions had less than 10% of their 2030 needs in place at year's end 2020. The largest charging deployment challenges are in the very rural areas of Nord-du-Québec, Outaouais, and Saguenay–Lac-Saint-Jean and the very urban area of Laval. The mostly rural regions have had few chargers deployed up to 2020, and with EV uptake lagging the provincial average up to 2030, charger utilization is expected to be sub-optimal, resulting in more chargers needed. In the highly urban areas, the above-average EV uptake in the years to come and the low home charging availability results in many public chargers needed.

Home chargers. Home chargers represent the largest category of chargers for every region, ranging from 86% of the total in Montréal in 2030 to 93% for Lanaudière. It is estimated that Québec will have around 1.1 million home chargers in 2030, of which 91% will be in detached houses. The region with the highest total number of chargers in

2030 (including private home) is Montérégie, with 281,000 units due to more EV owners having access to home charging than in Montréal.

Private workplace and depot chargers. As mentioned in the methodology, we report our numbers corresponding to the locations of the chargers rather than the activity meaning that many of the needed public chargers may be used by commuters during the workday. The assumption of one charger per two battery electric professional vans leads to a high number of depot chargers up to 2035, reaching 18,900 in 2030. Overall, the need for private workplace and depot chargers increases from 10,700 in 2025 to 42,600 in 2030, as shown in Table 4. At a more granular level, Montérégie and Montréal region have the highest needs of all regions in terms of both private workplace chargers with 5,200 and 4,600 units (respectively) and depot chargers with 3,700 and 4,100 units respectively in 2030.

Evolution of electric vehicles served per charger

Figure 10 left shows the evolution of the number of EVs per public (dark brown) and per non-home chargers (including workplace and in light brown) on the left axis and BEV per fast charger (blue) on the right axis. Figure 10 right shows the same data for Montréal city. In general, the ratio of EVs per charger increases through 2035. This trend is based on an increase in the utilization, due to a greater concentration of EVs in the same regions, and faster charging speeds for all public chargers.

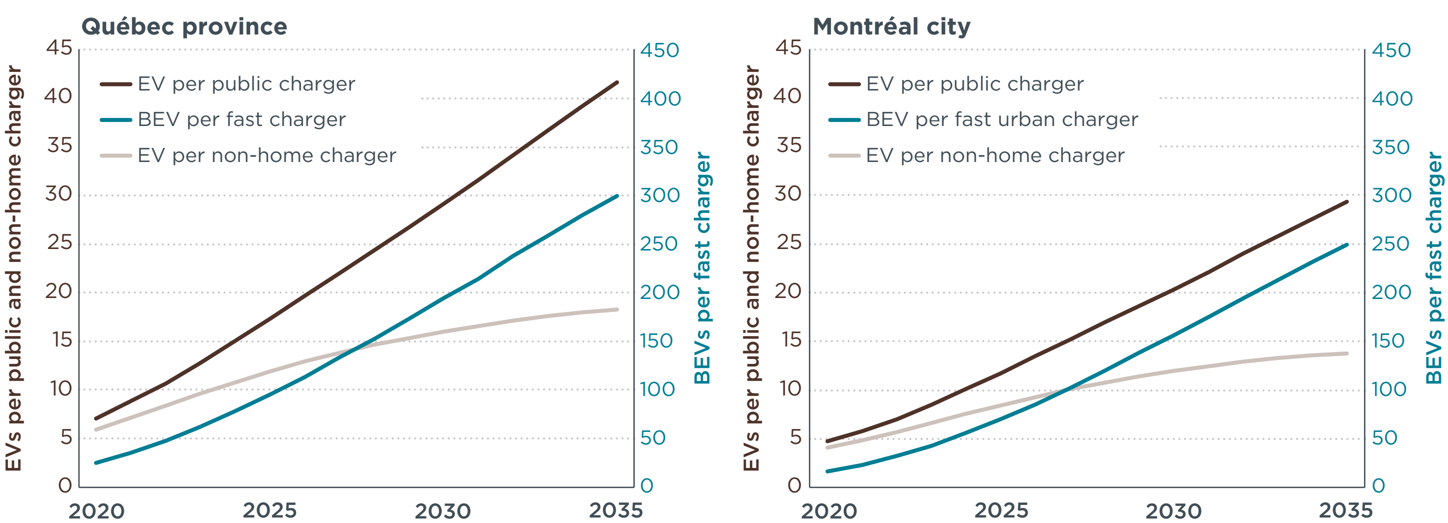

Figure 10. Evolution of the number of EVs per public and non-home chargers and BEVs per fast charger at the provincial level (left) and Montréal city level (right)

The number of EVs per public charger at the provincial level increases from 17 in 2025 to 29 in 2030 and continues upward through 2035. These figures show that in early market there is a need for even geographic coverage to ensure a minimum level of access to all, which leads to low utilization in areas with few EVs. After reaching this even coverage, chargers can be added where there is more demand. As the market develops, there is a higher utilization, resulting in more EVs per public charger and BEVs per fast charger. Additionally, higher charging power (particularly for DC fast chargers) allows for shorter charging sessions, enabling each charger to serve more vehicles and deliver more kWh per day.

While the graphs represent the average at the provincial and Montréal city level, these ratios vary by region and subdivision. A comparison of the figures shows that the number of EVs per public and per non-home charger and the number of BEVs per fast charger is lower in Montréal city due to low home-charging access, resulting in an increased reliance on public charging.

Nord-du-Québec is forecast to have 19 EVs per public charger in 2030, the lowest of all regions, due to a particularly low density, resulting in sub-optimal charger utilization. On the other hand, Lanaudière will have the highest ratio with 33 EVs per charger in 2030.

Focus on Montréal city

This analysis was performed at a greater geographic resolution for the Greater Montréal, Montréal administrative region, and Montréal city levels. Greater Montréal is composed of 5 main areas: Laval, Longueuil, Northern ring, Southern ring, and Montréal administrative region. Montréal administrative region in turn is composed of 15 cities, the most populous of which is Montréal city. Montréal city itself is divided in 19 districts. A map of all these divisions is provided in Figure A 2 of the Annex. This section presents the results for Montréal city. More detailed results can be found in the Annex.

Montréal city is the densest area of Québec with around 4,000 people per square km compared to around 1,000 at the metropolitan region level and fewer than 6 at the provincial level. As a result, Montréal has dramatically different housing and transport patterns compared to the rest of Québec, which in turn impacts charging infrastructure needs. Table 5 below presents the main results at the Montréal city level.

Table 5. Summary of key analysis results at the Montréal city level for 2020, 2025, 2030, and 2035

Area	Variable	2020	2025	2030	2035
Electric vehicles	Total EV population (thousands)	9	52	211	427
	Total BEV population (thousands)	5	37	172	383
	Total passenger EV population (thousands)	9	49	196	391
	EV share of new light-duty vehicle sales	7%	28%	84%	100%
	EV share of Montréal city light-duty vehicle population	2%	8%	36%	82%
EV owner characteristics	Home charging access share	42%	40%	38%	37%
	Commuter share of EV owners	67%	62%	56%	57%
	Workplace charging access share among EV commuters	35%	37%	38%	40%
	Home charging share of energy demand	43%	38%	36%	34%
	Work and depot charging share of energy demand	8%	10%	12%	13%
Number of chargers	Private home chargers (thousands)	4	21	80	157
	Private workplace chargers (thousands)	0	1	4	7
	Depot chargers (thousands)	0.03	0.5	3.1	9.4
	Public normal chargers (thousands)	1.42	3.8	9.1	12.8
	Public fast urban chargers (thousands)	0.1	0.5	1.1	1.5
EV charger dynamics	EVs per public charger	6	12	21	30
	EVs per non-home charger	5	8	12	14
	BEV per fast urban charger	103	70	157	249

Public chargers. In 2030, the total number of public chargers for Montréal city is estimated at 9,150 normal and 1,100 fast urban units. Table A 7 in the Annex provides the exact forecasted number for all charger categories and each subdivision in 2025, 2030, and 2035. In Montréal city, Ahuntsic Cartierville, Rosemont, and Côte des Neiges will require the highest number of public chargers, 850 to 900 units, in part due to the high number of people commuting to these areas, and to the number of taxi trips originating from or ending in these districts.[37] At the city level, Montréal has around 1,420 normal and 55 fast chargers in place through 2020[38] which represent 16% and 4.8% of the respective 2030 needs.

Home chargers. Montréal city is the densest area of Québec, with only 13% of its dwellings being houses (detached and attached) and the remaining 87% being low-, mid-, and high-rise buildings, and other types. Therefore, its home chargers will mostly be located in multi-unit dwellings. Indeed, among the estimated 80,200 home chargers for electric passenger cars in 2030, 42% will be in houses and the remaining 58% will be in multi-unit dwellings. In contrast, an estimated 95% of home chargers will be in attached or detached houses at the provincial level.

37 Jérôme La Violette, "Planification stratégique d'un système de transport par taxi," Département des genies civil, géologiques et des mines, École Polytechnique de Montréal, August 2017, https://publications.polymtl.ca/2738/#

38 Personal communication with Transports Québec and assumptions related to the share of Montréal region chargers in Montréal city.

Charging needs under alternative scenarios

The assumptions and results presented in the previous section represent the central scenario based on announced targets and our best projection of market development and consumer behavior under observed trends. However, the number of chargers is sensitive to key assumptions and variables. In order to show the effect of changing these assumptions and variables, three additional scenarios were analyzed for their impact on charging infrastructure needed in 2030, as compared to the central scenario results presented above.

Accelerated transition: Technology development and government policy continue to accelerate the pace of the EV transition relative to earlier projections. Many governments, including the federal government of Canada, have moved forward their target dates for reaching 100% zero-emission sales of new vehicles,[39] and an increasing number of auto manufacturers are also announcing targets for switching to all EVs.[40] Additionally, cost analyses show that EVs are expected to reach cost parity with ICEs for all segments before 2030.[41] To reflect these developments, an additional scenario was developed to represent an accelerated market transition to EVs resulting in 100% BEV sales as soon as 2033.

Increased workplace charging: EV driver charging behavior depends on many factors among which are convenience and price. If companies were to provide more workplace chargers at an attractive price, the share of drivers plugging-in at work could increase. The second scenario thus analyzes the impact of greater reliance on workplace charging. In this scenario, the share of EV commuters with access to workplace charging increases by 5 percentage points.

Reduced urban fast charging: Alternatively, if charging station operators were to extensively develop normal overnight curbside charging infrastructure with charging costs below those of fast charging at urban hubs, the share of normal AC charging events could increase at the expense of fast urban charging events. The third scenario assesses the effect of a higher reliance on normal public overnight charging and less fast urban hub charging.

The effects of these three cases, as a percentage change in the 2030 number of chargers relative to the base scenario, are shown in the Figure below.

39 Sandra Wappelhorst, *Update on Government Targets for Phasing out New Sales of Internal Combustion Engine Passenger Cars*, (ICCT: Washington, DC), June 15, 2021, https://theicct.org/publications/update-govt-targets-ice-phaseouts-jun2021.

40 Anh Bui, Peter Slowik, and Nic Lutsey, *Power Play: Evaluating the U.S. Position in the Global Electric Vehicle Transition*, (ICCT: Washington, DC, June 29, 2021), https://theicct.org/publications/us-position-global-ev-jun2021.

41 Gordon Bauer, Chih-Wei Hsu, and Nic Lutsey, "When Might Lower-Income Drivers Benefit from Electric Vehicles? Quantifying the Economic Equity Implications of Electric Vehicle Adoption," (ICCT: Washington, DC, February 16, 2021, https://theicct.org/publications/EV-equity-feb2021.

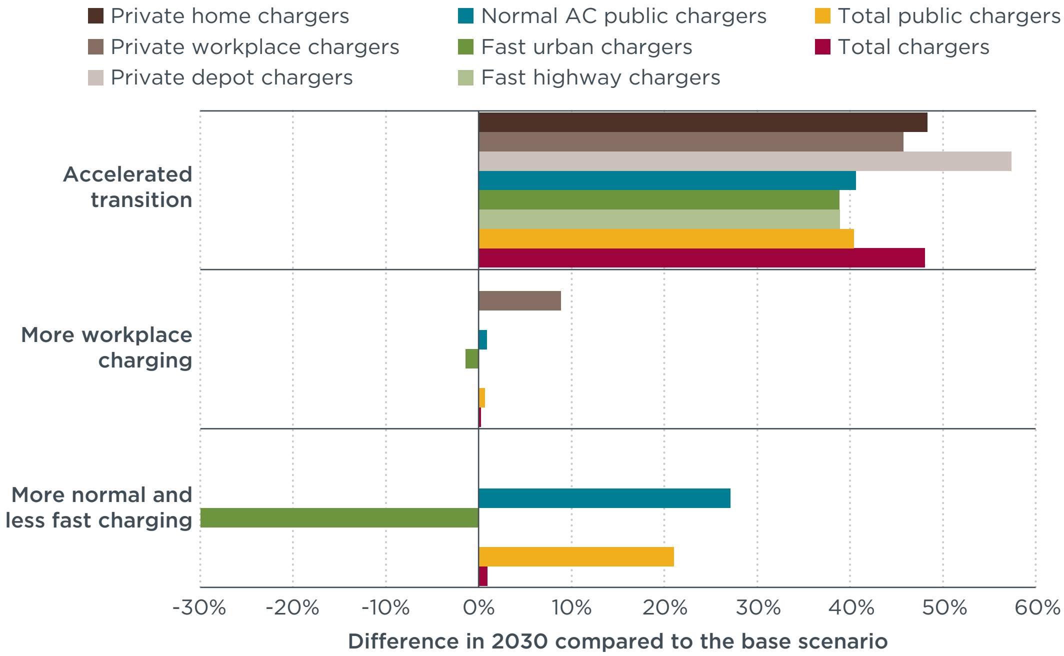

Figure 11. Percentage change in the 2030 number of chargers under alternative scenarios relative to the central scenario

The accelerated transition would result in an increased number of EVs on the roads, reaching 600,000 in 2025 and 2.23 million in 2030. To enable this accelerated uptake, 32% and 40% more public chargers would be needed in 2025 and 2030 respectively compared to the base scenario. As for the total number of public and private chargers, they would increase by 46% and 48% compared to the base scenario, in 2025 and 2030 respectively. Though not shown in the Figure, the region with the highest relative increase in total private and public chargers would be Nord-du-Québec (77%) and the one with the lowest relative increase would be Montréal (35%). This can be explained by Nord-du-Québec being at an earlier stage of EV adoption as of 2020 and thus having to catch up faster.

For the second case, if companies were to provide more workplace chargers, a 5 percentage point increase in the number of EV commuters with access to workplace charging would result in 9% more private workplace chargers, 1% more public normal chargers (since some workplace chargers are public) and a 1% decrease in fast chargers needed. Finally, the third scenario shows that if policies and pricing structures were to encourage more public normal overnight charging for EV owners without home charging, instead of fast urban charging at urban hubs, the need for public chargers could increase by 21%. This 21% reflects a decrease in the need for fast urban chargers of 30% while normal charger needs would increase by 27%.

Policy recommendations

Targeted government policy will be important to meet the growing need for charging infrastructure outlined above. This section provides several high-level policy recommendations to support the efficient development of Québec's charging network, focusing on actions that can be taken by the provincial government. Other reports have provided recommendations and best practices for both local and national governments to facilitate charging infrastructure deployment.[42] Table 6 below summarizes policy recommendations designed to enable increased charger deployment to achieve EV targets in Québec.

Table 6. Summary of policy recommendations to facilitate charger deployment in Québec

Category	Policy/Action type	Stakeholders	Description
Guidance and support to local authorities	Provide charger deployment targets	Local and provincial policy makers	Provide regional targets in terms of number of public chargers or charging capacity in kW for different time horizons.
	Charging deployment strategies	Municipalities, EV owners, distribution network operators, charge point operators	Reduce “soft costs” and encourage greater private sector investment in charger delivery by implementing a streamlined, coordinated charging installation process based on driver demand, with additional direction to ensure equitable charging access.
	Zero-emission zones (ZEZ)	Local and provincial policy makers	Encourage and facilitate the deployment of zero-emission zones in certain metropolitan areas and provide guidelines on their implementation.
Fiscal support	Fiscal support with contingencies	Municipalities, charging providers, property owners	Based on inputs from local authorities regarding gaps in charging, national support can help to share costs for charging infrastructure and building upgrades. Tax credits can partially defray upfront costs and promote equitable long-term electric vehicle access.
	Smart private charging	Provincial policy makers, distribution network operators, charge point operators	Favor the installation of smart private chargers.

Provide charger deployment targets. The Québec government could provide a normal and fast charger target per administrative region at different time horizons. This could include separate targets for fast and normal chargers. Table A 5 in the Annex provides the number of public chargers for each administration region in 2025, 2030, and 2035.

Another option would be to base the targets on the total number of kW that should be available at different time horizons. This approach is used in the latest proposal for a new regulation on the deployment of alternative fuel infrastructure in Europe.[43] This proposed regulation sets national targets for the total power output provided through publicly accessible recharging stations based on the number of electric vehicles registered in each country: 1 kW per BEV and 0.66 kW per PHEV.

Charging deployment strategies. In areas of high public charging demand due to low home charging access, such as Montréal, a demand-driven strategy could be considered.[44] Current or future EV drivers who do not have access to home charging and do not already have a public charger at less than a certain distance of their living place (300m for example) could be offered the possibility to request or suggest the implementation of a public charger close to their home. Another option could be for the local authority to compile a list of possible locations and then poll residents to choose the best option.

42 Marie Rajon Bernard and Dale Hall, “Efficient Planning and Implementation of Public Chargers: Lessons Learned from European Cities,” (ICCT: Washington, DC, February 2, 2021), https://theicct.org/publications/European-cities-charging-infra-feb2021; Marie Rajon Bernard, Dale Hall, and Nic Lutsey, “Charging infrastructure to support the electric mobility transition in France,” (ICCT: Washington, DC, November, 2021), https://theicct.org/publications/france-evs-infrastructure-transition-nov21

43 European Commission, Regulation of the European parliament and of the council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council, Pub. L. No. 2021/0223 COD (2021), https://ec.europa.eu/info/sites/default/files/revision_of_the_directive_on_deployment_of_the_alternative_fuels_infrastructure_with_annex_0.pdf.

44 Marie Rajon Bernard, and Dale Hall, “Efficient Planning and Implementation of Public Chargers: Lessons Learned from European Cities,” (ICCT: Washington, DC, January 2021), https://theicct.org/sites/default/files/publications/European-cities-charging-infra-feb2021.pdf.

This strategy has already been implemented in leading EV cities such as Amsterdam, London, New York, and Seoul.[45]

In order to balance high demand, which is of interest to private charging operators, and equitable access, authorities can use tenders in lots. This involves pairing, in tender processes, vendor commitments to supply chargers to low- and high-utilization locations, with the government potentially providing subsidies for chargers installed in areas of low demand to offset their lower profitability and to ensure that the charging network is complete and that there are affordable options to suit all potential EV drivers. In this approach, cities could also help to find sites that encourage a variety of uses from different fleets, resulting in high utilization. While local authorities will ultimately develop local charging strategies, national and provincial governments could provide guidelines, recommendations, and a template to follow.

Zero-emission zones. One of the most powerful actions local authorities can implement to spur EV uptake is the adoption of zero-emission zones (ZEZ).[46] While the implementation is mostly up to local governments, the provincial government can also regulate on this aspect or encourage ZEZ implementation. For example, the Netherlands was the first country in the world to give cities the freedom to implement zero-emission zones.[47] It is now supporting and coordinating zero-emission freight zone implementation in 30 cities.

Fiscal support with contingencies. Public funding can be provided with cost sharing from private industry only in regions where local governments have clear targets and policies to streamline charging deployment. The funding can be provided with the provision that recipients share expected and actual usage charger data and that the chargers meet interoperability and public-access requirements. Fiscal support to business, workplace, and property managers can also include tax credits which reduce company taxes and partially defray the upfront capital cost of charging infrastructure deployment. Such tax credits are attractive as they rely on forgone taxes rather than public expenditures, and they incentivize investments while ensuring that the charging company and property owners remain vested in the success and high usage of the stations.

Smart private charging. As shown in this report, the number of home chargers, and private chargers in general, should significantly increase in the years to come and represent the majority of charging events. While any grid impacts from electric vehicle energy demand should be accommodated within planned upgrades to the general grid, smart home and workplace charging would benefit the energy system by reducing the need for new generation capacity and network reinforcement. It would also benefit all energy consumers by potentially avoiding costly grid upgrades that would otherwise be spread among all customers. As an example, in the United Kingdom, pending legislation would require that all new private charge points (including in office buildings) be smart.[48] The legislation describes the smart function as "the ability to send and receive

45 Marie Rajon Bernard, Dale Hall, Hongyang Cui, and Jin Li, *Electric vehicle capitals: Accelerating electric mobility in a year of disruption*, (ICCT: Washington, DC, December 2021), theicct.org/publications/evs-capitals-electric-mobility-dec21.

46 Marie Rajon Bernard, Dale Hall, Hongyang Cui, and Jin Li, *Electric vehicle capitals: Accelerating electric mobility in a year of disruption*, (ICCT: Washington, DC, December 2021), theicct.org/publications/evs-capitals-electric-mobility-dec21.

47 Dale Hall, "Supporting governments with 100% ZEV targets," (ICCT: Washington, DC, November 2021) https://theicct.org/sites/default/files/publications/government-zev-targets-ZEVA-evs-nov21.pdf.

48 UK Department for Transport, "Electric Vehicle Smart Charging Government Response to the 2019 Consultation on Electric Vehicle Smart Charging," July 2021, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015285/electric-vehicle-smart-charging-government-response.pdf.

information and respond to this information by increasing or decreasing the rate of electricity flow through the chargepoint and changing the time at which electricity flows through the chargepoint." Another option, instead of mandating private chargers to be smart, could be to provide higher subsidies to smart private chargers or solely provide subsidies to these types of chargers.

Conclusions

This analysis uses a detailed bottom-up evaluation to quantify how much charging infrastructure Québec will require to enable a growing electric vehicle market and meet government targets through 2035. This is the first analysis to estimate charging and energy needs across 6 charging types (private home, depot, and workplace, and public normal AC, fast urban, and fast highway chargers) for all light-duty vehicles (private passenger cars, light commercial vehicles, and taxis) in the province. These results are provided at the regional level, with a specific focus on Montréal, enabling targeted policies to make progress toward meeting these public charging needs. Based on the analysis, we draw the following conclusions:

Québec will require 8 times more public chargers in 2030 compared to 2020. As the electric vehicle stock grows from 92,000 electric vehicles in 2020 to above 1.5 million on Québec roads in 2030, public chargers will need to increase from about 5,700 to 45,800 normal and 700 to 6,300 fast chargers. This number of fast chargers exceeds Québec's government mandate for 2,500 fast chargers to be installed by Hydro-Québec by 2030, suggesting that other stakeholders, including the private sector, will also need to contribute to the charging network. Reaching this target for public chargers represents a 23% annual growth rate from 2020 to 2030. Additionally, 1.1 million private home chargers, 23,700 private workplace, and 18,900 depot chargers will be needed by 2030. Montréal city represents a unique situation within Québec: Since more than 80% of households live in multi-unit dwellings in the dense city, only 38% of EV owners are expected to have private home charging in 2030. Therefore, public curbside and urban fast chargers will be of greatest importance.

Growing energy demand for electric vehicles over time can be beneficial if properly planned. Transportation electrification offers Québec an opportunity to dramatically reduce its energy imports and create economic benefits by leveraging its extensive hydropower production. Annual charging energy demand from electric vehicles will grow from 340 gigawatt-hours (GWh) in 2020 to 5.8 terawatt-hours (TWh) in 2030. The projected 2030 EV electricity demand amounts to about 2.7% of Québec's 2019 electricity production of 212 TWh, indicating that electric vehicles will not challenge the province's electricity generation or transmission infrastructure. However, charging may require localized upgrades in distribution infrastructure for areas with high EV uptake. This is particularly the case for Montréal, where we forecast EV electricity consumption of 570 GWh in 2030. A disproportionate share of that energy in Montréal comes from commercial settings (including fast charging) and multi-unit dwellings, whereas most other parts of the province will see the greatest energy demand in single-family residential areas.

The most-urban and most-rural areas require the greatest increases in public charging, but local needs vary, with DC fast charging playing a major role in enabling urban access to electromobility. The regions with the lowest share of 2030 public charging infrastructure in place through 2020 are the mostly rural areas of Nord-du-Québec, Outaouais, and Saguenay–Lac-Saint-Jean and the heavily urbanized area of Laval. These four regions have less than 10% of 2030 public charging infrastructure in place as of end of 2020, below the provincial average. However, the different settlement patterns across the province mean that charging will happen in different settings: in 2030, 79% of charging at Nord-du-Québec happens in private settings, compared to 74% for the provincial average and only 49% for Montréal city. Urban fast charging will play a particularly important role in enabling access to electromobility in cities. While Québec province had built 11% of its 2030 fast charging needs through 2020, this share is only 5% for Montréal city.

A coordinated charging infrastructure deployment approach could galvanize investments. Reaching the needed charging infrastructure deployment requires coordination between many private and public stakeholders and guidance from the provincial government. Governments can send a signal for investment by setting targets for the number of chargers, or total public charging power (in kW), to be deployed in different regions. A charging deployment strategy could assess demand based on drivers' requests or suggestions while ensuring equitable infrastructure access through tenders in lots. Tendering in lots involves pairing, in tender processes, vendor commitments to supply chargers at low- and high-utilization locations. The government could also potentially provide subsidies for chargers installed in areas of low demand during early market phases. This strategy could encourage the private sector to step in.

This analysis points to several other areas for future research. An important next step could be to investigate the more specific locations of charging infrastructure within regions, and within boroughs for Montréal, based on power grid availability, user demand, and land availability. Future work could also estimate the costs of building this charging infrastructure and develop financing models and taxation systems to distribute the costs among relevant stakeholders: all level of governments, fleets, Hydro-Québec, and the private sector. Detailed strategies and policy guidance at the regional and local level will also be vital to ensure that charging infrastructure deployment's pace does not slow electric vehicle uptake. Finally, given the inherent uncertainty about charging technology and travel patterns, this analysis can be updated as the market evolves to incorporate new developments.

Annex

This Annex provides a map key of Québec administrative regions (Figure A 1 and Table A 1) and Greater Montréal divisions (Figure A 2 and Table A 2) along with greater details on data inputs and assumptions in general (Table A 3) and for passenger cars more specifically (Table A 4).

In addition:

» Figure A 3 provides the number of non-home chargers in each administrative region in 2025, 2030, and 2035.

» Table A 5 displays the number of chargers for all settings and every Québec administrative region in 2025, 2030, and 2035.

» Table A 6 displays the number of chargers for all settings and every Greater Montréal division in 2025, 2030, and 2035.

» Table A 7 displays the number of chargers for all settings and every Montréal city district in 2025, 2030, and 2035.

» Table A 8 provides the number of corridor fast chargers per highway and national roads in 2025, 2030, and 2035.

» Table A 9 compares the results of the present study with the Scenario 2+ of the Dunsky report.

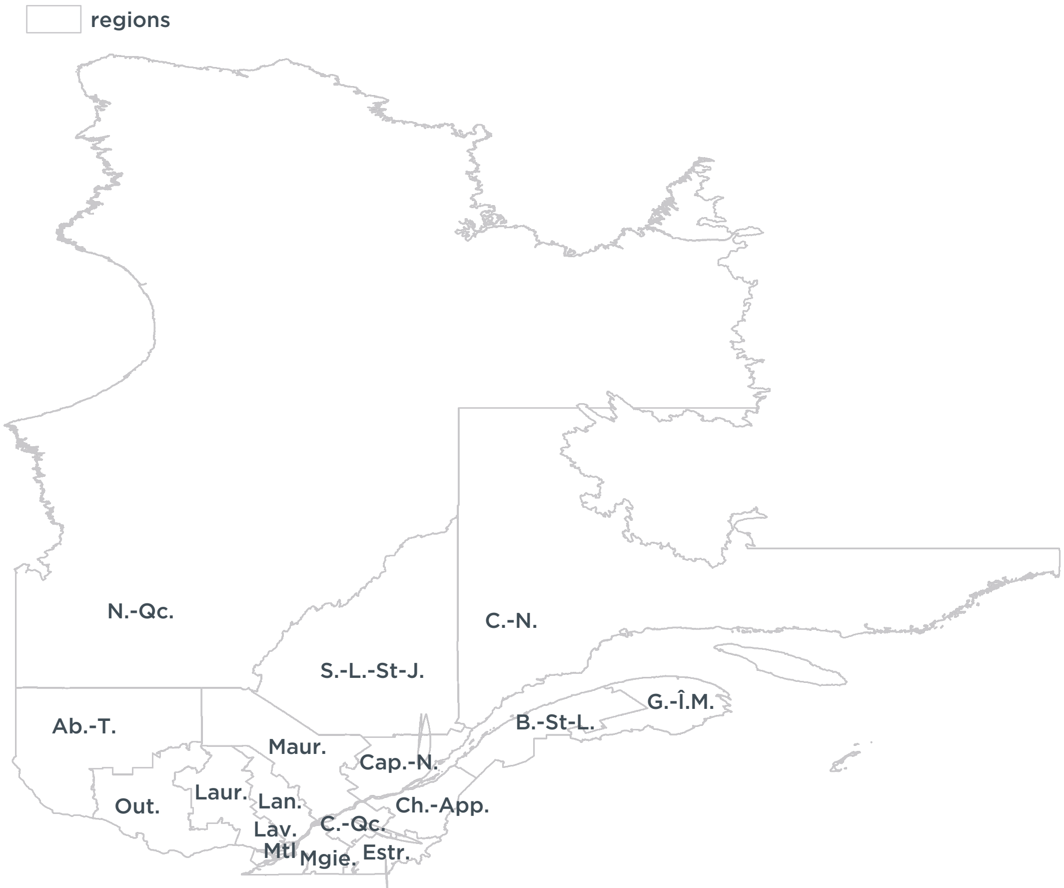

Figure A 1. Québec administrative regions' map key

Table A 1. Québec administrative regions' names

Region name	Abbreviation
Abitibi-Témiscamingue	Ab.-T.
Bas-Saint-Laurent	B.-St-L.
Capitale-Nationale	Cap.-N.
Centre-du-Québec	C.-Qc
Chaudière-Appalaches	Ch.-App.
Côte-Nord	C.-N.
Estrie	Estr.
Gaspésie–Îles-de-la-Madeleine	G.-Î.M.
Lanaudière	Lan.
Laurentides	Laur.
Laval	Lav.
Mauricie	Maur.
Montérégie	Mgie.
Montréal	Mtl
Nord-du-Québec	N.-Qc.
Outaouais	Out.
Saguenay–Lac-Saint-Jean	S.-L.-St-J.

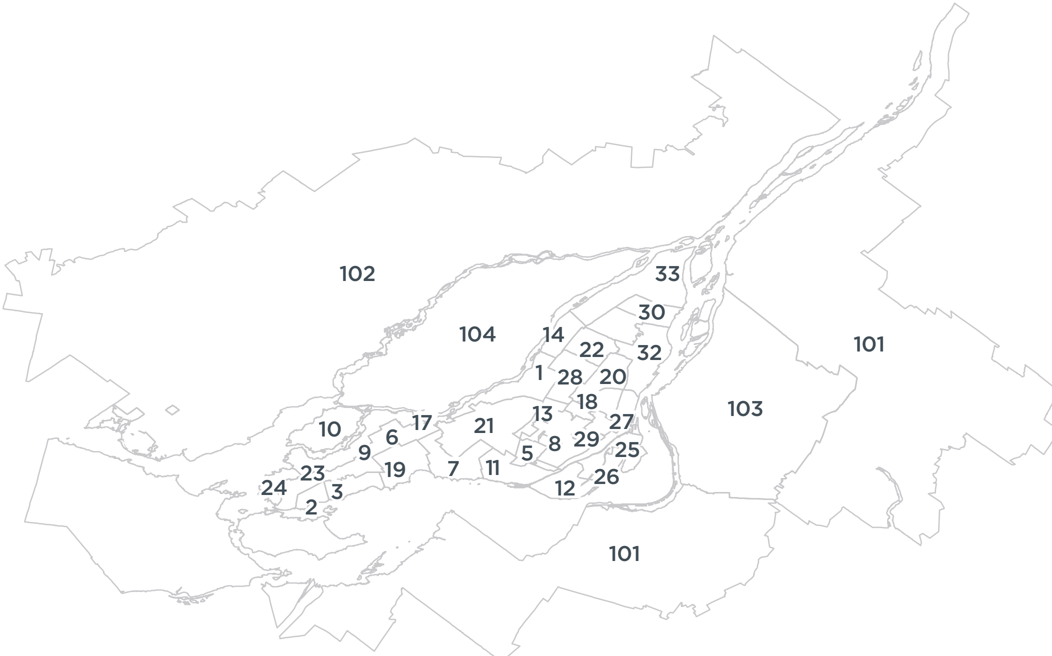

Figure A 2. Montréal metropolitan region map key

Table A 2. Montréal metropolitan region sub-divisions' names

Number	Name	Number	Name
1	Ahuntsic-Cartierville	**20**	Rosemont-La Petite-Patrie
2	Baie-d'Urfé	**21**	Saint-Laurent
3	Beaconsfield	**22**	Saint-Léonard
4	Côte-des-Neiges-Notre-Dame-de-Grâce	**23**	Sainte-Anne-de-Bellevue
5	Côte-Saint-Luc	**24**	Senneville
6	Dollard-des-Ormeaux	**25**	Sud-Ouest
7	Dorval	**26**	Verdun
8	Hampstead	**27**	Ville-Marie
9	Kirkland	**28**	Villeray-Saint-Michel-Parc-Extension
10	L'Île-Bizard-Sainte-Geneviève	**29**	Westmount
11	Lachine	**30**	Montréal-Est
12	LaSalle	**31**	Anjou
13	Mont-Royal	**32**	Mercier-Hochelaga-Maisonneuve
14	Montréal-Nord	**33**	Rivière-des-Prairies-Pointe-aux-Trembles
15	Montréal-Ouest	**101**	Couronne Sud
16	Outremont	**102**	Couronne Nord
17	Pierrefonds-Roxboro	**103**	Longueuil
18	Plateau-Mont-Royal	**104**	Laval
19	Pointe-Claire		

Table A 3. Main data inputs and assumptions at the Québec province level

		2020	2025	2030	2035
EV stock (thousands)		90	409	1,512	3,283
Market share of electric new vehicle registrations		7%	25%	73%	100%
Share of electric vehicle stock		2%	8%	28%	60%
Ratio of BEVs to new EVs registered		65%	75%	87%	100%
New passenger cars	**BEV efficiency (km/kWh)**	0.2047	0.2016	0.1990	0.1972
	PHEV efficiency (km/kWh)	0.2088	0.2066	0.2049	0.2043
New light commercial vehicles	**BEV efficiency (km/kWh)**	0.3294	0.3183	0.3121	0.3084
	PHEV efficiency (km/kWh)	0.3360	0.3300	0.3264	0.3253
Share of EV owners with access to home charging		85%	82%	79%	78%
Home charging availability by dwelling type	**Detached house**	93%	91%	90%	89%
	Attached house	73%	72%	71%	70%
	low-rise building	30%	30%	29%	29%
	mid-rise building	20%	20%	19%	19%
	high-rise building	27%	27%	26%	26%
	other	61%	61%	60%	59%
Number of light commercial BEVs sharing one depot charger		2			
Number of light commercial PHEVs sharing one depot charger		4			
% of EV owners who use their car to go to work everyday		70%	64%	58%	58%
Share of EV driving commuter who have access to workplace charging		34%	36%	38%	39%
Average kilometers driven per year		18,000			
Average rate of power draw	**BEV – AC normal charger**	6	7	8	10
	PHEV – AC normal charger	3	4	5	5
	Urban fast charger	24	53	82	111
	Corridor highway charger	58	87	116	144
Charger efficiency (electricity fed into the car / electricity fed into the charger)		90%			
Charger utilization (in hours per day)	**Normal AC**	1.84	3.48	4.97	5.88
	DC Fast	1.46	2.88	4.09	4.85
	Workplace	5 hours per workday			

Table A 4. Allocation of energy needs per driver category for private passenger cars

Vehicle	Commuting	Work charging	Home charging	Home	Work	Normal	Fast urban	Fast highway	Share of e-VKT	Share of vehicle stock in 2025	Share of vehicle stock in 2030	Share of vehicle stock in 2035
BEV	Yes	Yes	Yes	70%	20%	1%	4%	5%	100%	13%	14%	16%
			No	0%	70%	5%	20%	5%	100%	3%	4%	5%
		No	Yes	85%	0%	3%	7%	5%	100%	24%	23%	25%
			No	0%	0%	35%	60%	5%	100%	5%	6%	7%
	No	N/A	Yes	85%	0%	4%	6%	5%	100%	21%	28%	30%
			No	0%	0%	35%	60%	5%	100%	5%	7%	8%
PHEV	Yes	Yes	Yes	80%	15%	5%	0%	0%	85%	6%	3%	2%
			No	0%	85%	15%	0%	0%	70%	1%	1%	0%
		No	Yes	90%	0%	10%	0%	0%	85%	10%	5%	2%
			No	0%	0%	100%	0%	0%	40%	2%	1%	1%
	No	N/A	Yes	90%	0%	10%	0%	0%	80%	9%	6%	3%
			No	0%	0%	100%	0%	0%	40%	2%	2%	1%

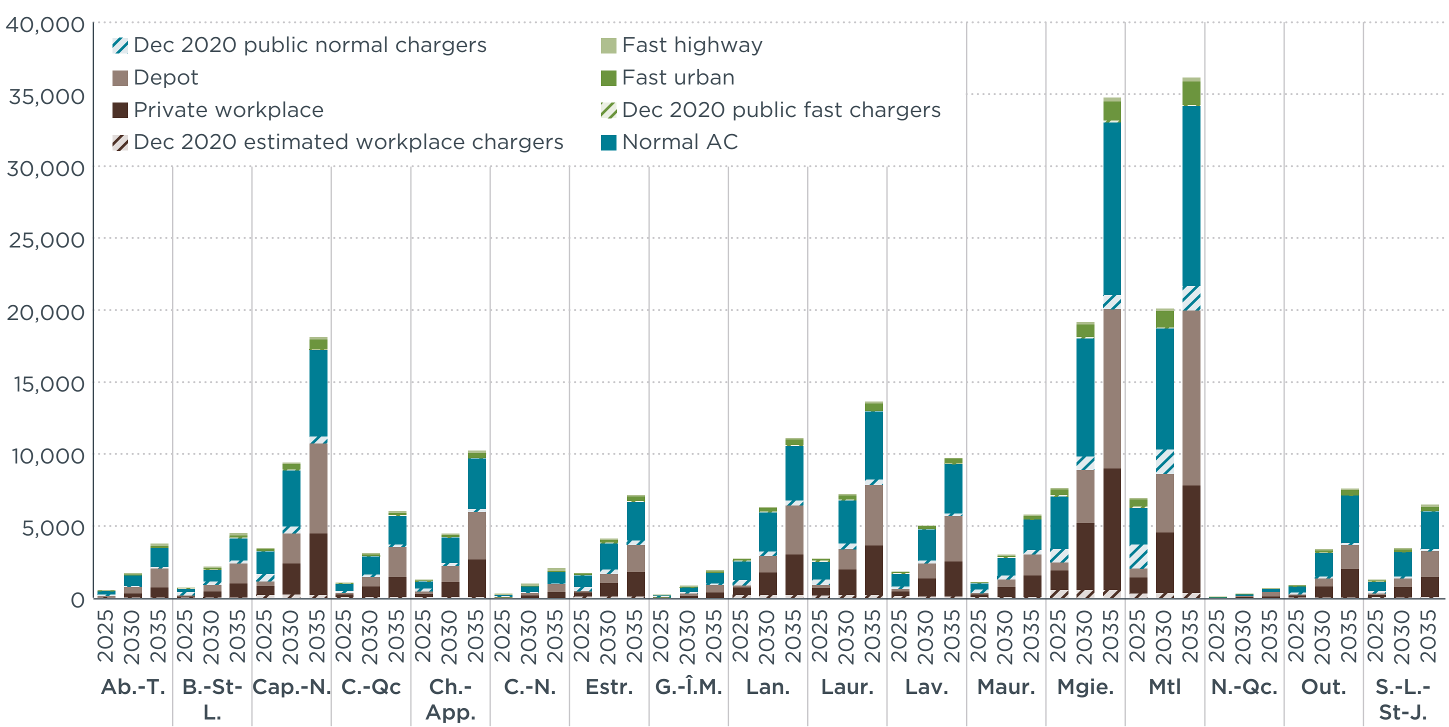

Figure A 3. Number of non-home chargers in 2025, 2030, and 2035 in Québec 17 administrative regions

Table A 5. Number of chargers for all settings and every Québec administrative region in 2025, 2030, and 2035

		Home	Private work	Depot	Normal AC	Fast urban	Fast highway
Abitibi-Témiscamingue	2025	3,971	79	69	331	28	38
	2030	18,525	308	443	814	84	85
	2035	52,638	728	1,326	1,404	178	127
Bas-Saint-Laurent	2025	6,333	123	73	422	42	40
	2030	27,451	450	469	1,039	109	89
	2035	71,557	990	1,405	1,754	206	134
Capitale-Nationale	2025	30,547	830	324	2,068	199	42
	2030	104,092	2,407	2,093	4,362	429	95
	2035	226,810	4,467	6,265	6,495	715	142
Centre-du-Québec	2025	11,014	247	107	611	66	29
	2030	41,242	783	693	1,399	143	65
	2035	91,187	1,475	2,074	2,139	233	97
Chaudière-Appalaches	2025	11,309	276	172	692	72	37
	2030	53,902	1,115	1,110	1,966	195	83
	2035	151,295	2,660	3,324	3,713	388	124
Côte-Nord	2025	1,859	38	28	148	13	56
	2030	10,263	175	180	438	45	125
	2035	30,563	436	540	810	98	188
Estrie	2025	16,878	377	98	1,088	128	26
	2030	54,438	1,040	630	2,123	237	57
	2035	110,126	1,818	1,887	2,983	350	86
Gaspésie–Îles-de-la-Madeleine	2025	1,657	25	27	117	12	29
	2030	10,867	140	172	410	45	65
	2035	35,507	385	515	837	104	97
Lanaudière	2025	30,105	706	177	1,654	172	18
	2030	90,155	1,776	1,141	3,027	303	40
	2035	180,524	3,010	3,416	4,152	445	60
Laurentides	2025	29,775	687	219	1,617	182	34
	2030	100,941	1,977	1,410	3,397	353	76
	2035	216,373	3,635	4,223	5,102	547	114
Laval	2025	17,340	452	164	1,069	126	9
	2030	60,231	1,351	1,059	2,348	251	20
	2035	129,363	2,519	3,172	3,610	393	29
Mauricie	2025	10,756	251	78	678	68	24
	2030	39,235	777	502	1,505	149	53
	2035	91,718	1,548	1,503	2,386	257	79
Montérégie	2025	81,414	1,901	572	4,572	514	79
	2030	261,881	5,199	3,692	9,132	955	176
	2035	528,493	9,020	11,054	12,989	1,418	264
Montréal	2025	31,379	1,407	631	4,225	582	67
	2030	118,881	4,575	4,069	10,085	1,205	164
	2035	232,329	7,805	12,183	14,208	1,705	260
Nord-du-Québec	2025	331	8	14	29	2	16
	2030	2,317	46	91	105	10	35
	2035	7,789	129	272	212	26	53
Outaouais	2025	7,266	163	86	544	53	29
	2030	41,908	802	554	1,772	177	65
	2035	124,418	2,018	1,659	3,426	384	98
Saguenay–Lac-Saint-Jean	2025	11,194	223	93	803	94	40
	2030	44,695	761	598	1,815	211	89
	2035	100,567	1,470	1,791	2,736	346	134

Table A 6. Number of chargers for all settings and every Greater Montréal division in 2025, 2030, and 2035

		Home	Private work	Depot	Normal AC	Fast urban
Montréal city	2025	20,567	1,257	486	3,828	531
	2030	80,237	4,111	3,133	9,144	1,096
	2035	156,584	6,989	9,382	12,810	1,538
Rest of Montréal agglomeration (w/o the city)	2025	10,812	150	145	397	51
	2030	38,644	464	936	941	109
	2035	75,745	816	2,801	1,398	167
Laval	2025	17,340	452	164	1,069	126
	2030	60,231	1,351	1,059	2,348	251
	2035	129,363	2,519	3,172	3,610	393
Longueuil	2025	16,743	328	123	862	100
	2030	52,012	882	794	1,689	182
	2035	111,391	1,641	2,377	2,558	286
Northern Ring	2025	31,215	797	209	1,770	191
	2030	92,497	1,994	1,349	3,246	328
	2035	188,567	3,449	4,038	4,583	483
Southern Ring	2025	25,369	666	163	1,403	156
	2030	77,074	1,710	1,054	2,641	268
	2035	157,574	2,970	3,155	3,777	389

Table A 7. Number of chargers for all settings and every Montréal city district in 2025, 2030, and 2035

		Home	Private work	Depot	Normal AC	Fast urban
Ahuntsic Cartierville	2025	1,786	108	41	341	48
	2030	6,539	331	268	777	95
	2035	12,657	564	801	1,094	133
Anjou	2025	663	38	30	122	16
	2030	2,506	118	194	279	33
	2035	4,930	201	581	390	48
Côte-des-Neiges-Notre-Dame-de-Grâce	2025	1,270	103	17	317	46
	2030	4,869	330	108	749	92
	2035	9,513	568	322	1,065	129
Lachine	2025	881	42	25	130	19
	2030	3,251	133	163	305	37
	2035	6,322	231	489	440	52
LaSalle	2025	723	55	13	173	23
	2030	3,494	226	81	486	56
	2035	6,920	394	242	694	81
Le Plateau-Mont-Royal	2025	656	61	11	170	25
	2030	2,339	174	71	372	47
	2035	4,363	273	213	492	62
Le Sud-Ouest	2025	857	54	17	189	27
	2030	3,257	166	109	428	53
	2035	6,012	259	326	553	69
L'Ile-Bizard-Sainte-Genevieve	2025	713	24	1	56	7
	2030	2,125	61	7	111	12
	2035	4,000	103	20	156	17
Mercier-Hochelaga-Maisonneuve	2025	1,278	108	17	301	38
	2030	4,971	346	113	703	80
	2035	9,772	589	337	981	114
Montréal-Nord	2025	569	40	14	133	18
	2030	3,403	205	87	435	50
	2035	6,819	359	261	623	73
Outremont	2025	455	26	2	69	10
	2030	1,037	51	11	112	14
	2035	1,701	75	32	141	17
Pierrefonds-Roxboro	2025	1,815	63	3	169	23
	2030	6,854	208	22	411	48
	2035	13,187	365	65	603	68
Riviere-des-Prairies-Pointe-aux-Trembles	2025	2,409	95	24	253	31
	2030	9,677	325	155	623	68
	2035	18,894	566	463	892	100
Rosemont-La Petite Patrie	2025	1,244	108	12	338	46
	2030	4,849	343	76	782	93
	2035	9,627	583	228	1,090	131
Saint-Laurent	2025	1,753	78	160	240	36
	2030	6,797	249	1,030	568	72
	2035	13,711	432	3,083	818	102
Saint-Léonard	2025	781	52	20	185	26
	2030	3,861	217	132	521	62
	2035	7,765	379	395	742	90
Verdun	2025	901	66	4	195	27
	2030	2,910	175	23	397	48
	2035	5,583	292	70	546	65
Ville Marie	2025	917	61	43	211	31
	2030	3,015	154	279	413	55
	2035	5,643	233	835	522	72
Villeray Saint Michel Parc Extension	2025	897	72	32	237	34
	2030	4,484	298	206	673	81
	2035	9,164	522	616	968	116

Table A 8. Number of corridor fast chargers per highway and national roads in 2025, 2030, and 2035

road type	road number	2025	2030	2035	road type	road number	2025	2030	2035
Highway	5	3	6	9	National road	101	1	2	3
	10	10	23	34		104	4	10	15
	13	23	52	77		105	2	5	7
	15	41	92	139		107	0	0	1
	19	3	7	11		108	2	6	8
	20	76	171	257		109	0	1	1
	25	27	60	91		111	1	2	3
	30	21	48	72		112	11	24	37
	31	1	2	3		113	0	0	1
	35	4	9	13		116	6	15	22
	40	108	243	365		117	8	19	28
	50	13	30	45		122	1	2	3
	55	8	19	28		125	3	7	10
	70	2	5	7		131	3	6	9
	73	25	56	84		132	16	37	55
	85	1	3	4		133	2	5	7
	410	3	6	9		134	0	1	1
	440	20	45	67		136	1	2	3
	520	3	7	10		137	1	1	2
	530	1	2	4		138	11	25	38
	540	4	9	14		139	2	4	5
	573	2	4	6		141	2	4	6
	610	1	2	4		143	1	3	4
	640	16	36	55		147	1	2	3
	730	1	2	3		148	9	20	30
	740	17	38	57		153	1	2	2
	930	1	3	5		155	1	1	2
	955	0	0	0		157	1	3	5
	973	4	8	13		158	4	8	12
						159	0	0	1
						161	1	2	3
						162	0	0	1
						165	1	1	2
						167	0	0	1
						169	4	9	14
						170	2	4	6
						171	0	1	1
						172	1	3	5
						173	2	4	6
						175	6	13	20
						185	0	0	0
						191	0	1	1
						195	0	1	1
						197	0	0	0
						198	0	1	1
						199	1	1	2

Table A 9. Electric vehicles and supporting chargers needed through 2030, comparing this analysis with the Scenario 2+ of the Dunsky report

		Québec			Greater Montréal			Montréal administrative region			Montréal city		
		2020 ref	ICCT	Dunsky	2020 ref	ICCT	Dunsky	2020 ref	ICCT	Dunsky	2020 ref	ICCT	Dunsky
2025	EV sales share	7%	25%		8%	28%	38%	7%	28%	30%	7%	28%	30%
	BEV sales share	5%	19%		6%	23%	30%	5%	23%		5%	22%	
	EVs	25,599	409,064		41,297	178,893	253,118	12,086	64,934	75,902	9,283	51,746	58,731
	BEVs	17,067	282,326		24,029	127,310	187,823	7,260	46,603	57,278	5,461	36,993	44,770
	PHEVs	8,532	126,738		17,269	51,583	65,295	4,826	46,603	18,624	3,821	14,754	13,961
	normal chargers	5,689	20,668	27,500	2,886	9,330	13,750	1,676	4,225		1,419	3,828	
	fast chargers	690	2,967	2,340	173	1,358	936	68	582		53	531	
	EV per charger	4	17		14	17	17	7	14		6	12	
	BEV per fast charger	25	95		139	94	201	107	80		103	70	
2030	EV sales share	7%	73%		8%	78%	70%	7%	84%	62%	7%	84%	61%
	BEV sales share	5%	63%		6%	70%	52%	5%	75%		5%	76%	
	EVs	25,599	1,512,371		41,297	625,040	756,976	12,086	259,766	252,288	9,283	210,623	199,746
	BEVs	17,067	1,216,752		24,029	510,482	558,815	7,260	212,178	190,611	5,461	171,735	151,969
	PHEVs	8,532	295,619		17,269	114,558	198,161	4,826	47,588	61,677	3,821	38,888	47,777
	normal chargers	5,689	45,738	80,000	2,886	20,009	40,000	1,676	10,085		1,419	9,144	
	fast chargers	690	6,284	5,100	173	2,661	2,040	68	1,205		53	1,096	
	EV per charger	4	29		14	28	18	7	23		6	21	
	BEV per fast charger	25	194		139	192	274	107	176		103	157	

This study's EV uptake projections are slightly lower than Dunsky's Greater Montréal results for 2025, but are similar to Dunsky's results for Montréal administrative region and city and higher for 2030. While this analysis projects a higher uptake in Montréal city compared to the Greater Montréal in response to ambitious Montréal electrification plans, Dunsky forecasts the opposite. In terms of charging infrastructure, this analysis forecasts a growing daily utilization of public chargers, which reduces the stock of public chargers needed and increases the ratio of electric vehicles per charger.