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Electric Vehicle Availability Standard: Potential Impacts on Ownership Costs and Charger Supply

OFFICE OF THE PARLIAMENTARY BUDGET OFFICER
BUREAU DU DIRECTEUR PARLEMENTAIRE DU BUDGET

The Parliamentary Budget Officer (PBO) supports Parliament by providing economic and financial analysis for the purposes of raising the quality of parliamentary debate and promoting greater budget transparency and accountability.

Under the Electric Vehicle Availability Standard, manufacturers will be required to ensure light-duty fleet offerings consistent with a zero-emission vehicle (ZEV) market share of 20 per cent in 2026, 60 per cent in 2030 and 100 per cent in 2035. This report provides an analysis of how the relative ownership costs of ZEV and internal combustion engine (ICE) vehicles, as well as the market provision of charging infrastructure, may need to adjust to meet the ZEV sales targets under the standard by 2030.

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Table of Contents

Highlights

The Electric Vehicle (EV) Availability Standard will compel automotive manufacturers to ensure fleet offerings of light-duty vehicles consistent with a zero-emission vehicle (ZEV) market share of 20 per cent in 2026, 60 per cent in 2030 and 100 per cent in 2035—significantly above the market share projected under a baseline scenario without the standard.

Assuming that preferences, technology and policies remain unchanged from a baseline scenario without the standard, PBO estimates that the relative ownership cost of battery-electric vehicles (BEVs) would need to decrease by 31 per cent to meet the ZEV sales target of 60 per cent in 2030. That is, the ownership cost of ZEVs relative to internal combustion engine (ICE) vehicles in 2030 under the standard would need to be 31 per cent lower compared to the baseline scenario without the standard in 2030.

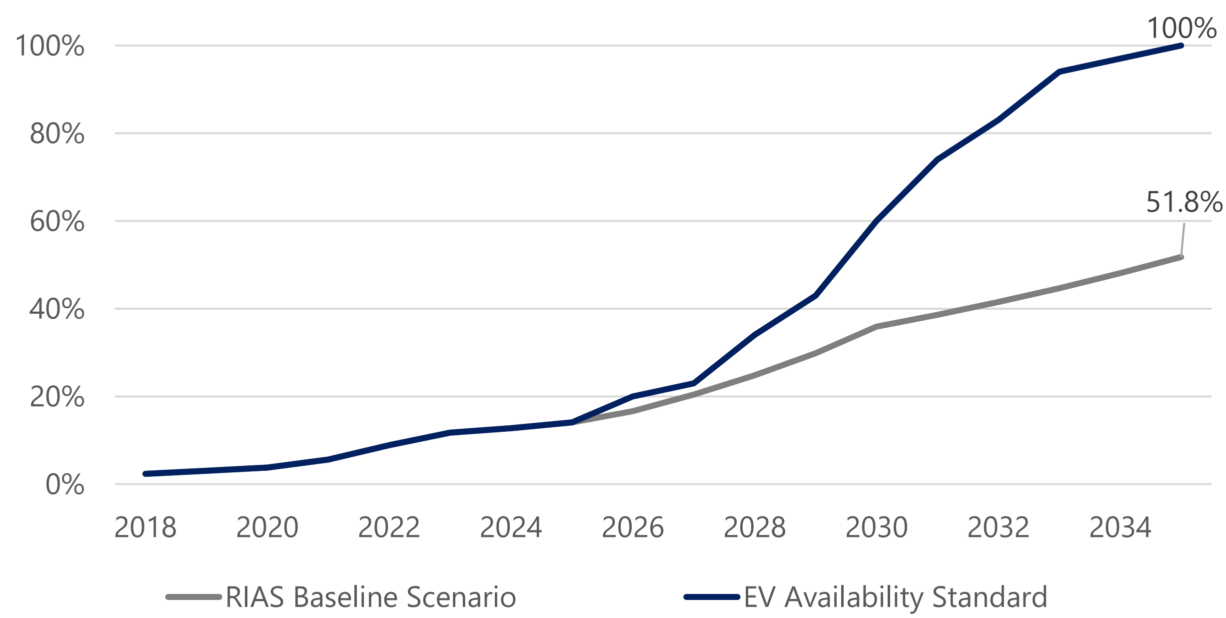
PBO estimates that achieving the ZEV sales targets under the EV Availability Standard would increase the market supply of L2 and L3 (fast) charging ports by 33,900 and 4,700 units, respectively, above baseline levels in 2030—somewhat less than what is required according to a recent needs analysis commissioned by Natural Resources Canada.

Summary

In December 2023, Environment and Climate Change Canada (ECCC) announced the details of the Electric Vehicle (EV) Availability Standard. Manufacturers will need to ensure fleet offerings of light-duty vehicles consistent with a zero-emission vehicle (ZEV) market share of 20 per cent in 2026, 60 per cent in 2030 and 100 per cent in 2035. These sales targets represent a significant increase from a baseline projection of the ZEV market share without the EV Availability Standard (Figure S-1).

Figure S-1

ZEV market share under the EV Availability Standard and baseline scenarios



Source:
Office of the Parliamentary Budget Officer, Environment and Climate Change Canada, and Transport Canada.

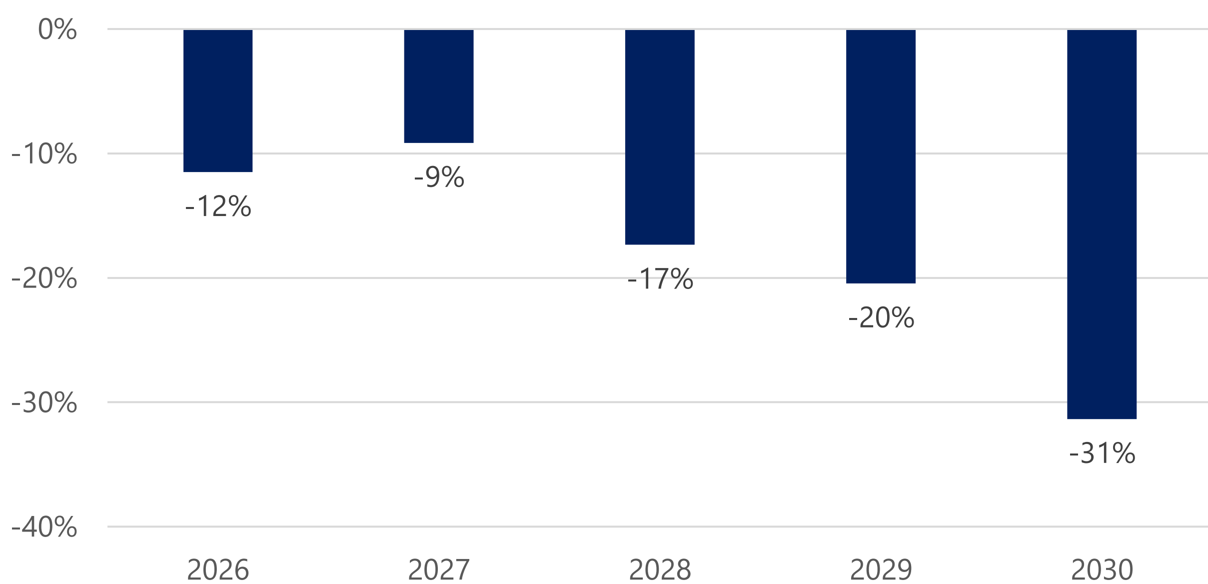
Note:
The Regulatory Impact Analysis Statement (RIAS) baseline scenario is taken from the December 2023 Regulations.

This report provides parliamentarians with an analysis of how the relative ownership costs of ZEV and internal combustion engine (ICE) vehicles, as well as the market provision of charging infrastructure, may need to adjust to meet the ZEV sales targets under the standard by 2030. There are several ways that market conditions could evolve to meet the 60 per cent ZEV market share by 2030 as required by the standard. These include faster changes in consumer preferences, unexpected technological advances, new policy measures and price adjustments by auto manufacturers.

Assuming that preferences, technology and policies remain unchanged from a baseline scenario without the standard, we estimate that the relative ownership cost of battery-electric vehicles (BEVs) would need to decrease by 31 per cent to meet the ZEV sales target of 60 per cent in 2030 (Figure S-2). That is, the ownership cost of ZEVs relative to ICE vehicles in 2030 under the standard would need to be 31 per cent lower compared to the baseline scenario without the standard in 2030.

Figure S-2

Change in relative ownership cost of BEVs required to meet ZEV targets under the EV Availability Standard

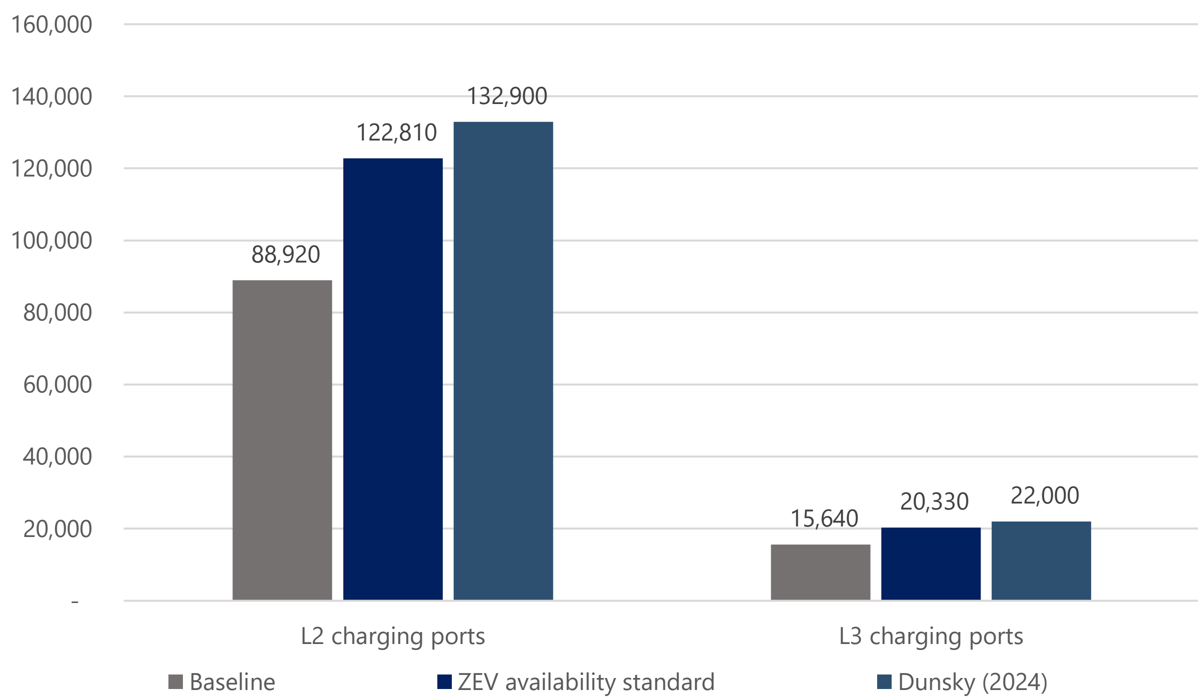


Source:
Office of the Parliamentary Budget Officer.

Note:
For each year, estimated impacts show the percentage difference between the relative ownership cost of BEVs to ICE vehicles under the standard and the relative ownership cost of BEVs to ICE vehicles in the baseline scenario without the standard. Estimates assume preferences, technology and policies remain unchanged from a baseline scenario without the standard. Relative cost adjustments and increases in chargers alone ensure that ZEV sales targets are met under the standard.

In addition, we estimate that achieving the ZEV sales targets under the EV Availability Standard would increase the market supply of L2 and L3 (fast) charging ports by 33,900 and 4,700 units, respectively, above baseline levels in 2030 (Figure S-3). We estimate that by 2030 the market provision of public charging ports will be somewhat less than what is required according to a needs analysis (Dunsky 2024) commissioned by Natural Resources Canada.

Figure S-3
Market provision of public charging ports by 2030



Source:
Office of the Parliamentary Budget Officer, Dunsky (2024).

Note:
Projections do not include private or workplace charging ports. Dunsky (2024) figures presented refer to the number of public community charging ports required by 2030.

Introduction

Electric Vehicle Availability Standard

In its 2022 Emission Reduction Plan, the federal government committed to put in place a phased-in ZEV sales mandate to ensure new light-duty vehicle sales would reach 100 per cent by 2035. In December 2023, Environment and Climate Change Canada (ECCC) announced the details of the Electric Vehicle Availability Standard.[1,2] Table 1-1 shows ZEV sales targets by model year.

Table 1-1

ZEV sales targets by model year under the Electric Vehicle Availability Standard

Model year	ZEV sales targets (%)
2026	20
2027	23
2028	34
2029	43
2030	60
2031	74
2032	83
2033	94
2034	97
2035 and beyond	100

Source:
Environment and Climate Change Canada.

Compliance credits provide an important financial incentive and flexibility mechanism under the standard. Companies can earn credits for excess ZEVs offered for sale which they can use to offset future compliance deficits or sell to other companies in a deficit position. Credits can also be created by making a financial contribution of up to $20,000 for charging infrastructure.[3] As a transition measure, plug-in hybrid vehicles (PHEVs) with an electric range of less than 80 kilometres will receive partial credits up to model year 2028.

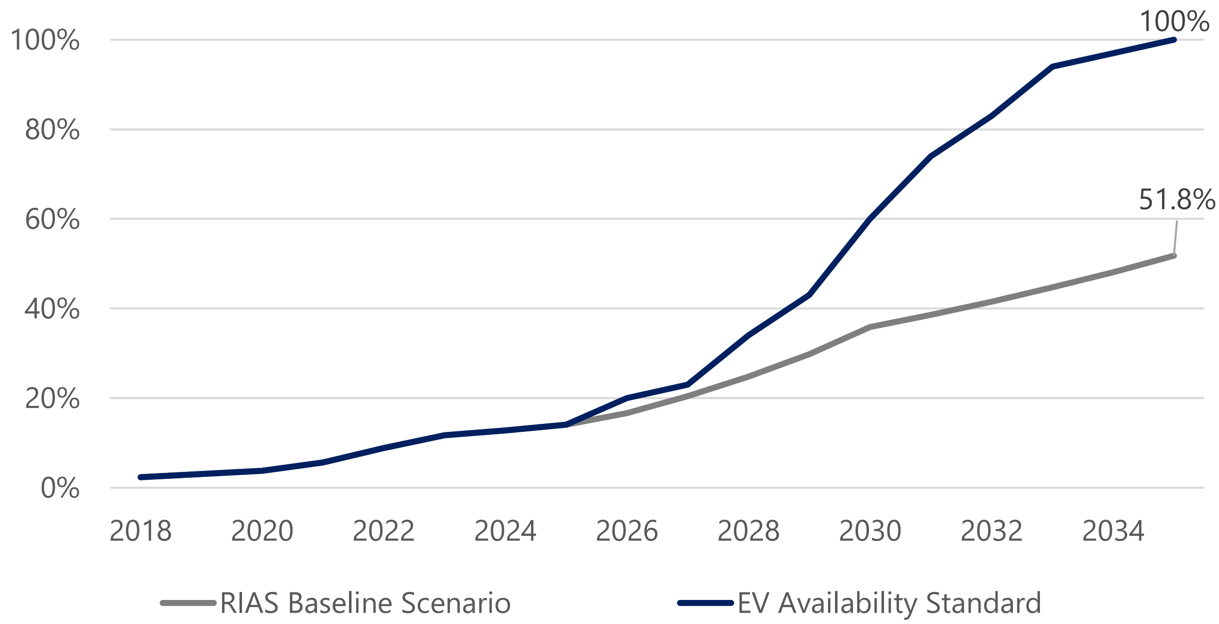
The ZEV sales targets are an important change in the market for new light-duty vehicles and could have a meaningful impact on federal policies related to ZEVs and charging stations, as well as on other federal tax revenues. Considering these important changes, parliamentarians have asked the PBO to analyze the impacts of the EV Accessibility Standard.

To develop the capacity to analyze and cost programs related to the sales of ZEVs and charging stations, the PBO has built a model of ZEV demand and supply of charging ports in Canada. The PBO's model is calibrated to ECCC's Regulatory Impact Analysis Statement (RIAS) and can be used to analyze the impacts of vehicle prices, operating costs, the size of the charging network in Canada, as well as subsidies for purchasing ZEVs or building charging stations. The main purpose of the PBO's model is to estimate the market impact and fiscal cost of policies, including the ZEV sales mandate, and not to forecast ZEV adoption.

ECCC's RIAS provides a cost-benefit analysis of the EV Availability Standard. It focuses on three main categories of monetized impacts: vehicle and home charger costs, energy savings and avoided climate damages due to greenhouse gas (GHG) emission reductions. The analysis concludes that the EV Availability Standard will have total net benefits of $78.6 billion over 2024 to 2050. These benefits accrue relative to a counterfactual baseline scenario without the standard, and the ZEV share evolves based on current policies and trends (Figure 1-1). The RIAS did not attempt to estimate how the standard would impact the ownership cost of light-duty vehicles.

Figure 1-1

ZEV market share under the EV Availability Standard and baseline scenarios



Source:
Office of the Parliamentary Budget Officer, Environment and Climate Change Canada, and Transport Canada.

Charging infrastructure is differentiated by power and speed: L1 home chargers, L2 chargers for locations with longer charging times (for example, workplaces) and L3, Direct Current Fast Chargers (DCFC) for highways and corridors. The Government of Canada's ZEV charging and refuelling infrastructure targets are currently 84,500 chargers and 45 hydrogen stations to be deployed by 2029.[4] Major government funding sources to support ZEV charging infrastructure include:

- $630 million via the ZEV Infrastructure Program to support projects focusing on EV charger deployment in public places, on-street, in multi-unit residential buildings, at workplaces, and for vehicle fleets. Natural Resources Canada will contribute up to 50 per cent of project costs;
- $500 million from the Canada Infrastructure Bank to invest in large-scale ZEV charging and refuelling infrastructure that is revenue generating and in the public interest; and,
- $637 million in funding commitments by provincial governments that target public charging infrastructure.

The federal government has not published a projection of the number of chargers in Canada's public network. Dunsky (2024) estimates that Canada's public charging network will require 154,900 community and 79,600 workplace charging ports by 2030 to meet growing demand under the EV standard.

This report aims to provide parliamentarians with the following analysis of the EV Availability Standard:

- An estimate of the change in relative ownership costs of ZEVs and ICE vehicles to meet the 60 per cent ZEV sales target in 2030 under the standard, if tastes, technology and other factors evolve in line with current trends (ECCC baseline); and,
- A projection of the number of market-supplied EV chargers added to the public network by 2030 under the EV standard.

Alignment with United States vehicle emission standards

The federal government's Emission Reduction Plan committed to align Canada's light-duty vehicle regulations with the most stringent performance standards in North America post-2025, whether at the United States federal or state level.[5] On March 20, 2024, the U.S. Environmental Protection Agency (EPA) published its final rule for GHG vehicle emission standards for light-duty vehicles from model years 2027 to 2032.[6]

Canada has not yet formally adopted the new EPA standards and therefore they are not included in ECCC's baseline scenario. Given Canada's history of aligning with the EPA on GHG emission standards, this is an important context with which to view the counterfactual baseline scenario.

Model structure and inputs

Model structure

Following Cole et al. (2023) and the Congressional Budget Office (2023)[7], PBO built a model in which the demand (quantity) for ZEVs and the supply of charging ports are jointly determined. Any policy affecting the demand for ZEVs will affect the supply of charging ports and vice versa.

Demand for electric vehicles

The demand component of the PBO model uses a discrete choice framework for two vehicle classes, more specifically cars and light-duty trucks.[8] The model assumes that for each class of vehicles consumers make a choice between a ZEV vehicle or an ICE vehicle. This choice is determined by vehicles' relative ownership costs, the number of L2 and L3/DCFC charging ports in Canada, and an evolving taste parameter for ZEVs. The taste parameter is meant to capture evolving unmodelled attributes of ZEVs such as battery range or consumer awareness.[9] The choice model provides shares of sales of ZEVs per year for both cars and light-duty trucks. The ZEV shares are then used to obtain the stock of ZEVs that is required by the supply of charging ports model.

The choice model is calibrated using parameter estimates from the literature to match observed sales shares of ZEVs for both cars and light-duty trucks in 2023. In addition, the parameter responsible for the sensitivity of sales shares to ownership costs is fixed such that in 2023 the elasticity of demand with respect to ownership cost is -2.5 as in Cole et al. (2023). The parameters responsible for the sensitivity to the stock of charging ports is the average value of the parameters used by the Congressional Budget Office (CBO) (2023). The evolving taste parameter is calibrated by running the model forward, which incorporates our supply of charging ports model, and was chosen such that in 2035, the total sales shares of ZEVs match the RIAS baseline scenario of 51.8 per cent.

Supply of charging ports

PBO's model of the supply of charging ports follows Cole et al. (2023). It is based on a static entry/exit model where firms make the decision to either build or not a charging port. If a firm builds a charging port in a given year, it receives a discounted stream of profits that are a function of the present and future stock of ZEVs, but it also must pay a fixed cost of building the charging port. In a free-entry equilibrium, firms are indifferent between building a port this year or the next, which implies that the profit in the current year (which itself is a function of the current stock of EVs) is equal to the discounted differential in costs of building a charging port today versus next year.[10] This relationship between the stock of ZEVs and the cost of building charging ports is used to determine the total stock of charging ports in a given year in the model.

The supply of charging ports model uses both parameters taken from the literature as well as other parameters calibrated such that the model matches the observed stock of L2 and L3/DCFC charging ports in 2023. The main parameter for the elasticity of the supply of charging ports with respect to the stock of EVs for L2 chargers is chosen to be 0.8.[11] The elasticity parameter for the supply of charging ports with respect to the stock of EVs for L3/DCFC chargers is set to 0.65 as in CBO (2023).[12] As in Cole et al. (2023), the fixed cost of building a charging port declines each year at a decreasing rate and is assumed to reach 50 per cent of the 2023 cost in the long run. The cost is assumed to decrease by roughly 3 per cent in the first year and about 2.4 per cent in 2030.

Further details on the model's specification can be found in Appendix B.

Model inputs

Model data inputs were constructed using historical data and projections for vehicle and charger stocks, sales, prices and operating costs, as well as relevant taxes and subsidies. PBO combined data inputs from Transport Canada, Environment and Climate Change Canada, the International Council for Clean Transportation (ICCT), and CBO (2023) to construct vehicle quantity and price series which are specific to the Canadian market.

Ownership costs

PBO estimates the ownership costs of ICE, BEVs and PHEVs using the approach of CBO (2023) among others.[13] We combine the vehicle and home charger purchase price, adjusted for taxes and subsidies, along with the current-year value of future operating costs such as energy prices, motor efficiency and maintenance.[14] Appendix A provides more details on the sources underpinning these calculations.

PBO estimates that BEVs are less cost competitive than ICE vehicles on a purchase price basis (in the absence of subsidies)[15] but have significantly lower annual operating costs (Table 2-1). Importantly, our analysis complements existing literature by providing estimates of ownership costs that account for Canada-specific policies such as government incentives and the federal fuel charge.

Table 2-1

2022 Canadian dollars

Vehicle prices and ownership cost in the baseline scenario

	2022		2026		2030	
Cars	BEV	ICE	BEV	ICE	BEV	ICE
Purchase price	56,850	46,220	61,520	54,800	65,140	61,610
Incentives	7,425	-	480	-	-	-
Annual operating cost	1,683	4,158	1,893	3,313	2,105	3,361
Total 8-year discounted ownership cost	**62,920**	**71,680**	**75,850**	**78,910**	**80,510**	**85,460**
SUVs, minivans and trucks	BEV	ICE	BEV	ICE	BEV	ICE
Purchase price	73,400	57,220	75,500	64,010	76,320	69,720
Incentives	7,425	-	480	-	-	-
Annual operating cost	2,737	6,296	3,079	5,069	3,427	5,136
Total 8-year discounted ownership cost	**87,940**	**95,950**	**99,120**	**100,870**	**101,330**	**106,230**

Source:

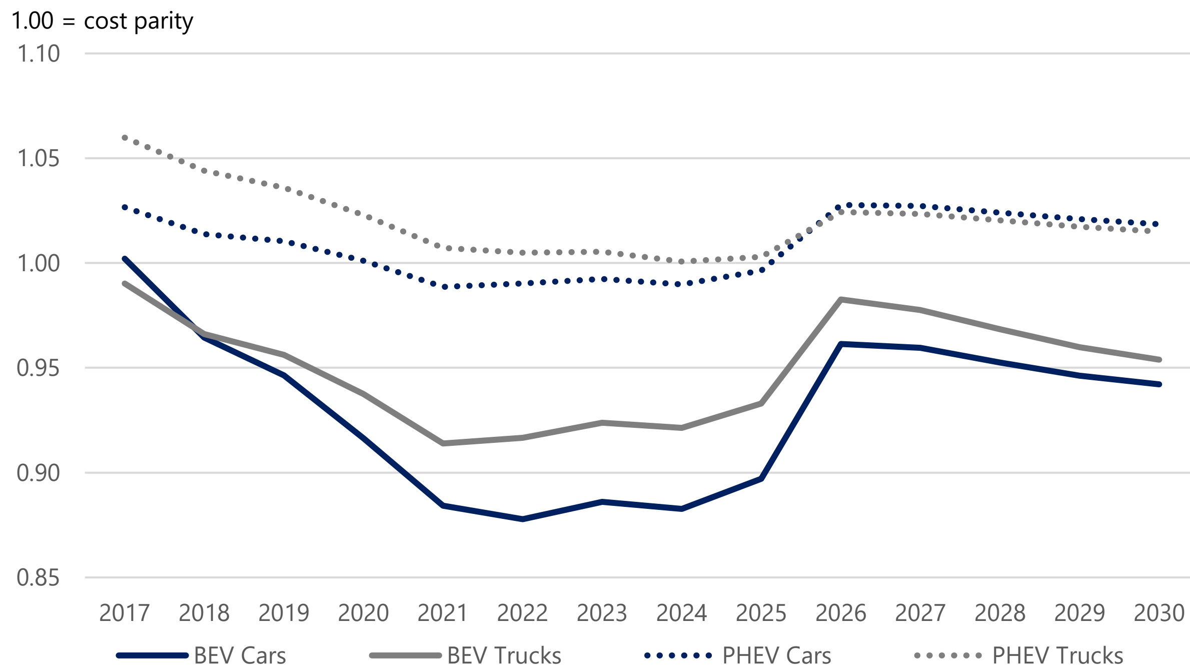
Office of the Parliamentary Budget Officer.

Note:

Purchase prices are based on manufacturing cost differentials, home charging equipment and include sales taxes. They do not include differences in margins. Incentives include federal and provincial ZEV subsidies weighted by national ZEV share. Annual operating costs include energy use, efficiency, gas and electricity prices, kilometres driven and maintenance. They do not include differences in depreciation. Future operating costs are discounted at a 3 per cent rate. ICE costs are based on gasoline-powered vehicles.

We assume that federal incentives will expire at the end of 2025 and provincial incentives wind down by the end of 2026.[16] This contributes to a sharp increase in the (net) purchase price of BEVs and PHEVs in 2026. Nonetheless, we project that BEVs will have lower eight-year total ownership costs than ICE vehicles even as government incentives expire due to significantly lower operating costs (Figure 2-1). PHEVs by contrast are not projected to achieve cost parity before 2030.

Figure 2-1
Relative ownership costs for BEV and PHEVs in the baseline scenario



Source:
Office of the Parliamentary Budget Officer.

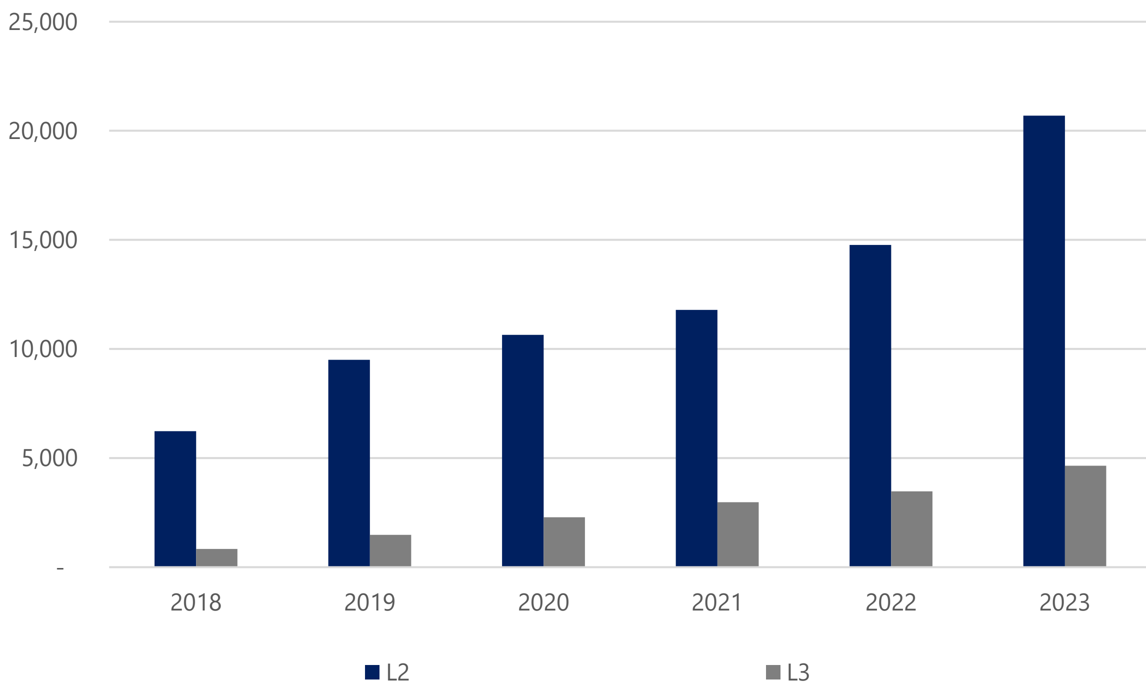
Note:
Cost parity (1.00) implies that the ownership cost of a BEV or PHEV is equal to the ownership cost of the equivalent ICE vehicle. Ownership costs include the purchase price of a vehicle, applicable taxes and incentives, home charging equipment and the present value of 8 years of operating costs discounted at 3 per cent.

Charging infrastructure

We obtained historical data on the number of public charging stations for ZEVs in Canada by type, size and location from the Alternative Fuels Data Center (Figure 2-2).

We estimate that in 2023 there were 20,700 L2 and 4,640 L3 charging ports in Canada's public network. Dunsky (2024) projects that total capital and installation costs will be $15,000 for L2 and $160,000 for L3/DCFC chargers respectively.

Figure 2-2
Public electric charging ports



Source:
Office of the Parliamentary Budget Officer and Alternative Fuels Data Center.

Results

This report aims to provide parliamentarians with an analysis of Canada's automotive market under the EV Availability Standard. We focus on how the relative ownership costs of ZEVs and ICE vehicles and the market provision of charging infrastructure could adjust to achieve a higher ZEV market share under the standard.

We estimate the impact on ownership costs and charging infrastructure over 2026 to 2030. Given that our modelling assumptions are grounded in current market trends, technological projections and account for few behavioural changes, our approach would face limitations beyond this horizon.

Estimated cost adjustment

There are several ways that market conditions could evolve to meet the 60 per cent ZEV sales target by 2030, from a 30 per cent market share under the baseline scenario.[17] These include faster changes in consumer preferences, unexpected technological advances, policy measures and price adjustments by auto manufacturers.

Our modelling assumes that preferences, technology[18] and policies remain unchanged from a baseline scenario without the standard. Our analysis assumes that auto manufacturers meet the sales targets each year and do not use a compliance flexibility mechanism. We provide an estimate of how much ownership costs alone would need to adjust to meet the ZEV sales targets under the standard. Our modelling is agnostic on how this adjustment occurs. Manufacturers could increase (reduce) the price of ICE (ZEV) cars, governments could enact new subsidies for ZEVs, increase fuel taxes or reduce electricity prices. Future technological advances related to energy efficiency could also reduce ownership costs.

Relative ownership costs

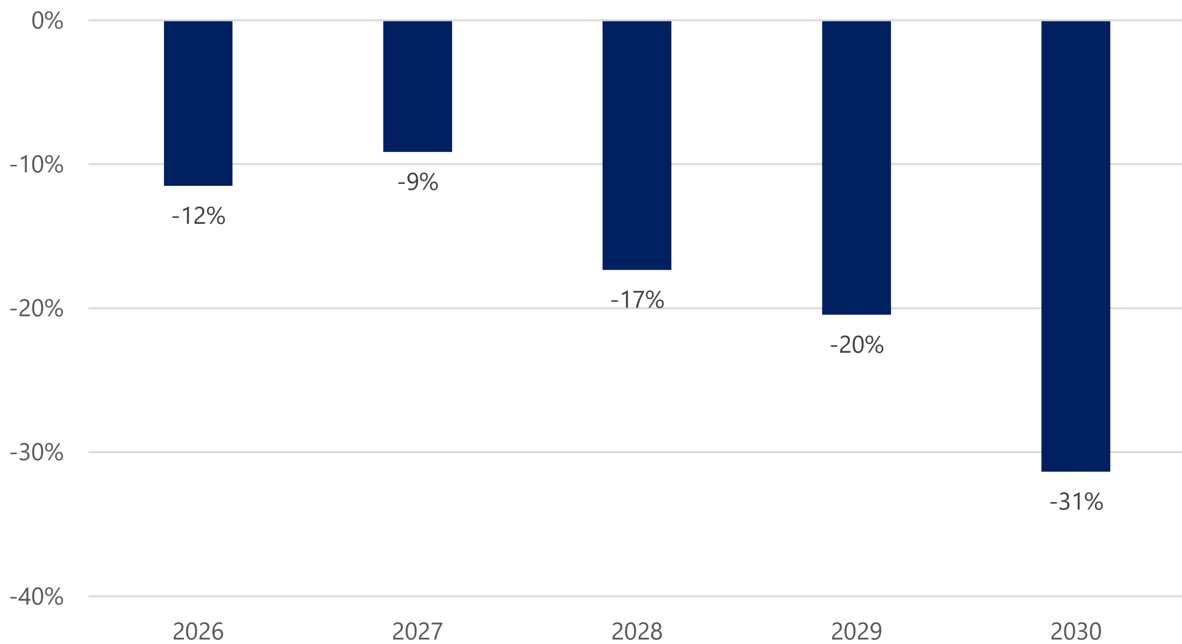
We estimate the total ownership costs of different vehicle types using the purchase price, adjusted for incentives or subsidies, and the projected future costs of operating the vehicle over an eight-year horizon. Operating costs include fuel or electricity, changes in motor efficiency, maintenance and are discounted at the rate of 3 per cent beyond the first year of ownership.

The relative ownership cost of a ZEV is calculated by dividing the total 8-year ownership costs of a ZEV by the total eight-year ownership costs of an ICE vehicle over the same time period. In PBO’s model, the relative ownership cost is an important determinant of vehicle market share and therefore a potentially key adjustment mechanism to achieve market equilibrium for a given sales target.

Assuming that preferences, technology and policies remain unchanged from a baseline scenario without the standard, we estimate that the relative ownership cost of battery-electric vehicles (BEVs) would need to decrease by 31 per cent to meet the ZEV sales target of 60 per cent in 2030 (Figure 3-1). That is, the ownership cost of ZEVs relative to ICE vehicles in 2030 under the standard would be 31 per cent lower compared to the baseline scenario without the standard. For example, under the baseline scenario in 2030, the relative (eight-year) ownership cost of a BEV truck is 0.95 (that is, the ownership cost of a BEV truck is equal to 95 per cent of the ownership cost of an ICE light truck); the 31 per cent reduction required to achieve the sales target would result in a relative ownership cost of a BEV truck of 0.65 (that is, the ownership cost of a BEV truck would be equal to 65 per cent of the ownership cost of an ICE light truck).

Figure 3-1

Change in ownership cost of BEVs relative to ICE vehicles required to meet ZEV sales targets under the EV Availability Standard



Source:

Office of the Parliamentary Budget Officer.

Note:

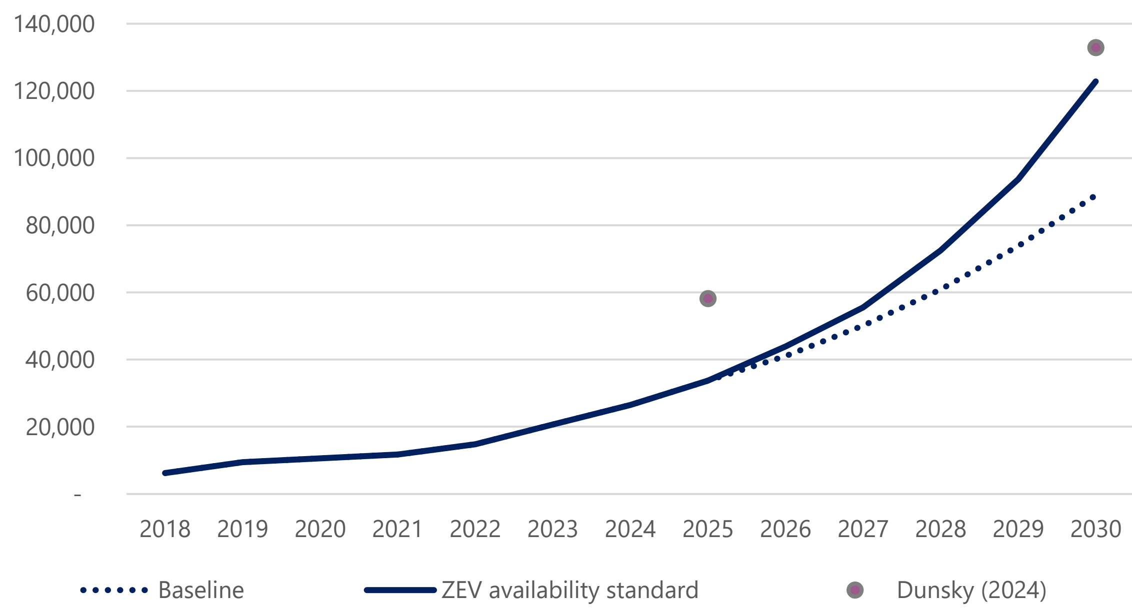
For each year, estimated impacts show the percentage difference between the relative ownership cost of BEVs to ICE vehicles under the standard and the relative ownership cost of BEVs to ICE vehicles in the baseline scenario without the standard. Estimates assume preferences, technology and policies remain unchanged from a baseline scenario without the standard. Relative cost adjustments and increases in chargers alone ensure that ZEV sales targets are met under the standard.

Axsen and Bhardwaj (2022) estimate that an EV standard targeting close to 100 per cent market share by 2035 would increase the price of ICE vehicles by 6.1 per cent and reduce the price of ZEVs by 22 per cent by 2035, relative to a baseline without a standard.

Projections of charging infrastructure

We project that, under the EV Availability Standard, the number of L2 charging ports in the public network will increase from 20,700 in 2023 to 122,810 in 2030 (Figure 3-2) as the private sector invests to meet the demand of new ZEVs. This is 33,900 more L2 public charging ports compared to the baseline scenario, but lower than the 132,900 ports estimated in the Dunsky (2024) needs assessment.[19]

Figure 3-2
Market provision of L2 public charging ports

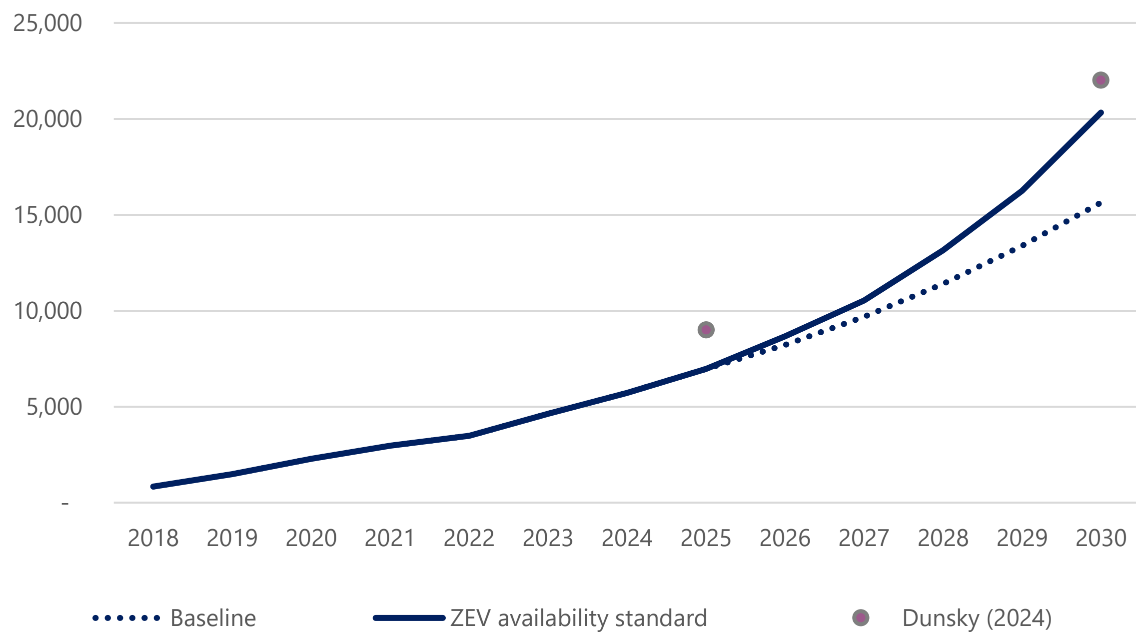


Source:
Office of the Parliamentary Budget Officer, Dunsky (2024).

Note:
We use the estimate for public L2 community charging ports from Dunsky (2024), which excludes private charging stations and workplaces.

Regarding L3 (fast) chargers, we project that, under the EV Availability Standard, the number of ports will increase from 4,640 in 2023 to 20,330 in 2030 (Figure 3-3). This is 4,700 more L3 public ports compared to the baseline scenario, but slightly lower than the 22,000 ports estimated in the Dunsky (2024) needs assessment.

Figure 3-3
Market provision of L3 public charging ports



Source:
Office of the Parliamentary Budget Officer, Dunsky (2024).

Note:
We use the estimate for public L3 community charging ports from Dunsky (2024), which excludes private charging stations and workplaces.

The supply of charging infrastructure is largely demand driven in our model and increases with the total stock of ZEVs. To account for public funding available for charging infrastructure, our modelling assumes a 50 per cent subsidy of project costs based on the ZEV infrastructure program parameters.[20] Our projection of charging ports implies total public support of roughly $2 billion by 2030, which is slightly higher than the $1.8 billion in government funding that has already been announced.[21]

Caveats

PBO chose a parsimonious approach to modelling the demand of ZEVs and supply of charging ports in Canada. Our modelling has limits to the type of questions it can be used to answer as well as potential biases that can result from the modelling choices. An important consideration is that the model relies on the relative ownership costs to allocate the sale share of ZEVs. Furthermore, the model cannot be used to estimate the economic impact of policies on the automobile sector.

The model does not incorporate supply-side response from automakers to policies. Hence, automakers' decisions related to prices and quantities sold of ZEVs and ICE vehicles are not modelled, which makes incorporating questions of incidence of subsidies and their overall impact on demand for ZEVs more difficult. In this model, full passthrough of subsidies to purchasers is assumed. In addition, price differentials between ZEVs and ICE vehicles are based on manufacturer cost differentials and do not incorporate other margins.

Another important aspect of the parsimonious nature of the model is that the substitution patterns allowed in the model are limited. In the model, only two classes of vehicle are considered and are modelled in two siloed models, restricting substitution between light-duty trucks and cars. The only choice is between ZEVs and ICE vehicles within a class. In addition, alternative transportation arrangements and their attractiveness are not modelled. Plug-in hybrid vehicles (PHEV) are not explicitly modelled as a distinctive option (although the 2023 stock and market shares of electric cars include the stock and sales of plug-in hybrid cars).

The PBO model considers the demand for ZEVs and the supply of chargers at the national level. Ownership costs for each vehicle type are constructed as a national average of different prices. The model is then calibrated so that it attains national targets in the year 2023. Provincial sales mandates are integrated in the calibration but are not modelled specifically. The model does not produce province-specific outputs.

Consumer taste heterogeneity is limited to idiosyncratic taste shocks in our model. More refined heterogeneous consumer types as found in Axsen and Bhardwaj et al. (2022), for example, early adopters, are not considered. In the present model, the evolving taste parameter is calibrated to match the ZEV market share in 2035 under the RIAS baseline scenario. Individuals' tastes may evolve differently in response to the change in relative ownership costs required to meet the ZEV sales targets under the standard or in direct response to the ZEV sales targets themselves.

Appendix A: Model assumptions

Table A-1

Key model inputs and assumptions

Variable	2023 value	Notes
Fuel economy (cars)	7.3 litres/100km	ECCC
Fuel economy (light trucks)	9.3 litres/100km	ECCC
Gas price (excl. taxes)	$1.10/litre	Grows by 0.2% annually (ECCC)
Electricity price (excl. taxes)	$0.11/kWh	Residential, grows by 3% annually (ECCC)
Maintenance (ICE cars)	$0.10 /km	CBO (2023)
Maintenance (ICE light trucks)	$0.15 /km	CBO (2023)
Maintenance (BEV cars)	$0.042 /km	CBO (2023)
Maintenance (BEV light trucks)	$0.063 /km	CBO (2023)
Annual vehicle kilometres (cars)	15,894	Transport Canada (2016)
Annual vehicle kilometres (light trucks)	17,119	Average of SUVs, minivans and pick up trucks
L2 charger cost per port	$15,000	Dunsky (2024), based on 2025 estimated costs
L3 charger cost per port	$160,000	Dunsky (2024), based on 2025 estimated costs
Consumer discount rate	3%	CBO (2023)
Charger interest rate	8%	CBO (2023)
Vehicle price growth	3%	Historical average from 2011 to 2019
Charger price growth	-3% in first year	Cole et. al. (2023), $\zeta = -0.06$
Consumer foresight	8-year horizon	CBO (2023)
EV own price elasticity	-2.5	CBO (2023), mean value
Charger network size elasticity	0.4	CBO (2023), mean value
Charger own cost elasticity	0.65	CBO (2023), mean value
L2 EV fleet size elasticity	0.8	PBO
L3 EV fleet size elasticity	0.65	CBO (2023), mean value

Source:

Office of the Parliamentary Budget Officer.

Note:

All dollar values are in $2022 CAD.

Appendix B: Demand for EVs and supply of charging ports model

Electric Vehicle Demand

The PBO models EV demand using a logit discrete choice model. A consumer indexed by i chooses between and EV and ICE vehicle so that their utility is maximized. The utility of consumer i from purchasing an EV of class j in year t relative to an ICE vehicle is:

$$u_{ijt} = \alpha_j + \beta_p \ln(P_{jt}) + \beta_{L2} \ln(N_t^{L2}) + \beta_{L3} \ln(N_t^{L3}) + \psi_t + \epsilon_{ijt} = V_{jt} + \epsilon_{ijt},$$

where P_{jt} is the ratio of the ownership cost of EV relative to the ICE ownership cost in year t, N_t^{L2} and N_t^{L3} are the stock of L2 and L3 charging ports in year t, ψ_t is the evolving taste parameter and ϵ_{ijt} is an idiosyncratic taste shock that is distributed independently, identically extreme value. By normalizing the utility of owning an ICE vehicle to 0, the EV sales share for vehicle class j in year t is

$$s_{jt} = \frac{\exp(V_{jt})}{1 + \exp(V_{jt})}.$$

With this particular specification, the elasticity of demand with respect to the relative ownership cost P_{jt} is $\eta_P = (1 - s_{jt})\beta_P$ and the elasticity of demand with respect to the stock of level K of charging ports is $\eta_{Lk} = (1 - s_{jt})\beta_{Lk}$.

Finally, the evolving taste parameter in year t evolves in the following way:

$$\psi_t = \mu + \psi_{t-1},$$

with $\psi_0 = 0$.[22]

The stock of EVs of class j in year t evolves in the following way:

$$Q_{jt} = M_{jt} s_{jt} + (1 - \theta_j) Q_{jt-1},$$

where M_{jt} is the forecasted number of vehicles of class j sold in year t, which is exogenous to the model and θ is the vehicle scrappage rate of EVs. The total stock of EVs Q_t in a year, is thus the sum of the stock of cars and light-duty trucks.

Supply of charging ports

The free-entry equilibrium equates the profits in year t to the cost differential in charging investments between year t and $t+1$, that is,

$$\pi_t^{Lk}\left(N_t^{Lk}, Q_t\right) = C_t^{Lk} - \frac{1}{1+\rho} C_{t-1}^{Lk},$$

where π_t^{Lk} is the profit in year t earned by operating a charging station port of level k, C_t^{Lk} is the fixed cost of building a charging port in year t and ρ is the discount rate. The equation determining the number of charging ports of level k in year t is obtained by using the following functional form for profits:

$$\pi_t^{Lk}\left(N_t^{Lk}, Q_t\right) = \left(\frac{\exp(\kappa_{Lk})}{N_t^{Lk}}\right)^{1/\gamma} \cdot Q_t,$$

Taking the log of the free-entry condition on both sides and rearranging gives the following equation for the number of charging ports of level k in year t:

$$\ln\left(N_t^{Lk}\right) = \kappa_{Lk} + \gamma \ln(Q_t) - \gamma \ln\left(\tilde{C}_t^{Lk}\right),$$

where $\tilde{C}_t^{Lk} = C_t^{Lk} - \frac{1}{1+\rho} C_{t-1}^{Lk}$.

The model assumes that the fixed cost of building charging ports evolves according to the following equation:

$$C_t^{Lk} = C_0^{Lk} \cdot (0.5 + 0.5 \exp(\zeta \cdot t)).$$

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Notes

[1] Canada's Electric Vehicle Availability Standard.

[2] Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations.

[3] Companies are limited in the degree to which they can use compliance credits to meet their ZEV fleet targets.

[4] Zero Emission Vehicle Infrastructure Program.

[5] A Healthy Environment and a Healthy Economy.

[6] EPA

[7] Cole et al. (2023) present a discrete choice simulation model for the joint estimation of EV demand market share and the provision of public charging infrastructure. David Austin of the Congressional Budget Office (CBO) builds on the work of Cole et al. (2023), using a similar model to analyze the market impact of recent U.S. government subsidies and tax credits for ZEVs and related infrastructure (CBO (2023)). Model parameters and pricing inputs are calibrated based on recent work of Li et al. (2017), Nicholas (2019), Springel (2021) among others.

[8] Light-duty trucks include SUVs, vans and trucks. These comprise the majority of light-duty vehicles.

[9] The taste parameter is modelled to be identical for both classes of vehicles.

[10] See Zhou and Li (2018) for the entry/exit model and its derivation.

[11] This elasticity is set below 1, which is consistent with the empirical literature. However, we adopt a higher elasticity than the one used in both Cole et al. (2023) and Austin (2023) to ensure a profile over time that is more in line with experts and reports consulted in constructing our model.

[12] The value chosen in this report is the mean value of the parameter used in Austin (2023).

[13] The International Council for Clean Transportation (ICCT) has produced numerous studies on the market for electric vehicles and charging infrastructure. Nicholas and Lutsey (2019) estimate that most BEV cars, crossovers and SUVs will be cost competitive with ICE vehicles on a total ownership basis from 2022 to 2028. Slowik et al. (2022) present similar findings and note that plug-in hybrids (PHEVs) will be slower to achieve vehicle price parity than BEVs.

[14] We used Canadian data, primarily from government sources, as much as possible. Where necessary, we filled gaps using data and assumptions from U.S. literature.

[15] PBO's calculates the difference in purchase price between BEV and ICE vehicles based on the projected manufacturing cost differential from ECCC's RIAS. Other studies have estimated that BEVs will achieve purchase price parity earlier than 2030 (Lutsey & Nicholas 2019).

[16] This is consistent with current program timelines. Our analysis does not include the recently announced EV purchase rebate program by the government of Manitoba.

[17] PBO's baseline scenario is calibrated to obtain a ZEV market share of 51.8 per cent in 2035, consistent with the RIAS baseline scenario. However, our baseline path for the ZEV market share differs somewhat from the RIAS baseline in the years leading to 2035. For example, our baseline ZEV market share is 30 per cent in 2030 compared to 36 per cent in the RIAS.

[18] This refers to technology that is exogenous to ownership costs such as hedonic pricing, battery range or performance improvements.

[19] We compare our L2 charger projection with the estimate of the amount of community L2 charging ports required by 2030 in Dunsky (2024). We do not include private or workplace charging stations in our modelling. Although some workplace charging stations allow for public access, we estimate that they comprised only 2 per cent of charging ports in 2023.

[20] Our model does not incorporate direct government spending by provinces or the Canada Infrastructure Bank on charging infrastructure. We estimate that over $1.8 billion in government funding has been committed to build public EV charging infrastructure. We do not cap the subsidy in our model at the current funding envelope or allow it to expire in 2027 as currently indicated.

[21] This amount does not include potential funding from the Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative or the Smart Renewables and Electrification Pathways Program. Some of this funding may not take the form of a subsidy of a share of private investment costs (as assumed in our model). For example, governments may directly fund the creation of charging infrastructure.

[22] Note that this is equal to having $\psi_t = \mu t$.

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