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Taking Charge

How Ontario can create jobs and benefits in the electric vehicle economy

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Contents

List of Figures

List of Tables

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Executive summary

With 90% of the largest global automakers committing to increase electric vehicle (EV) sales and offers, Ontario will soon see the ripple effects of over $4 billion in recent investments into EV production capacity in Oakville, Windsor, and Ingersoll. The province's EV supply chain is also positioned to grow due to significant production of cobalt, nickel, and copper, as well as aluminum processing and a nascent battery manufacturing and recycling sector.

These latest investments by government and automakers will undoubtedly help ignite Ontario's EV market, and will potentially bring the province closer to the Canadian average EV market share of 3.5% (from its 2020 provincial share of 1.75%).

But much more is needed beyond seed funding if Ontario is to be economically competitive with the United States, Europe, and China, each of which have secured sizeable shares of the EV manufacturing supply chain over the past 10 years. In 2020, governments around the world invested considerable financial resources in electric vehicles, dedicating US$14 billion in financial incentives alone.

The first to enter the EV market are poised to benefit the most. Analysis by the International Council on Clean Transportation shows that approximately 80% of electric vehicles produced are sold in the same region where they are manufactured. These jurisdictions are ready to benefit from the economic activity that comes from EV production and consumer spending on vehicle purchases and associated services and infrastructure. As a result of the coronavirus pandemic, the impetus for EV supply chain localization increased among auto-sector stakeholders as investors worried about supply-chain sustainability and a reliance on China for battery manufacturing. Currently, most battery production and EV sales occur outside of Canada, predominantly in China, Europe, the U.S., Japan, and South Korea.

Nevertheless, there remains significant opportunity for Ontario to continue to capitalize on the economic growth potential in EV development and production. At the global level, automakers have been projected to invest around $300 billion over the next five to 10 years. But what are the potential benefits of a growing EV sector for Ontarians and businesses?

In this paper, we present the economic and job-creation potential of accelerating electrification in Ontario's light-duty vehicle market, from manufacturing to

maintenance to the development and installation of charging-infrastructure. Our economic analysis considers the Government of Canada's announcement in June 2021 of a mandatory target for all new light-duty car and passenger-truck sales to be zero-emission by 2035. If Ontario expands the light-duty electric vehicle market to 100% of total new light-duty vehicle sales by 2035, the potential direct, indirect and induced economic benefits associated with EV manufacturing are estimated to reach more than 24,200 jobs and over $3.4 billion in gross domestic product by 2035. The additional direct, indirect and induced economic and job benefits associated with EV charging are estimated to reach 23,100 or more jobs and approximately $2.7 billion in GDP. This analysis does not consider the economic growth potential of a low-carbon hydrogen and fuel-cell sector, nor does it examine the potential effects of growing the electric medium- and heavy-duty vehicle sector in Ontario.

Ontario is well positioned to increase EV supply, and can capitalize on this by developing a comprehensive framework for electrification that includes policies and strategies for direct investment and for attracting private-sector capital to build supply and infrastructure and to accelerate the mass adoption of electric vehicles. In doing so, Ontarians and businesses can realize even greater economic benefits as well as boost job creation both in the near and long term.

Leaders in EV production, such as China, Japan, South Korea, the United States, and Europe, deploy a mix of policies and incentives to accelerate supply and demand. We recommend the following actions:

1. ***Establish an Ontario Transportation Electrification Council*** to lay out a long-term, co-ordinated and holistic electrification strategy for the province. This strategy should include policies for securing jobs and economic benefits from a growing EV market, with co-operation from departments responsible for transportation, economic development, energy, natural resources, and environment as well as labour, training, and skills development.
2. ***Build consumer awareness*** about the potential operational savings from driving EVs over time to address consumer concerns about the higher purchase cost of an EV.
3. ***Mobilize private capital in ZEV infrastructure.*** Ontario should issue a green bond to finance infrastructure for electric vehicles.
4. ***Increase widespread availability of EV-charging infrastructure.*** Amend the Ontario Building Code to require new residential buildings to be EV-ready.

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5.! ***Fill gaps in public charging station availability*** to address range anxiety of EV drivers. Invest in public charging stations, including Level 2 chargers and DC fast chargers.

6.! ***Help Ontarians save on electric vehicle and private charging purchases*** by introducing a medium-term financial incentive program to reduce the difference in purchase price between electric vehicles and comparable internal combustion engine vehicles. Subsidies can be available to both businesses and consumers, with program design considerations to increase EV accessibility to lower-income households and small- and medium-sized enterprises. A financial incentive program should also be created to support and encourage the purchase of private EV chargers, with funding streams for homes, workplaces, and fleets.

Through decisive and targeted action, Ontario can take charge, reimagine its automotive industry, and be a competitive player in a rapidly shifting global automotive sector that is trending towards electrification.

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1.! Introduction

Electric vehicles have exploded in consumer popularity in recent years. EVs produce significantly lower life cycle greenhouse gas emissions than traditional internal combustion engine (ICE) vehicles[1] and, in general, do not release smog-forming pollutants, which impact human health.[2]

What is an electric vehicle?

An electric vehicle is a vehicle with the potential to produce **zero tailpipe emissions.** This includes **battery electric vehicles (BEVs)**, which use battery packs that contain electric energy to power a motor;[3] **plug-in hybrid electric vehicles (PHEVs)**, which use batteries to power a motor as well as diesel or gasoline to power a separate propulsion source such as an internal combustion engine (ICE);[4] and **fuel-cell electric vehicles (FCEVs)**, which are powered by hydrogen fuel cells that use hydrogen (a colorless and tasteless substance and the universe's most abundant element) to produce electricity.[5,6,7]

A growing number of consumers are choosing to purchase electric vehicles. Between 2014 and 2020 the global stock of electric cars increased from under one million to more

[1] International Energy Agency, "Comparative life-cycle greenhouse gas emissions over ten year lifetime of an average mid-size car by powertrain, 2018." https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-over-ten-year-lifetime-of-an-average-mid-size-car-by-powertrain-2018

[2] United States Environmental Protection Agency, "Light Duty Vehicle Emissions". https://www.epa.gov/greenvehicles/light-duty-vehicle-emissions

[3] Alternative Fuels Data Center, "All-Electric Vehicles." https://afdc.energy.gov/vehicles/electric_basics_ev.html

[4] Alternative Fuels Data Center, "Plug-In Hybrid Electric Vehicles." https://afdc.energy.gov/vehicles/electric_basics_phev.html

[5] Alternative Fuels Data Center, "Fuel Cell Electric Vehicles." https://afdc.energy.gov/vehicles/fuel_cell.html

[6] This is synonymous with Transport Canada's definition of 'zero-emission vehicles'. Source: Transport Canada, "Zero-emission vehicles." https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles

[7] LiveScience, "Facts About Hydrogen." https://www.livescience.com/28466-hydrogen.html

Office of Energy Efficiency & Renewable Energy, "Fuel Cells." https://www.energy.gov/eere/fuelcells/fuel-cells

than 10 million.[8,9] Similar growth has occurred in Canada: electric vehicle sales increased by more than 900% during the same period.[10] In 2019, over 50% of Canadians were strongly considering going electric in the purchase of their next car, motivated by concerns about air pollution, the climate crisis, and fuel costs.[11] This increased to nearly two-thirds by late 2020.[12] In Ontario, electric vehicle sales increased from under 250 vehicles in 2011 to more than 10,000 in 2020.[13]

In Europe, Asia, and North America, government policies targeted at tackling the health and global-warming implications of transport-sector emissions have been critical to the proliferation of EVs.[14] But there are also significant economic and job creation opportunities in this transition to a new transportation and energy system. As of 2021, more than 20 countries had implemented ICE car bans or established 100% electrification targets.[15] Jurisdictions have also established mandates for the sale of EVs. In 2020, governments world-wide collectively spent US$14 billion on financial incentives to promote the purchase of electric cars.[16] Eighteen of the 20 largest original equipment manufacturers have announced commitments to increase EV sales and offers.[17] General Motors, for example, pledged to sell only electric vehicles as of 2035.[18]

[8] International Energy Agency, *Global EV Outlook 2020* (2020), 40. https://www.iea.org/reports/global-ev-outlook-2020

[9] International Energy Agency, "Global EV Data Explorer." https://www.iea.org/articles/global-ev-data-explorer

[10] Statistics Canada, "New motor vehicle registrations," spreadsheet, June 2021. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101

[11] According to an Abacus Data and Clean Energy Canada survey released in early 2019, 54% of respondents chose "Certain to buy E", "Very Likely E" or "Inclined E But Would Compare" when asked "If buying a car what would you do?" Source: Clean Energy Canada, "Poll: Canadians see electric vehicles becoming mainstream, soon," media release, March 2019. https://cleanenergycanada.org/poll-canadians-see-electric-vehicles-becoming-mainstream-soon/

[12] Clean Energy Canada, "Poll: Electric vehicles are picking up speed in public support," media release, December 2020. https://cleanenergycanada.org/poll-electric-vehicles-are-picking-up-speed-in-public-support/

[13] Statistics Canada, "New motor vehicle registrations," spreadsheet, June 2021.

[14] *Global EV Outlook 2020*, 15, 86.

[15] International Energy Agency, *Global EV Outlook 2021: Accelerating ambitions despite the pandemic* (2021), 47. https://www.iea.org/reports/global-ev-outlook-2021

[16] *Global EV Outlook 2021,* 21.

[17] As of April 2021. Source: *Global EV Outlook 2021,* 25.

[18] General Motors, "General Motors, the Largest U.S. Automaker, Plans to be Carbon Neutral by 2040," media release, January 2021. https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html

Notable economic benefits can be realized, not only in auto manufacturing and assembly, but also in installation of electric vehicle charging and associated operational services, clean-energy generation, and battery material development and recycling. The International Energy Agency forecasts annual global demand for EV battery capacity to increase from 0.17 terawatt-hours to 1.5 in 2030[19] and for the demand for EV battery materials — including cobalt, lithium, manganese, and nickel — to increase between 700% and 1,300% in the same timeframe.[20]

The Government of Canada recently made a number of commitments aimed at unlocking the economic benefits of an electric vehicle transition. The 2020 *A Healthy Environment and a Healthy Economy* plan proposes to support the development of the battery supply chain and to attract investments in the manufacturing of zero-emissions transportation products.[21] In February 2021, Canada and the United States announced a "Roadmap for a Renewed U.S. — Canada Partnership" and called for collaboration "to build the necessary supply chains to make Canada and the United States global leaders in all aspects of battery development and production."[22] More recently, in June 2021, the Government of Canada announced a new target for 100% of new light-duty car and passenger truck sales to be zero-emission as of 2035.[23]

As a way of advancing the province's strategy for the auto industry, *Driving Prosperity,*[24] the Ontario government made a financial commitment to support automaker investment in EV manufacturing, directing nearly $300 million toward the retooling of Ford of Canada's Oakville Assembly Complex "into a global hub for battery electric vehicle production,"[25] and included an investment of over $50 million in the 2021

[19] *Global EV Outlook 2020,* 177.

[20] *Global EV Outlook 2020,* 179.

[21] Environment and Climate Change Canada, *A Healthy Environment and a Healthy Economy* (2020), 44. https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf

[22] Office of the Prime Minister of Canada, "Roadmap for a Renewed U.S.-Canada Partnership." https://pm.gc.ca/en/news/statements/2021/02/23/roadmap-renewed-us-canada-partnership

[23] Government of Canada, "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada," media release, June 29, 2021. https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html

[24] Province of Ontario, *Driving Prosperity: The Future of Ontario's Automotive Sector* (2019), 13. https://files.ontario.ca/auto-strategy-en-final.pdf

[25] Government of Ontario, "Historic Ford Canada Investment Transforming Ontario into Global Electric Vehicle Manufacturing Hub," media release, October 8, 2020. https://news.ontario.ca/en/release/58736/historic-fordcanada-investment-transforming-ontario-into-global-electric-vehicle-manufacturing-hub

budget for an Ontario Vehicle Innovation Network to increase the development of technologies such as EVs.[26,27]

While these are good first steps, additional actions must be taken in order to grow Ontario's EV market beyond its current market share of 1.75%, and to be more in line with the Canadian average (3.5%) and with other leading jurisdictions including California (8%)[28], Iceland (52%) and Norway (75%).[29]

The purpose of this paper is to demonstrate that growing Ontario's EV market can result in significant direct, indirect and induced economic benefits and job creation for Ontarians in areas that include electric-vehicle manufacturing, the associated battery supply chain, EV infrastructure, and EV operations.

[26] Province of Ontario, *Ontario's Action Plan: Protecting People's Health and Our Economy* (2021), 114. https://budget.ontario.ca/2021/pdf/2021-ontario-budget-en.pdf

[27] Robert Benzie, "Doug Ford reverses opposition to electric vehicles, says he's 'all in' with investment in Oakville plant," *Toronto Star*, October 8, 2020. https://www.thestar.com/politics/provincial/2020/10/08/doug-ford-teams-up-with-justin-trudeau-to-boost-electric-vehicle-production-in-ontario.html

[28] InsideEVs, "California: Plug-Ins Capture over 8% of the Market in 2020." https://insideevs.com/news/486199/california-plugin-electric-car-sales-q4-2020/

[29] International Energy Agency, "Global EV Data Explorer." https://www.iea.org/articles/global-ev-data-explorer

"New motor vehicle registrations."

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2.! State of play

2.1! Ontario's auto sector is in decline

Ontario's auto sector is an important driver of the province's economy and accounts for 100% of Canada's light-vehicle production.[30]

As of December 2020, the province was home to five original equipment manufacturers: Stellantis, with locations in Brampton and Windsor; Ford of Canada, based in Oakville; General Motors in Ingersoll; Honda Canada in Alliston; and Toyota, located in Cambridge and Woodstock.[31]

Ontario's auto sector has been estimated to account for over 100,000 direct jobs, thousands of additional spin-off jobs, and a supply chain that includes more than 700 parts firms and over 500 tool, die and mold makers. In 2017, the province ranked as the number one auto-producing area in North America, with an output of nearly 2.2 million vehicles.[32]

The 2017 ranking, however, masks significant declines in Ontario's auto sector. Over the past two decades, nearly 47,000 jobs have been lost and auto sector GDP has declined more than 30% (Figure 1). Over the same period, Canada's motor vehicle production dropped from over 2.5 million vehicles (4.5% global share) to about 1.4 million (1.8% of global share),[33] with a net loss of five vehicle-assembly plants.[34]

[30] Industry, Science and Economic Development Canada, *Invest in Canada: Canada's Competitive Advantages: Automotive Sector* (2018), 3. https://www.international.gc.ca/investors-investisseurs/assets/pdfs/download/vp-automotive.pdf

[31] Innovation, Science and Economic Development Canada, "Canadian automotive industry." https://www.ic.gc.ca/eic/site/auto-auto.nsf/eng/home

[32] *Driving Prosperity*, 5.

[33] International Organization of Motor Vehicle Manufacturers, "2020 Production Statistics." https://www.oica.net/category/production-statistics/2020-statistics/

International Organization of Motor Vehicle Manufacturers, "2001 Production Statistics." https://www.oica.net/category/production-statistics/2001-statistics/

[34] Ben Sharpe, Nic Lutsey, Cedric Smith and Carolyn Kim, *Power Play: Canada's role in the electric vehicle transition* (Pembina Institute and ICCT, 2020), 33. https://www.pembina.org/pub/power-play

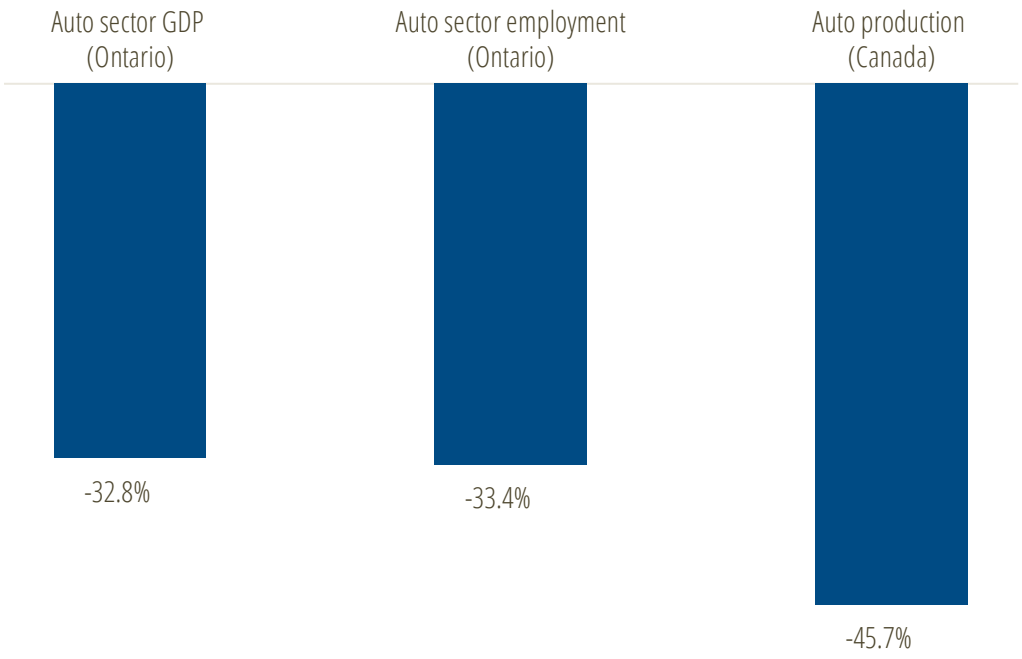

Figure 1. Ontario's declining auto sector, 2001-2020

Data sources: OICA and Statistics Canada[35]

2.2! Ontario's EV supply chain is well positioned for growth

Until recently, Ontario's electric vehicle production lagged behind international competitors. In 2018, the Chrysler Pacifica plug-in hybrid, produced in Brampton and Windsor, was the only light-duty electric vehicle manufactured in Canada, and represented approximately 0.4% of Canada's production.[36] This level of EV production was significantly below that of international competitors with similar levels of total vehicle production, including the United Kingdom (3.2%) and France (2.6%) as well as

[35] Statistics for Ontario's auto sector are derived through the summation of NAICS codes 3361: Motor vehicle manufacturing, 3362: Motor vehicle body and trailer manufacturing and 3363: Motor vehicle parts manufacturing. Data is for changes from 2001 to 2020. Sources: Statistics Canada, "Gross domestic product (GDP) at basic prices, by industry, provinces and territories (x 1,000,000)," spreadsheet, June 2021. https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3610040201; Statistics Canada, "Employment by industry, annual," spreadsheet, June 2021. https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1410020201

"2020 Production Statistics."

"2001 Production Statistics."

[36] *Power Play: Canada's role in the electric vehicle transition,* 4, 29.

leading vehicle manufacturing jurisdictions such as the U.S. (3.1%) and China (4.2%). It was about 80% below the global average of 2.3%.[37]

What makes up the EV supply chain?

Electric vehicle manufacturing is the most visible part of a broader supply chain, which includes the **exploration for, and mining of, minerals**, the **processing of minerals**, the **manufacturing of EV components** — particularly battery components — and the **re-use and recycling of EV components.**[38] Increased electric vehicle manufacturing in Ontario can provide benefits across a wide array of industries.

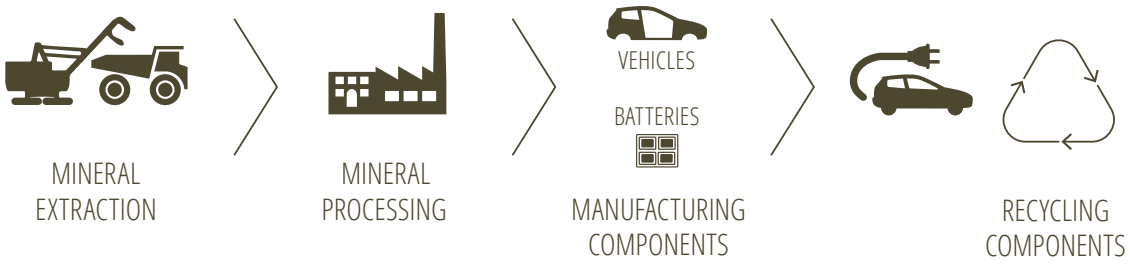

Figure 2. Electric vehicle supply chain

Production facilities

A 2020 report by the International Council on Clean Transportation and the Pembina Institute concluded that Canada must quickly accelerate development of its electric vehicle production and supply chain so as not to lose an important sector of its economy. There are indications that Canada is missing out on automaker EV investments, with the report noting that Canada was not explicitly identified as one of the markets that would see the $300 billion worth of planned automaker EV investments worldwide tallied at the time of the report.[39,40] Recently, however, there have been positive developments, as automakers have announced investments in electric-vehicle production in the province.

[37] *Power Play: Canada's role in the electric vehicle transition*, 4-5.

[38] *A Healthy Environment and a Healthy Economy,* 43.

[39] *Power Play: Canada's role in the electric vehicle transition,* 28, 33.

[40] Paul Lienert, Norihiko Shirouzu and Edward Taylor, "Exclusive: VW, China spearhead $300 billion global drive to electrify cars," *Reuters*, January 10, 2019. https://www.reuters.com/article/us-autoshow-detroit-electric-exclusive-idUSKCN1P40G6

In September 2020, an investment of $1.8 billion to retool Ford of Canada's Oakville Assembly Complex to produce battery electric vehicles (BEV) was announced.[41] This was supported by $590 million from the provincial and federal governments.[42] It is expected that production will begin in 2025[43] and that the initiative will "help secure 5,400 well-paying jobs across Ford's production workforce in Canada."[44]

In October 2020, Unifor members ratified a $1.5-billion agreement with Fiat Chrysler to produce BEVs and plug-in hybrid electric vehicles at the Windsor Assembly Plant.[45] It is expected that this agreement will help secure 2,000 jobs in Windsor[46] with, at minimum, one new model as of 2025.[47] While not a direct support for EV manufacturing, the Ontario government provided $210,000 to assist workers recently laid off by Fiat Chrysler. This has been framed as a bridge to future production at the plant.[48]

Most recently, in January 2021, Unifor members ratified an agreement with General Motors for $1 billion to produce electric delivery vans at the Ingersoll plant. The Ingersoll plant currently employs nearly 2,000 Unifor Local 88 workers.[49] According to General Motors, this will represent the first large-scale electric commercial vehicle production in Canada.[50]

[41] "Historic Ford Canada Investment Transforming Ontario into Global Electric Vehicle Manufacturing Hub."

[42] Unifor, "Unifor applauds federal and provincial support for electric vehicle production," media release, October 8, 2020. https://www.unifor.org/en/whats-new/press-room/unifor-applauds-federal-and-provincial-support-electric-vehicle-production

[43] Ford Authority, "Unifor President Shares Timeline for EV Retooling at Ford Oakville Assembly Plant." https://fordauthority.com/2020/09/unifor-president-shares-timeline-for-ev-retooling-at-ford-oakville-assembly-plant/

[44] Office of the Prime Minister of Canada, "New commitment to battery-electric vehicle manufacturing in Ontario," media release, October 8, 2020. https://pm.gc.ca/en/news/news-releases/2020/10/08/new-commitment-battery-electric-vehicle-manufacturing-ontario

[45] Unifor, "Deal with Fiat Chrysler secures $1.5 billion electric vehicle investment," media release, October 15, 2020. https://www.unifor.org/en/whats-new/press-room/deal-fiat-chrysler-secures-15-billion-electric-vehicle-investment

[46] "Unifor members ratify new FCA contract that delivers new jobs and investment."

[47] "Deal with Fiat Chrysler secures $1.5 billion electric vehicle investment."

[48] Unifor, "Ontario Supporting Laid-Off Auto Workers in Windsor," news release, December 18, 2020. https://news.ontario.ca/en/release/59768/ontario-supporting-laid-off-auto-workers-in-windsor-1

[49] Unifor, "Unifor members at CAMI ratify agreement with General Motors," media release, January 18, 2021. https://www.unifor.org/en/whats-new/press-room/unifor-members-cami-ratify-agreement-general-motors

[50] General Motors, "CAMI Assembly." https://plants.gm.com/Facilities/public/ca/en/CAMI/news.html

Electric vehicle metals and minerals

Canada is a key global player when it comes to reserves and production of minerals and metals used in electric vehicles. The country ranks among the top-10 producers of graphite, nickel, cobalt, and aluminum and has one of the largest identified lithium reserves.[51] It also has significant resources and reserves of rare earth elements, estimated to be over 15 million tonnes.[52]

Much of this production is located in Ontario. The province accounts for more than 20% of Canada's cobalt production, over 25% of its copper production, and nearly 40% of its nickel production. While Ontario does not currently produce graphite,[53] it is home to over 40% of Canadian businesses engaged in the extraction of alumina and the production and processing of aluminum.[54,55]

Ontario has existing mining operations for nickel, cobalt, and copper, with underground and concentrator facilities including Nickel Rim South, Strathcona and Kidd Creek.[56]

Mining companies with a presence in Ontario are working with government, original equipment manufacturers, and other stakeholders to help develop a North American EV supply chain. In early 2021, for example, junior miner Canada Nickel Co. Ltd. is reported to have "held talks with U.S. government officials about potentially supplying nickel for electric-car batteries".[57] Just prior, in December 2020, the federal government and Ontario announced investments of $5 million each into First Cobalt Corporation to increase production of battery-grade cobalt sulfate, noting its importance in long-range

[51] Natural Resources Canada, "Minerals and Metals Facts." https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/20507

United States Geological Survey, *Mineral Commodity Summaries 2021* (2021), 21, 51, 99. https://www.usgs.gov/centers/nmic/mineral-commodity-summaries

[52] Natural Resources Canada, "Rare earth element facts." https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/rare-earth-elements-facts/20522

[53] Natural Resources Canada, "Annual Statistics of Mineral Production." https://mmsd.nrcan-rncan.gc.ca/prod-prod/ann-ann-eng.aspx?FileT=2019&Lang=en

[54] ISED, "Summary - Canadian Industry Statistics: Alumina and Aluminum Production and Processing - 3313." https://www.ic.gc.ca/app/scr/app/cis/summary-sommaire/3313

[55] ISED, "Businesses - Canadian Industry Statistics: Alumina and Aluminum Production and Processing - 3313." https://www.ic.gc.ca/app/scr/app/cis/businesses-entreprises/3313

[56] Natural Resources Canada, "The Atlas of Canada - Minerals and Mining." https://atlas.gc.ca/mins/en/index.html

[57] Automotive News Canada, "Canada Nickel held talks with U.S. government on supplying metal for EV batteries," February 8, 2021. https://canada.autonews.com/electric-vehicles/canada-nickel-held-talks-us-government-supplying-metal-ev-batteries?utm_source=dlvr.it&utm_medium=twitter

EV production. It was also noted that the resultant facility would be able to produce 25,000 tonnes annually.[58]

What are the key EV metals and minerals?

Copper, lithium, nickel, cobalt, graphite, aluminum, and rare-earth elements are all essential to the manufacturing of electric vehicles:

Copper is an electric conductor that can help connect batteries to chargers.

Lithium transfers charge within lithium-ion batteries.

Nickel and cobalt are used in battery cathodes.

Graphite is used in battery anodes.[59]

Rare earth elements, including neodymium (Nd), praseodymium (Pr) and dysprosium (Dy) are often used in magnets contained within EV motors. [60]

Aluminum, a non-battery-specific material, is anticipated to be used to a significantly greater extent, on a per-kilogram basis, in EVs than in conventional vehicles.[61]

Electric vehicle batteries

Mississauga-based Electrovaya Inc. manufactures lithium-ion batteries and related systems and products for electric transportation and other purposes.[62] Stromcore, another Mississauga-based firm, specializes in lithium batteries for forklifts.[63] Tesla

[58] FedNor, "Government of Canada and Province of Ontario invest $10 million to establish North America's first cobalt refinery in Northern Ontario," media release, December 16, 2020. https://www.canada.ca/en/fednor/news/2020/12/government-of-canada-and-province-of-ontario-invest-10-million-to-establish-north-americas-first-cobalt-refinery-in-northern-ontario.html

[59] Research Interfaces, "Key Canadian minerals for electric transportation – Fact Sheet." https://researchinterfaces.com/canadian-minerals-for-electric-transportation/

[60] Claudiu Pavel et al., "Role of substitution in mitigating the supply pressure of rare earths in electric road transport applications," *Sustainable Materials and Technologies* 12 (2017). https://doi.org/10.1016/j.susmat.2017.01.003

[61] UBS, *UBS evidence lab electric car teardown: Disruption ahead?* (2017). https://neo.ubs.com/shared/d1ZTxnvF2k/. cited in *Power Play: Canada's role in the electric vehicle transition*, 11.

[62] Electrovaya, "About Us." https://electrovaya.com/company/

[63] Stromcore, "Industry Leading Charging Speeds With Freezer Certified Lithium Batteries to Keep Your Forklifts Productive in the Toughest Environments." https://www.stromcore.com/

purchased York Region-based Hilbar Systems in 2019, indicating the appeal of Ontario's battery sector to global EV players.[64]

Internationally, battery production is concentrated among a small group of companies. The International Council for Clean Transportation (ICCT) has estimated that five companies — CATL, LG Chem, Panasonic, BYD, and Samsung — produced cells for over 200,000 EV battery packs in 2019.[65] Announcements for new and/or expanded facilities as of 2025 are expected to bring nearly 1,000 GWh in new global capacity.[66] Given that about 20% of this announced capacity has yet to be committed to a regional location, this represents a significant investment and economic growth opportunity for Ontario.[67]

Work to ensure that Ontario secures a share of battery manufacturing investment is underway. Stellantis NV, for example, has been reported to be in discussions with the federal government about a potential electric vehicle battery plant in either Ontario or Quebec.[68]

Spotlight on Li-Cycle

Recycling electric-vehicle batteries when they reach end-of-life is also an important part of the EV value chain. It has been estimated that 43,000 to 90,000 metric tonnes of batteries are going to reach end of life as of 2025 in the U.S. Northeast.[69]

One prominent Ontario company that offers "full-service lithium-ion battery recycling" is Mississauga-headquartered Li-Cycle. Li-Cycle has a plant in the U.S. and in Kingston, Ont.

[64] Emma Jarratt, "Tesla acquires Canadian battery specialist, Hilbar Systems," Electric Autonomy, October 4, 2019. https://electricautonomy.ca/2019/10/04/tesla-acquires-canadian-battery-specialist-hibar-systems/

[65] Peter Slowik, Nic Lutsey, and Chih-Wei Hsu, *How Technology, Recycling, and Policy Can Mitigate Supply Risks to the Long-Term Transition to Zero-Emission Vehicles* (ICCT, 2020), 7. https://theicct.org/publications/mitigating-zev-supply-risks-dec2020

[66] *How Technology, Recycling, and Policy Can Mitigate Supply Risks,* 9.

[67] *How Technology, Recycling, and Policy Can Mitigate Supply Risks,* 10.

[68] Eric Atkins, "Stellantis CEO says Canada could be the location of its new electric-vehicle battery plant," *The Globe and Mail*, July 21, 2021. https://www.theglobeandmail.com/business/article-stellantis-ceo-says-canada-could-be-the-location-of-its-new-electric

[69] Propulsion Quebec, *Study of Extended Producer Responsibility for Electric Vehicle Lithium-Ion Batteries in Quebec* (2020), 4. https://propulsionquebec.com/wp-content/uploads/2020/11/ETUDE-REP-EN-FINAL-WEB.pdf

which was recently upgraded and has the capacity to process 5,000 tonnes worth of lithium-ion batteries annually.[70,71]

2.3! Ontario's EV market share lags leading jurisdictions

Ontario's EV adoption is low[72] and currently represents less than 2% of the total provincial market in sales of vehicles. As shown in Figure 3, ICE models make up most of the overall automotive market.

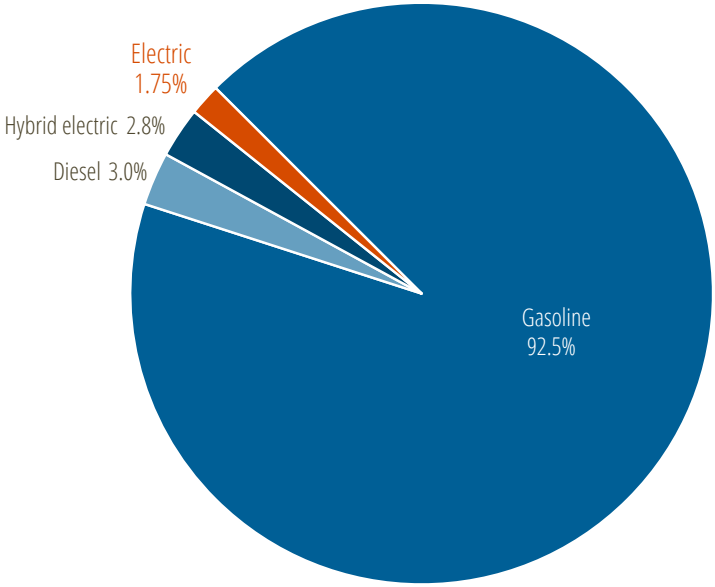

Figure 3. Ontario's vehicle market, 2020

Data source: Statistics Canada[73]

[70] Li-Cycle, "Making lithium-ion batteries a truly circular and sustainable product." https://li-cycle.com/about/

[71] Li-Cycle, "Contact." https://li-cycle.com/contact/

[72] Electric vehicles manufactured in Ontario are being exported and hitting the road in other jurisdictions, however, including the United States. Source: *Power Play: Canada's role in the electric vehicle transition*, 6.

[73] Electric vehicles definition in footnote #1 used here. Source: "New motor vehicle registrations".

Electric vehicles are trending towards battery electric

Between 2011 and 2020, the share of BEVs in Ontario's EV market increased from 33% to 78% while the share of PHEVs declined from 67% to 22%. This has not been an unbroken trend, however, with BEVs overtaking PHEVs in 2013, PHEVs gaining the lead again in 2016, and BEVs coming out on top once more in 2019.[74] The market for light-duty FCEVs remains nascent, with just over 100 on the road in Canada in 2020.[75]

The Boston Consulting Group has projected that the trend of an increasing BEV share will continue, and that, globally, BEVs will make up about 82% of EV sales in 2030 and 88% in 2035 — and that FCEVs will account for only a sliver of sales by 2035.[76]

While Ontario is by no means at the bottom of the pack in terms of EV market penetration — Manitoba, Saskatchewan, New Brunswick, and P.E.I. are all below 1%[77] — it trails leading jurisdictions both within Canada and internationally. Within Canada, Quebec and British Columbia are leaders, at 6.8% and 8.4% market share respectively[78] and internationally, EV market share is strongest in Norway (74.5%) and Iceland (52.4%). (See Figure 4.)

[74] Statistics Canada, "Table 20-10-0021-01: New motor vehicle registrations." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101

[75] Natural Resources Canada, *Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen: A Call to Action* (2020), 46. https://www.nrcan.gc.ca/climate-change/the-hydrogen-strategy/23080

[76] Boston Consulting Group, "Why Electric Cars Can't Come Fast Enough." https://www.bcg.com/en-ca/publications/2021/why-evs-need-to-accelerate-their-market-penetration

[77] "New motor vehicle registrations".

[78] Statistic Canada provides data on "British Columbia and the Territories". Source: "New motor vehicle registrations."

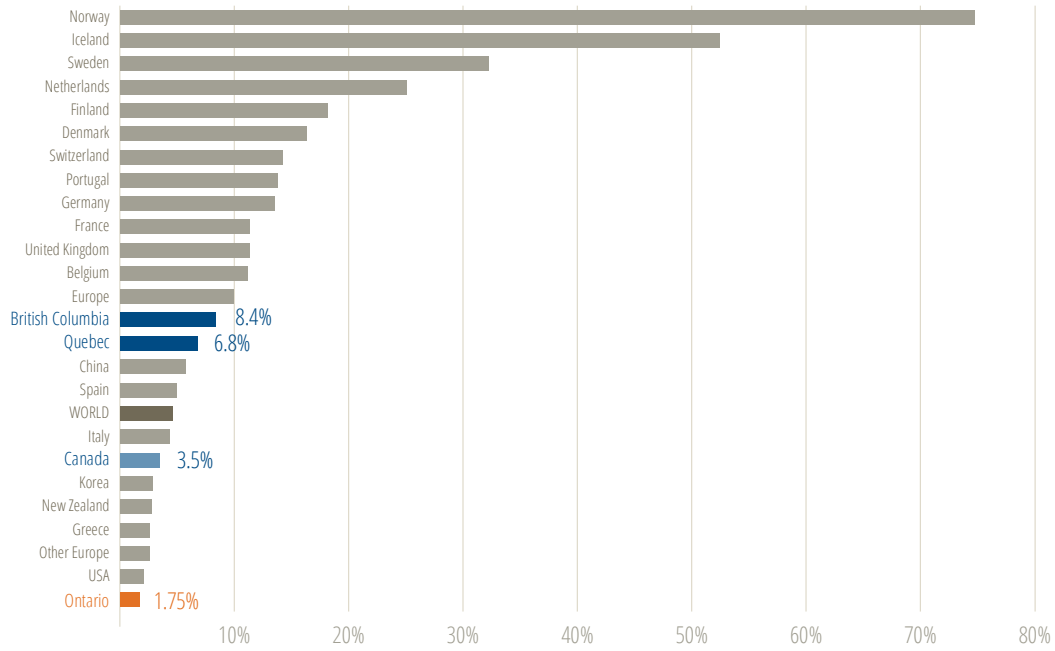

Figure 4. Electric vehicle market share, selected jurisdictions, 2020

Data sources: International Energy Agency, Statistics Canada[79]

We investigated why Ontario's EV market share is considerably lower than leading Canadian jurisdictions and found that while the federal government offers significant EV market support, several data points show that Ontario cannot rely on federal programs alone to accelerate EV adoption in the Ontario market. As shown in Table 1, British Columbia and Quebec, two leading Canadian provinces when it comes to ZEV incentives, account for a disproportionate share of Canadian ZEV uptake and infrastructure. The maximum federal purchase incentive of $5,000, for example, does not cover the average EV-ICE price differential of $10,000 to $27,000.[80] Stackable

[79] International Energy Agency, "Global EV Data Explorer." https://www.iea.org/articles/global-ev-data-explorer

"New motor vehicle registrations."

[80] Nic Lutsey and Michael Nicholas, *Update on electric vehicle costs in the United States through 2030* (ICCT, 2019), 6. https://theicct.org/publications/update-US-2030-electric-vehicle-cost U.S. dollar differences provided by the ICCT were converted to Canadian dollars using the Bank of Canada's 2018 exchange rate. Bank of Canada, "Annual Exchange Rates." https://www.bankofcanada.ca/rates/exchange/annual-average-exchange-rates/

incentives offered in Quebec[81,82] and other provinces[83] help make up the difference. Between 2019 and 2021, individual purchasers of EVs in British Columbia and Quebec submitted 85% of requests for EV purchase incentives under the iZEV incentive program.[84]

Table 1. Share of Canada's ZEV sales and infrastructure by Ontario, Quebec and British Columbia

Measure	Ontario	Quebec	British Columbia
Share of Canadian vehicle sales, all fuel types (2020)	39%	25%	12%
Share of Canadian EV sales (2020)	19%	48%	28%
Share of Canadian PEV[85] inventory (2020)	16%	56%	20%
EV market share (2020)	1.75%	6.8%	8.4%
Share of iZEV incentive requests (May 2019–May 2021)	11%	56%	29%
Share of Canadian gasoline stations (2020)	29%	25%	13%
Share of EV charging and refueling stations (2018)	26%	46%	18%

Data source: Multiple[86]

[81] Province of Quebec, "New vehicle rebate." https://vehiculeselectriques.gouv.qc.ca/english/rabais/ve-neuf/programme-rabais-vehicule-neuf.asp

[82] Province of Quebec, "Frequently asked questions." https://vehiculeselectriques.gouv.qc.ca/english/rabais/ve-neuf/faq-rabais-vehicule-neuf.asp

[83] Transport Canada, "Zero-emission vehicles." https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles#/find/nearest?country=CA

[84] Transport Canada, "Program statistics." https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/program-statistics

[85] A "plug-in electric vehicle" (PEV) refers to a subset of electric vehicles including battery-electric and plug-in hybrid electric vehicles. Source: Alternative Fuels Data Center, "Electricity." https://afdc.energy.gov/fuels/electricity.html

[86] Statistics Canada, "Table 20-10-0021-01: New motor vehicle registrations." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101

Dunsky Energy Consulting, *Plug-In Electric Vehicle Availability: Estimating PEV Sales Inventories in Canada: Q1 2020 Update* (2020), iii. https://www.dunsky.com/wp-content/uploads/2020/07/DunskyZEVAvailabilityReport_Availability_20200805.pdf

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Government of Canada, “Businesses - Canadian Industry Statistics.” https://www.ic.gc.ca/app/scr/app/cis/businesses-entreprises/447

Natural Resources Canada, “Electric Charging and Alternative Fueling Stations Locator.” https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/electric-charging-alternative-fuelling-stationslocator-map/20487#/analyze?country=CA&fuel=HY&fuel=ELEC&hy_nonretail=true

Transport Canada, “Program statistics.” https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/program-statistics

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3.! Overview of EV policies

Supply-side and demand-side EV policy

Supply-side, or direct industrial-support policy seeks to assist the EV manufacturing industry directly, spurring research and development in EVs and the deployment thereof. Examples include R&D support and production incentives.[87]

Demand-side, or market-support policy, seeks to increase consumer adoption of electric vehicles. Examples include financial and non-financial incentives and electric vehicle infrastructure buildouts.[88]

3.1! Ontario's policies

3.1.1! Supply-side EV policies

In early 2019, Ontario released *Driving Prosperity: The Future of Ontario's Automotive Sector* to promote the health, growth, and global competitiveness of its auto sector.[89]

Actions to support the automotive sector outlined in the strategy included a commitment to reduce the regulatory burden by 25% as of 2020, to develop a network of support infrastructure for connected and autonomous vehicles and EVs, and to "explore support for strategic investments in the automotive industry".[90]

Since the release of the strategy, Ontario's support for EV production has included investing about $300 million in retooling the Ford Oakville Assembly Complex to manufacture battery electric vehicles and, in its 2021 budget, an over $50 million investment in the creation of an Ontario Vehicle Innovation Network (OVIN).[91] OVIN will support the accelerated development of technologies related to EVs, as well as

[87] This definition of supply-side policies focuses on direct support to manufacturers, as opposed to regulations that would mandate cleaner vehicles or increased ZEV supply.

[88] *Power Play: Canada's role in the electric vehicle transition*, 23, 24.

[89] Province of Ontario, *Ontario's Action Plan: Protecting People's Health and Our Economy* (2021), 108. https://budget.ontario.ca/2021/pdf/2021-ontario-budget-en.pdf

[90] *Driving Prosperity*, 12, 13, 14, 16.

[91] *Ontario's Action Plan: Protecting People's Health and Our Economy,* 108.

connected and autonomous vehicles.[92] Supply-side programming has also included the province's contribution of $5 million to First Cobalt Corporation.[93]

3.1.2! Demand-side EV policies

Ontario's demand-side EV policy is limited in its capacity to significantly grow EV adoption or support domestic EV producers.

Perhaps Ontario's most prominent demand-side policy is the Green Vehicle License Plate program, which provides electric vehicles weighing less than 3,000 kg with privileged access to high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes.[94] This type of non-financial incentive, however, is limited in its impact on EV adoption. According to the Sustainable Transportation Action Research Team (START), a research collaborative at Simon Fraser University, HOV lane access scores "poorly in terms of effectiveness… because there is a limited number of roads with HOV lanes in Canada and HOV lanes only benefit drivers during times of traffic congestion."[95]

Ontario also has policies and programs aimed at increasing the availability of electric vehicle charging infrastructure. The Ontario Job Creation Investment Incentive allows businesses to write off specified clean energy equipment[96,97] including EV charging equipment.[98] Ontario's 2019 Reserved Parking for Electric Vehicle Charging Act created a provision that restricted the capacity of non-EVs and non-charging EVs to park in electric vehicle charging stations.[99] Ontario's 2018 Environmental Plan, meanwhile,

[92] *Ontario's Action Plan: Protecting People's Health and Our Economy,* 114.

[93] "Government of Canada and Province of Ontario invest $10 million to establish North America's first cobalt refinery in Northern Ontario."

[94] Ontario Ministry of Transportation, "Ontario's Green Vehicle License Plate Program." http://www.mto.gov.on.ca/english/vehicles/electric/green-licence-plate.shtml

[95] Noel Melton, John Axsen, Suzanne Goldberg, Barbar Moawad, Michael Wolinetz, *Canada's ZEV Policy Handbook* (Sustainable Transportation Action Research Team, 2017), 32. https://sustainabletransport.ca/portfolio/canadas-zev-policy-handbook/

[96] Province of Ontario, "Annex: Details of Tax Measures." https://budget.ontario.ca/2019/annex.html#section-7

[97] Department of Finance Canada, *Investing in Middle Class Jobs* (2018), 156. https://www.budget.gc.ca/fes-eea/2018/docs/statement-enonce/fes-eea-2018-eng.pdf

[98] Natural Resources Canada, "Technical Guide to Class 43.1 and 43.2: 2019 Edition (2020), 177. https://www.nrcan.gc.ca/sites/nrcan/files/energy/pdf/Class_431-432_Technical_Guide(En)_-Dec-16-ACC.pdf

[99] Government of Ontario, *Bill 123, Reserved Parking for Electric Vehicle Charging Act, 2019* Bill 123 2019 iii.1 https://www.ola.org/en/legislativebusiness/bills/parliament-42/session-1/bill-123

promised to "improve rules and remove regulatory barriers that block private investors from deploying low-carbon refueling infrastructure…"[100]

The province does not have a major public infrastructure buildout program, nor does it provide incentives for the purchase of electric vehicle charging equipment or vehicles, which can help reduce the cost differential between electric and traditional internal combustion engine vehicles.

3.2! Federal demand-side policies

The federal government offers several EV market-supports to encourage EV adoption. The Incentives for Zero-Emission Vehicles program provides point-of-sale incentives of up to $5,000 for the purchase or lease of an eligible ZEV.[101] The 2019 federal budget proposed a 100% tax write-off for light-, medium- and heavy-duty zero-emission vehicle purchases by businesses.[102] The Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative provides funding to establish a nation-wide network of fast-charging stations along major highway systems as well as hydrogen refueling stations in major metropolitan areas.[103] The Zero Emission Vehicle Infrastructure Program offers funding to increase localized charging and refueling infrastructure.[104]

Recently, the federal government announced a mandatory target that 100% of new light-duty car and passenger truck sales be zero-emission as of 2035. It has also committed to setting interim targets for 2025 and 2030. The federal government has indicated that this mandatory target will be achieved through existing and new regulation and investment.[105]

[100] Ministry of the Environment, Conservation and Parks, *Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan* (2018), 33. https://www.ontario.ca/page/made-in-ontario-environment-plan

[101] "Zero-emission vehicles."

[102] "Zero-emission vehicles."

[103] Government of Canada, "Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative." https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/electric-and-alternative-fuel-infrastructure/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352

[104] Government of Canada, "Zero Emission Vehicle Infrastructure Program." https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876

[105] Transport Canada, "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada," media release.

It is anticipated that much of the progress towards achieving the 100% target will occur through the federal government aligning its light-duty vehicle greenhouse gas emission regulations with the most ambitious regulations in the United States.[106] It should be noted that the U.S. has set a target of 50% of new vehicle sales being zero-emission as of 2030.[107] In August 2021, the United States Environmental Protection Agency (EPA) proposed strengthening federal passenger car and light truck GHG emission standards through the setting of standards for model years 2023 to 2026. The standards would set 10% stringency increases for model years 2022 and 2023, followed by 5% increases for every model year from 2024 to 2026. The EPA anticipated this would result in an 8% light-duty vehicle fleet penetration by plug-in electric vehicles as of model year 2026.[108] The Biden Administration also intends to further strengthen standards post model year 2026.[109] In California, the Advanced Clean Cars program includes a number of regulations, including the LEV III GHG regulations, which have been projected to reduce GHG emissions from new vehicles by about 40% as of 2025 relative to 2012 model year vehicles. The Canadian federal government indicated it would adopt "additional mandatory measures" should alignment with U.S. fuel economy regulations be insufficient to meet the new target.[110]

3.3! International practices

In 2019, over 95% of EVs and EV batteries were produced in China, Europe, the United States, Japan, and South Korea.[111] Within Europe, the most significant manufacturers have been Germany, France, and the United Kingdom.[112]

https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html

[106] "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada."

[107] The White House, "Fact Sheet: President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks." https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/

[108] U.S. Environmental Protection Agency, *Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards: Regulatory Update* (2021), 1,5. https://www.epa.gov/system/files/documents/2021-08/420r21056.pdf

[109] "Fact Sheet: President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks."

[110] "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada."

[111] *How Technology, Recycling, and Policy Can Mitigate Supply Risks*, 2-3.

[112] *Power Play: Canada's role in the electric vehicle transition*, 24.

In the 2020 report *Power Play: Canada's role in the electric vehicle transition* by the ICCT and the Pembina Institute, policies to support the EV sector in the countries mentioned above were analyzed. The report found a healthy mix of supply-side policy (including support for research and development and tax incentives for local manufacturing); demand-side policy to increase EV market share (most prominently vehicle-purchase incentives and funding for public charging networks), and regulatory policy. Policies existed either at the national level or at a regional or local level. [113]

Top EV-producing regions continue to implement comprehensive and balanced policy frameworks. Zero-emission vehicle standards, which require a certain percentage of vehicles sold by manufacturers to be electric, are currently in place in areas including China, California, and numerous other states in the U.S.[114] In response to the coronavirus pandemic, some countries have also introduced or extended purchasing incentives for EVs. Germany added more incentives for EVs and hybrids, France increased existing subsidies or introduced new subsidies for various EV types, and China extended its EV subsidy program to 2022.[115] Countries have also introduced new supply-side policies. The United Kingdom's *Ten Point Plan for a Green Industrial Revolution* included a commitment of £1 billion (C$1.7 billion[116]) towards "the electrification of UK vehicles and their supply chains,"[117] and the European Union has announced the European Battery Innovation, a 2.9-billion-euro support package targeting the full battery value chain.[118]

[113] *Power Play: Canada's role in the electric vehicle transition,* 24.

[114] Clean Energy Canada, "Media brief: What is a 'zero-emission vehicle standard' and why does Canada need one?", media release, September 22, 2020. https://cleanenergycanada.org/media-brief-what-is-a-zero-emission-vehicle-standard-and-why-does-canada-need-one/

[115] Elisabetta Cornago, "Promoting vehicle efficiency and electrificatoin through stimulus packages," November 23, 2020. https://www.iea.org/articles/promoting-vehicle-efficiency-and-electrification-through-stimulus-packages

[116] Conversion based on 2020 exchange rates sourced from the Bank of Canada.

[117] HM Government, *The Ten Point Plan for a Green Industrial Revolution* (2020), 14. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf

[118] *Global EV Outlook 2021,* 62.

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4.! Economic benefits of growing Ontario's EV market

4.1! The importance of a domestic EV market

Ontario has attracted significant electric vehicle production investments from original equipment manufacturers, in part because of the province's supply-side investments.[119]

If Ontario is to protect and build on this production foothold, however, it will need to expand its domestic EV market. Manufacturers generally sell electric vehicles in the same region where they are produced — in 2018, 80% of electric vehicles produced worldwide were sold in the same region where they were manufactured.[120] The United States (74%), Europe (81%), South Korea (85%), Japan (92%), and China (almost 100%) were all close to this figure.[121]

> "With announced launches of new EV models spiking, both automakers and suppliers are increasing their global footprints in target markets by localizing the production of vehicles and components...
>
> "... Tesla began construction of its Shanghai plant in January 2019 and delivered the first locally produced EV that December."
>
> — McKinsey & Company.[122]

Motor vehicle manufacturers often seek to locate assembly close to markets, especially as they increase in volume.[123] The investment and production location decisions of major electric vehicle manufacturers follow this trend:

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[119] Government of Ontario, "Historic Ford Canada Investment Transforming Ontario into Global Electric Vehicle Manufacturing Hub," media release, October 8, 2020. https://news.ontario.ca/en/release/58736/historic-fordcanada-investment-transforming-ontario-into-global-electric-vehicle-manufacturing-hub

[120] *Power Play: Canada's role in the electric vehicle transition,* 5.

[121] *Power Play: Canada's role in the electric vehicle transition,* 5-6.

[122] Thomas Gersdorf, Patrick Hertzke, Patrick Schaufuss, and Stephanie Schenk, *McKinsey Electric Vehicle Index: Europe cushions a global plunge in EV sales* (2020), 9. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/mckinsey-electric-vehicle-index-europe-cushions-a-global-plunge-in-ev-sales

[123] *Power Play: Canada's role in the electric vehicle transition,* 30.

- The Nissan Leaf is produced in the United Kingdom for the European market and in Japan for markets in Asia.[124]
- Following the phase-out of a United States financial incentive in 2019, Tesla increased its focus on supplying European countries that have incentives including the Netherlands, the United Kingdom, and Norway. Tesla is investing in manufacturing facilities in Berlin and Shanghai to produce vehicles closer to those major markets.[125,126]
- Volkswagen aims to produce 4 million electric vehicles annually as of 2028 at eight new manufacturing facilities in North America, China, and Europe. Over 95% of the vehicles are destined for those same regions.[127]
- Nearly 90% of the top-selling international EV models are produced within the markets where their sales are greatest.[128]

Battery production has followed a similar trend. According to the ICCT, through 2019, about 98% of global electric vehicle sales and battery production has occurred in six main regions — China, Europe, the U.S., Japan, South Korea, and Canada.[129]

This trend is accelerating, according to McKinsey & Company, which noted that the majority of new capacity will be in Central Europe, in response to regional demand. Large battery manufacturers are increasingly investing overseas, with Chinese manufacturer CATL building a factory in Germany and South Korean SK Innovation announcing additional investment in a factory in the U.S. [130]

There was greater impetus for supply-chain localization in 2020 as the coronavirus pandemic highlighted the global reliance on China for battery manufacturing and the associated supply risks[131] and caused investors to become increasingly concerned with

[124] *Power Play: Canada's role in the electric vehicle transition,* 30.

[125] *How Technology, Recycling, and Policy Can Mitigate Supply Risks,* 16.

[126] *McKinsey Electric Vehicle Index: Europe cushions a global plunge in EV sales,* 9.

[127] *How Technology, Recycling, and Policy Can Mitigate Supply Risks,* 14.

[128] *How Technology, Recycling, and Policy Can Mitigate Supply Risks,* 3.

[129] *How Technology, Recycling, and Policy Can Mitigate Supply Risks,* 2.

[130] *McKinsey Electric Vehicle Index: Europe cushions a global plunge in EV sales,* 9, 10.

[131] Markets Insider, "Electric Vehicle (EV) Market Assessment 2020-2025 - Growing Interest Among Various Stakeholders for Localization/Regionalization of Supply Chains due to COVID-19 Disruptions," July 2020. https://markets.businessinsider.com/news/stocks/electric-vehicle-ev-market-assessment-2020-2025-growing-interest-among-various-stakeholders-for-localization-regionalization-of-supply-chains-due-to-covid-19-disruptions-1029456854

environmental, social, and governance (ESG) factors and thus with the sustainability of "the entire battery supply chain, from mining to end-user."[132]

These trends demonstrate that, while supply-side policy is beneficial in attracting electric vehicle production, and while high EV sales are no guarantee of new production facilities, a comprehensive EV industrial policy in Ontario must include efforts to grow the domestic market.

4.2! Automobile supply chain and production

At the federal level, the Government of Canada has set a target of 100% of new light-duty cars and passenger truck sales being zero-emission as of 2035.[133,134]

The Pembina Institute has modeled the direct, indirect, and induced economic benefits and job creation that Ontario could potentially realize in a scenario where 100% of new LDV sales are electric as of 2035[135].

[132] S&P Global Platts, "China continues to dominate global EV supply chain: BNEF," September 2020. https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/091620-china-continues-to-dominate-global-ev-supply-chain-bnef

[133] "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada."

[134] The Canada Energy Regulator's November 2020 Canada's Energy Future report provides some indication of what ZEV penetration in Canada may look like in 2035 under business as usual. The report has two main projection scenarios: a "Reference" scenario, which assumes limited additional climate action on top of current policies; and an "Evolving" scenario, which assumes a continued increase in the pace of climate action. In the CER's "Reference" scenario, Canada achieves a 10% ZEV market share in 2035. In its "Evolving" scenario, Canada achieves a 17% ZEV market share in the same year. It should be noted that, in 2019 and 2020, Ontario's ZEV market share was less than half of the Canadian average. *Sources:* Canada Energy Regulator, "Scenarios and Assumptions," *Canada's Energy Future*. https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/assumptions/index.html; Canada Energy Regulator, media release, "New CER report shows that policy and technology change will be key drivers of Canada's energy transition." https://www.cer-rec.gc.ca/en/about/news-room/news-releases/2020/new-cer-report-shows-policy-technology-change-will-be-key-drivers-canadas-energy-transition.html; Canada Energy Regulator, "Towards Net-Zero." https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/net-zero/index.html; "New motor vehicle registrations."

[135] This paper focuses on the adoption and economic benefits of light-duty electric vehicles. The market for electric medium- and heavy-duty vehicles remains very nascent, with less than 600 sold in the U.S. and Canada in 2019. Source: Ben Sharpe, Claire Buysse, Jason Mathers and Victor Poudelet, *Race to zero: How manufacturers are positioned for zero-emission commercial trucks and buses in North America* (ICCT, 2020). https://theicct.org/publications/canada-race-to-zero-oct2020

Direct, indirect, and induced economic impacts

Direct economic impacts: These are impacts that result from an increase in demand for an industry's output on that industry. For example, an increase in demand for automobiles may increase employment in assembly plants.

Indirect economic impacts: These are the impacts of an increase in demand for an industry's output on other industries involved in various stages of production. For example, an increase in demand for automobile manufacturers may increase employment at a tool-and-die manufacturer.

Induced economic impacts: These are the impacts of an increase in demand for an industry's output on production through increased labour income due to direct and indirect impacts. For example, an increase in demand for automobile manufacturers may increase demand for restaurants near the assembly plant and also near the associated tool-and-die manufacturers.[136]

Based on our analysis, the direct, indirect and induced impacts of market growth in Ontario's EV sector could result in over 24,200 jobs and $3.44 billion in GDP in 2035. (Table 2; see Appendix A for an overview of our modeling methodology.)

Table 2. Potential jobs and economic benefits from the increased production, sales, and use of EVs and EV chargers in Ontario

	100% EV light-duty vehicle market share by 2035	
	Jobs	Economic benefit (GDP)
EV manufacturing	24,200 jobs	$3.44 billion
EV charger manufacturing installation	 5,800 jobs 17,400 jobs	 $0.67 billion $2.03 billion

Note: Includes direct, indirect and induced jobs and economic benefits. See Appendix A for details and assumptions.

[136] Statistics Canada, "Input-output multipliers, detail level," spreadsheet, March 2021. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610059401

4.2.1! Growth in Ontario's EV sector can help offset job losses elsewhere in the automobile sector

Over the past two decades, Ontario's auto sector has been in decline, having suffered a loss of nearly 32,000 jobs in the manufacturing of motor vehicles and motor vehicle parts in that time.[137] EV production and the associated supply chain can help offset this loss and provide new employment opportunities to affected autoworkers and new Ontarians entering/re-entering the labour market. The high-value-added nature of auto-sector jobs — automotive wages in Canada are nearly 30% higher than the national average for all workers[138] — increases the importance to protect and grow these jobs. Recent investments in electric vehicle manufacturing have often been made in locations experiencing economic difficulties. Mere months prior to the announcement of EV manufacturing in Windsor, for example, the plant cancelled its third shift.[139] In the ratification announcement, Unifor noted that, "Fiat Chrysler forecasts the return of the third shift in Windsor by 2024."[140] Similarly, according to Unifor, prior to the announcement of EV production, the Oakville Assembly Complex had had "a question mark over its head for months… amid analysts' projections that it would stop producing the Edge SUV."[141]

In late 2019, the Pembina Institute attended the "What's Next for Oshawa and Auto?" public meeting prior to the closing of the city's General Motors plant[142,143] where it heard

[137] Statistics for Ontario's auto sector are derived through the summation of NAICS codes 3361: Motor vehicle manufacturing, 3362: Motor vehicle body and trailer manufacturing and 3363: Motor vehicle parts manufacturing. Data is for changes from 2001 to 2019. Sources: Statistics Canada, "Gross domestic product (GDP) at basic prices, by industry, provinces and territories (x 1,000,000)," spreadsheet, March 2021. https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3610040201; Statistics Canada, "Employment by industry, annual," spreadsheet, March 2021. https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1410020201

[138] Unifor, "Canada's Auto Industry Fast Facts 2020," (2020). https://www.unifor.org/en/canadas-auto-industry-fast-facts-2020-1\

[139] Stellantis, "Windsor Assembly Plant." https://media.stellantisnorthamerica.com/newsrelease.do?id=344

[140] Unifor, "Unifor members ratify new FCA contract that delivers new jobs and investment." https://www.unifor.org/en/whats-new/press-room/unifor-members-ratify-new-fca-contract-delivers-new-jobs-and-investment

[141] Unifor Local 584, "Ottawa says governments offering $500M to bring electric vehicle production to Ford's Oakville plant," media release, September 21, 2020. http://uniforlocal584.org/current_news.html

[142] Leyland Cecco, "It's just weird': Oshawa sends of GM plant as thousands scramble for jobs," *The Guardian,* December 19, 2019. https://www.theguardian.com/business/2019/dec/19/oshawa-general-motors-plant-closure

[143] Blue Green Canada, "What's Next for Oshawa and Auto? Oct 28th Public Meeting." http://www.bluegreencanada.ca/blog/whats-next-oshawa-and-auto-oct-28th-public-meeting

from affected members of the community who described the ripple effect on the broader community (including restaurants and stores) and feeling a lack of control over their personal destinies. However, we also heard community members advocate for EV manufacturing, a desire to be part of a transitioning auto sector, and a willingness to be retrained in EV production.

To what extent will retraining be necessary? And will increased EV manufacturing be capable of fully absorbing current auto-sector workers? Analysis from the Boston Consulting Group (BCG) indicates that there are two main areas in which battery electric vehicles (BEVs) differ from internal combustion engine vehicles (ICEVs). The first is the powertrain. In a BEV, the ICE engine and auxiliary systems are replaced with an electric motor and a battery pack. The second is power electronics — including converters and power electronics controllers.[144]

According to BCG, ICE vehicles have significantly more components than BEVs.[145] Despite this, BCG analysis indicates that the content per vehicle — a measure of component value[146] — of BEVs is about 30% higher than that of ICE vehicles, largely due to high battery costs.[147] BCG analysis indicates that some aspects of vehicle production will not significantly change in the shift from ICE vehicles to BEVs — including activities in press, body, and paint shops.[148]

Labour hours per vehicle also remain relatively constant in vehicle assembly, but would shift from activities such as fuel-tank installation and engine wiring to battery alignment and charging-unit installation.[149] The transition from ICEVs to BEVs is likely to significantly reduce labor hours in component and engine/motor manufacturing, while increasing hours in the manufacturing of battery cells, battery modules, and

[144] Daniel Kuepper, Kristian Kuhlmann, Kazutoshi Tominaga, Aakash Arora and Jan Schlageter, *Shifting Gears in Auto Manufacturing* (Boston Consulting Group, 2020), 1. https://web-assets.bcg.com/fd/de/20c24ec2407d9622175e45e84a2c/bcg-shifting-gears-in-auto-manufacturing-sep-2020.pdf

[145] *Shifting Gears in Auto Manufacturing*, 1.

[146] BCG defines content per vehicle as 'the value of the vehicle's components to an OEM [original equipment manufacturer] (mainly the amount of raw materials, labor, and profit)'. Source: *Shifting Gears in Auto Manufacturing,* 3.

[147] *Shifting Gears in Auto Manufacturing,* 1.

[148] *Shifting Gears in Auto Manufacturing,* 10-11.

[149] *Shifting Gears in Auto Manufacturing,* 10-11.

battery packs.[150] Battery manufacturing will require labour in areas including equipment operation, production process control, and quality inspection.[151]

Overall, BCG analysis indicated that "total labor hours ***across the automotive value chain*** to assemble an electric vehicle will be on par with ICEV manufacturing…"[152] BCG also noted that its comparison was between BEVs and ICEVs, and that hybrid vehicles that have both an electric motor and an engine would have higher labor numbers than either BEVs or ICEVs.[153] This is significant as plug-in hybrid electric vehicles (PHEVs) made up over 50% of Ontario's EV market as recently as 2017.[154]

It is important to note that, while labour hours may hold more or less constant across the automotive value chain in the shift from BEVs to ICEVs, there will be, as already noted, shifts within the chain. A significant shift will be from automakers to suppliers when automakers choose not to manufacture batteries in-house. BCG analysis indicates that, in the most likely scenario of a mix of in-house and outsourced production, labour hours are reduced by four percentage points.[155]

To maximize the potential for the shift to electrification to contribute to a just transition for autoworkers, policymakers should keep in mind changes in labour and skills requirements within the value chain, as well as the importance of keeping as much of the EV supply chain within the province as possible.

It is important to note that the transition to EVs is an opportunity to address persistent inequities in the sector.[156] Women represent 23% of the workforce in assembly plants, and 25% in parts facilities. This is less than the share of women in the overall manufacturing sector (28%). Women of colour represent 11% of the automotive-parts workforce, which is in line with the national average of 10%, but only 4% of automobile assembly jobs.[157] Skills-training programs should be designed in ways that enable underrepresented demographics, including women, people of colour, rural Ontarians,

[150] *Shifting Gears in Auto Manufacturing,* 9-10.

[151] *Shifting Gears in Auto Manufacturing,* 10.

[152] *Shifting Gears in Auto Manufacturing,* 12.

[153] *Shifting Gears in Auto Manufacturing,* 11.

[154] Statistics Canada, "Table 20-10-0021-01: New motor vehicle registrations." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101

[155] *Shifting Gears in Auto Manufacturing,* 11.

[156] Just Powers, "How might we use energy transition to imagine more livable futures for all?" https://www.justpowers.ca/

[157] Unifor, "Canada's Auto Industry Fast Facts 2020," (2020.) https://www.unifor.org/en/canadas-auto-industry-fast-facts-2020-1\

and Indigenous peoples, to contribute fully to the growth in Ontario's automotive sector and overall economy.

4.3! EV infrastructure and services

In addition to electric vehicle manufacturing, there are significant potential economic opportunities associated with the operation of electric vehicles, including the manufacturing and installation of charging infrastructure and the maintenance of EVs.

4.3.1! Charging infrastructure

Ontario's public electric vehicle charging network currently consists of nearly 1,400 Level 2 chargers and over 300 direct current (DC) fast chargers, located at facilities such as hotels, municipal government buildings, and car dealerships.[158] Most of these stations are part of the ChargePoint and FLO networks.[159] ChargePoint is headquartered in California[160] while FLO has its headquarters and assembly plant in Quebec.[161]

Nevertheless, Ontario-based, public charging-station providers are increasing in prominence. SWTCH Energy is headquartered in Toronto.[162] Most of its Level 2 and all of its Level 3 stations were built in 2020.[163] Ontario Power Generation and Hydro One launched the Ivy Charging Network in February 2020, with an anticipated 160 fast chargers installed by the end of 2021.[164]

[158] Natural Resources Canada, "Alternative Fuel Stations; Country: Canada; Province/Territory: Ontario," spreadsheet, March 2021. https://developer.nrel.gov/api/alt-fuel-stations/v1.csv?access=public%2Cprivate&api_key=ZCWrO9fKZWtFzxsMrqfGlCcBnCx1ibQSqvJfhA1y&cards_accepted=all&cng_fill_type=all&cng_psi=all&cng_vehicle_class=all&country=CA&download=true&e85_has_blender_pump=false&ev_

[159] "Alternative Fuel Stations; Country: Canada; Province/Territory: Ontario."

[160] ChargePoint, "Contact Information." https://www.chargepoint.com/en-ca/about/contact/

[161] FLO, "About FLO." https://www.flo.com/en-CA/about/

[162] SWTCH, "About SWTCH." https://swtchenergy.com/about-us

[163] Luke Sarabla, "Canadian EV charging networks post double-digit growth since start of pandemic," February 4, 2021. https://electricautonomy.ca/2021/02/04/canadas-ev-charging-networks-2021/

[164] Ontario Power Generation, "New Ivy Charging Network set to give electric vehicle drivers peace of mind." https://www.opg.com/story/new-ivy-charging-network-set-to-give-electric-vehicle-drivers-peace-of-mind/

Public infrastructure, however, is only a small part of scaling up EV charging options. About 80% of EV charging happens at the owner's residence.[165] A group of Ontario-based firms offer EV-charging products and installation. In 2018, for example, Autochargers opened what was touted as Ontario's "first ever EV charger manufacturing plant" in Markham, projecting an output of 40,000 chargers annually as of 2019 and the creation of 100 jobs.[166] Autochargers currently assembles the Grizzl-E charger at its Markham plant and claims high levels of Canadian content, indicating the flowering of a domestic EV charger supply chain.[167] In addition, GBatteries, an Ottawa-headquartered firm, has created a technology it claims will allow for faster charging with lower battery degradation, while Markham-based MetroEV offers hardware-agnostic EV charger installation services.[168]

Growing Ontario's EV market would increase demand for associated public and private charging infrastructure. The Pembina Institute projects that, should Ontario hit a target of 100% of the light-duty auto market being electric as of 2035, its electric vehicle charging sector could benefit from nearly 23,200 direct, indirect and induced jobs and over $2.7 billion in GDP.

4.3.2! EV maintenance and services

Overall, electric vehicles cost less to maintain than internal combustion engine vehicles. For example, BEV drivetrains have 90% fewer moving parts; there is less wear and tear on brake pads due to the use of regenerative breaking; and do not require some of the maintenance that ICEVs do such as oil changes. According to the 2 Degrees Institute, BEVs do not require any of the top 10 most common auto repairs and cost approximately 47% less to maintain annually per household compared to ICE vehicles.[169,170]

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[165] Melissa DeYoung, Steve McCauley, Mariana Eret, Erin Williamson and Joe Rogers, *Zero Emission Vehicle Charging in Multi-Unit Residential Buildings and for Garage Orphans* (2019), v. https://www.pollutionprobe.org/zev-charging-in-murbs/

[166] The Energy Mix, "Ontario's First EV Charger Manufacturing Plant Opens In Markham," March 25, 2018. https://theenergymix.com/2018/03/25/ontarios-first-ev-charger-manufacturing-plant-opens-in-markham/

[167] AutoChargers.ca, "FAQ." https://www.autochargers.ca/faq.html

[168] GBatteries, "Technology." https://www.gbatteries.com/technology

[169] Ryan Logtenberg, James Pawley and Barry Saxifrage, *Comparing Fuel and Maintenance Costs of Electric and Gas Powered Vehicles in Canada* (2 Degrees Institute, 2018), 5, 11-12. https://www.2degreesinstitute.org/reports/comparing_fuel_and_maintenance_costs_of_electric_and_gas_powered_vehicles_in_canada.pdf

[170] CarMD, "2018 Vehicle Health Index." https://www.carmd.com/wp/vehicle-health-index-introduction/2018-carmd-vehicle-health-index/

Nevertheless, there are complexities in the maintenance of electric vehicles. According to the U.S. Bureau of Labor Statistics, while routine EV maintenance and repair work can be performed by standard repair workers, work on the drivetrain and electrical systems will require a greater degree of specialization.[171] Tesla Canada has warned that using a non-Tesla outfit for repairs and maintenance could affect warranty coverage.[172] Mechanics may also be reluctant to service electric cars if they don't have the proper training or experience.[173]

There are however some EV-specialized maintenance and repair shops and EV original equipment manufacture service centres in Ontario (predominantly in southern Ontario).[174] Growing Ontario's EV market would also have the knock-on benefit of growing a specialized EV maintenance and repair sector.

[171] U.S. Bureau of Labor Statistics, "Careers in Electric Vehicles." https://www.bls.gov/green/electric_vehicles/#maintenance

[172] Tesla Canada, "Support." https://www.tesla.com/en_CA/support/car-maintenance

[173] Carl Meyer, "Most mechanics 'scared' to work on electric vehicles, industry veteran says," Canada's National Observer, November 2020. https://www.nationalobserver.com/2020/11/03/news/mechanics-scared-electric-vehicle-maintenance

[174] Tesla Canada, "Tesla Service Centers in Canada." https://www.tesla.com/en_CA/findus/list/services/Canada

Colorworks Autobody Centers, "Locations." https://colorworks.ca/locations/#Ontario

Hello Tire Automotive Repair, "Electric and Hybrid Vehicle Repair." https://www.hellotire.ca/Richmond%20Hill-electric-hybrid.html

Eccles Auto Service, "Hybrid Services." https://ecclesautoservice.ca/hybrid-services/#!search?year=2020&make=Tesla&model=Model%203&season_id=all&location_id=11753

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5.! Policy recommendations

If Ontario is to build on its foothold in electric vehicle manufacturing and generate robust and equitable economic benefits through a strong EV manufacturing sector with a strong supply chain, the province should follow the lead of global EV manufacturing jurisdictions and adopt comprehensive EV industrial policies that encompass supply- and demand-side supports, incentives and regulations.

5.1! Establish an Ontario Transportation Electrification Council and roadmap

There are opportunities to bolster the province's strategy for the auto industry and improve intergovernmental policy and program co-ordination to ensure efficient and effective use of public spending and continued private sector investment in Ontario's auto sector. Based on our examination of Canadian EV strategies and elicited factors that are key to achieving desired results, an effective EV strategy and policy framework should include accountability measures, performance indicators and governance structures that identify specific government departments and individuals responsible for strategy co-ordination and implementation.[175,176]

Recommendation #1: The Ontario government should establish an Ontario Transportation Electrification Council that will develop a long-term, co-ordinated and holistic electrification strategy for the province. Recognizing the economic benefits from a growing EV market, this strategy should outline a policy approach with co-operation from the departments responsible for transportation, economic development, energy, natural resources, and environment, as well as labour, training, and skills development.

[175] Verificateur general de la Ville de Montreal, *2018 Annual Report: 4.3. Transportation Electrification Strategy* (2019), 131, 140. http://www.bvgmtl.ca/wp-content/uploads/2019/06/AR2018_En_Section4_3-1.pdf

[176] Carolyn Kim and Cedric Smith, *Building a zero-emission goods-movement system: Policy recommendations to strengthen Canada's ZEV freight sector* (Pembina Institute, 2020), 12. https://www.pembina.org/pub/building-zero-emission-goods-movement-system

5.2! Build consumer awareness of EV cost savings

Electric vehicles have significantly higher upfront purchase prices than traditional ICE vehicles. The price difference is in the range of $10,000 for short-range cars and $27,000 for long-range SUVs.[177]

While EV purchase prices remain higher than those of comparable ICE vehicles, EV drivers can save significantly in operational expenditures. Canada's Energy Regulator (CER) has developed a "Levelized cost of driving" indicator, which estimates the cost of driving a vehicle per kilometre over the course of the vehicle's lifespan, accounting for maintenance costs, fuel costs, and purchase price. CER analysis indicates that, in Ontario, when accounting for fuel and maintenance costs, EVs are only slightly more expensive on a life cycle basis than comparable ICE vehicles, and will represent a cost-saving proposition as early as 2030. Canada-wide, CER estimates that EV cars are already cost-saving on a life cycle basis relative to ICE cars.[178]

However, consumers may not be aware of lower EV operational costs. A survey of 1,000 ICE-car owners and 192 EV owners in the Greater Toronto and Hamilton Area found that owners of ICE vehicles appeared unaware of EV operational savings.[179] And even consumers who are aware of EV operational savings may not adequately factor them into their vehicle purchase decisions as they may focus on higher upfront purchase prices for EVs and discount the medium- and long-term operational savings (also referred to as consumer "hyperbolic discounting" in behavioural economic theory).[180,181]

Research has shown that the hyperbolic discounting effect can be combatted by providing information that presents the total cost of ownership of an electric vehicle

[177] Nic Lutsey and Michael Nicholas, *Update on electric vehicle costs in the United States through 2030* (ICCT, 2019), 6. https://theicct.org/publications/update-US-2030-electric-vehicle-cost U.S. dollar differences provided by the ICCT were converted to Canadian dollars using the Bank of Canada's 2018 exchange rate.

[178] Canada Energy Regulator, "Market Snapshot: Levelized costs of driving EVs and conventional vehicles." https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2019/market-snapshot-levelized-costs-driving-evs-conventional-vehicles.html

[179] Plug 'N Drive, *Driving EV Uptake in the Greater Toronto and Hamilton Area: How Driver Perceptions Shape Electric Vehicle Ownership in the GTHA* (2017), 4. https://www.plugndrive.ca/wp-content/uploads/2017/10/Driving-EV-Uptake-in-the-Greater-Toronto-and-Hamilton-Area.pdf

[180] New Zealand Ministry for the Environment, *Reducing barriers to electric vehicle uptake: Behavioural insights: Analysis and review* (2018), 8. https://www.iccc.mfe.govt.nz/assets/PDF_Library/ad42c96b5f/MfE-Reducing-Barriers-to-Electric-Vehicle-Uptake.pdf

[181] Mohsin Bin Latheef, Patrick Rooney and Dilip Soman, *Electric Vehicles: Plugging in with Behavioural Insights* (Behavioural Economics in Action at Rotman, 2018), 17. https://www.rotman.utoronto.ca/-/media/Files/Programs-and-Areas/BEAR/White-Papers/BEAR-Plugging-in-with-Behavioural-Insigts.pdf

and communicating operational savings from EVs in terms of savings missed by consumers through delaying the switch from an ICE vehicle to an EV.[182] In California, the Air Resources Board's DriveClean website provides information on electric vehicle annual fuel costs.[183] Canada's Plug 'N Drive website, meanwhile, provides estimates on longer-term cost savings from EVs.[184]

Recommendation #2: To combat low consumer awareness of operational savings from EVs and also the "hyperbolic discounting" effect, the Ontario government can improve its communications efforts to highlight how much Ontarians can potentially save in the longer term from driving EVs.

5.3! Mobilize private capital into EV infrastructure

In recent years, momentum has grown in the area of sustainable finance, driven by factors including new regulations and guidance in the financial sector, changing attitudes and investment profiles among investors, and increased interest in environmental, social, and governance (ESG) performance in the wake of the coronavirus pandemic.[185] Fundamentally, sustainable finance is about leveraging private capital to help meet climate objectives and can be defined as financial processes, risk management activities and, most importantly, capital flows that "assimilate environmental and social factors as a means of promoting sustainable economic growth and the long-term stability of the financial system."[186]

Green bonds are one illustrative example of progress in sustainable finance. The first green bond was issued in 2007 by the World Bank with issuances increasing rapidly since then. As of 2019, the World Bank had issued US$13 billion in green bonds in 20 different currencies[187] and a cumulative US$754 billion has been issued since market

[182] *Reducing barriers to electric vehicle uptake: Behavioural insights: Analysis and review,* 8.

[183] California Air Resources Board, "DriveClean". https://driveclean.ca.gov/search-vehicles

[184] Plug 'N Drive, "Kia Niro EV." https://ev.plugndrive.ca/vehicles/Kia_Niro_EV__BEV_2020_CA

[185] Cedric Smith and Morrigan Simpson-Marran, *Sustainable Finance for a Safe Climate: Perspectives on mobilizing capital for a swift, resilient recovery* (Pembina Institute, 2021), 15, 22. https://www.pembina.org/reports/sustainable-finance-for-safe-climate.pdf

[186] Government of Canada, *Final Report of the Expert Panel on Sustainable Finance (2019), 2.* https://www.canada.ca/en/environment-climate-change/services/climate-change/expert-panel-sustainable-finance.html

[187] Responsible Investment Association, *Green Bonds Fact Sheet for Investors* (2019), 1. https://www.riacanada.ca/content/uploads/2019/02/Green-Bonds-Fact-Sheet.pdf

inception.[188] Globally, the top three sectors that have benefitted from the proceeds from green bonds are energy (32%), buildings (30%) and transport (20%).[189]

What is a bond? What is a green bond?

A **bond** is a financial mechanism in which an issuer (a government or a financial corporation) takes on debt to raise capital.

A **green bond** is a bond where funds raised from an issuance are exclusively used for environmental and climate change purposes.[190]

For investors, green bonds offer risk characteristics that are similar to conventional bonds offered by the same issuers but have added benefits of transparency and impact investing.[191]

Ontario is currently the largest issuer of Canadian currency green bonds, which "capitalize on the province's ability to raise funds at low interest rates," making nine issues with a total value of $8 billion C.[192] Similarly, research has indicated that green bonds may benefit the issuer through a "greenium" — the suggestion that investors will accept lower yields than those of comparable conventional bonds.[193]

The province uses the Ontario Green Bond Framework to define which projects in areas that include clean transportation, energy efficiency and conservation, clean energy and technology, forestry, agriculture and land management, and climate adaptation and resilience can be funded with capital raised from green bond issuances.[194] Over 70% of the funds raised under Ontario's green-bond issuances have gone to seven clean-transportation projects, including six LRT and subway projects and one bus rapid-

[188] Climate Bonds Initiative, *Green Bonds Global State Of the Market 2019* (2019), 2. https://www.climatebonds.net/files/reports/cbi_sotm_2019_vol1_04d.pdf

[189] *Green Bonds Global State Of the Market 2019*, 7.

[190] Ryan Riordan, "How Green Bonds Work," *Smith Business Insight*, December 20, 2019. https://smith.queensu.ca/insight/content/how-green-bonds-work.php

[191] Mark Fattedad, "Sustainable Finance Bonds: 2020 Canadian Market," *IR leader*, 2020 http://publications.ciri.org/IR-Leader/2020/Volume-30/Issue-3/Sustainable-Finance-Bonds.aspx

[192] Ontario Financing Authority, "Province of Ontario Green Bonds." https://www.ofina.on.ca/greenbonds/greenbonds.htm

[193] Kristin Ulrike Loeffler, Aleksandar Petreski and Andreas Stephan, "Drivers of green bond issuance and new evidence on the "greenium"," *Eurasian Economic Review*

[194] "Province of Ontario Green Bonds"

transit project.[195] Ontario could likewise finance electric vehicle infrastructure investments through revenue generated by green bonds. The City of Toronto's Green Debenture Program, for example, considers infrastructure for electric and low-carbon vehicles eligible for green debenture financing.[196] The City of Ottawa Green Debenture Framework generally considers clean energy vehicle infrastructure to be eligible.[197] Finally, Hydro Ottawa's Green Bond Framework considers the "development, acquisition, maintenance, or refurbishment of infrastructure for hybrid-electric, electric, and/or fuel cell vehicles" to be eligible investments.[198]

Recommendation #3: The Province of Ontario should issue a green bond to finance and grow its EV infrastructure.

5.4! Ensure Ontario's transportation infrastructure system is ready for EVs

"Range anxiety," the worry that EVs may lose power during a trip, is a commonly noted barrier to increasing EV-ownership.[199] The ability to charge vehicles at the owner's residence is also important to increasing EV adoption, as most EV charging happens at home.

Level 2 and DC fast chargers

Level 2 chargers, similar to most power outlets, use alternating current (AC) and thus may also be referred to as AC chargers. The EV battery converts the AC charge to direct current (DC) within the vehicle. This conversion process is one reason for the relatively slower speeds of Level 2 chargers. Level 2 chargers are often used for home, work, or public charging. Level 2 chargers often have power outputs ranging between 3 and 22 kW.

[195] Ontario Financing Authority "Green Bond Projects"https://www.ofina.on.ca/greenbonds/projects.htm

[196] City of Toronto, "Green Debenture Program". https://www.toronto.ca/city-government/budget-finances/city-finance/investor-relations/green-debenture-program/

[197] City of Ottawa, "Green Bonds City of Ottawa." https://ottawa.ca/en/business/research-and-data/investor-relations/green-bonds-city-ottawa

[198] Hydro Ottawa, "Green Bond Framework." https://static.hydroottawa.com/documents/publications/bonds/Hydro%20Ottawa%20Green%20Bond%20Framework_EN.pdf

[199] *Driving EV Uptake in the Greater Toronto and Hamilton Area*, 4.

DC fast chargers convert AC to DC power within the charging station and send DC power straight to the EV battery. As a result, DC chargers are faster. DC chargers are most likely to be used for public charging and often have power outputs ranging from 20 kW to 100 kW. [200,201,202]

To ensure Ontario's transportation infrastructure system is ready for EVs, sufficient private (home and workplace) and public charging infrastructure must be available to minimize range anxiety and ensure the ability to charge from home. In addition, EV-readiness requirements can be useful in ensuring that new or existing buildings are supplied with electric vehicle charging infrastructure.

EV-readiness requirements

The term "electric vehicle readiness" usually refers to requirements for buildings to have at least a minimum amount of infrastructure for EV charging. They may range from requirements for electrical conduit installation in parking spaces to requirements for the installation of EV chargers and related infrastructure.[203]

Globally, most of the major auto-producing regions have policies or targets in place related to EV infrastructure. In 2020 and 2021 surveys, the International Energy Agency found policies including EV-readiness requirements, funding for charging stations, and targets for publicly accessible chargers in major EV-producing regions including China, the European Union, Japan, and the U.S.[204,205]

The U.K. has committed to investing £1.3 billion into charging infrastructure with a focus on fast chargers on major roads and motorways as well as on-street chargers close

[200] Greenpeace, *The impact of a 2030 ICE phase-out in the UK* (2020), 33. https://www.greenpeace.org.uk/wp-content/uploads/2020/11/The-impact-of-a-2030-ICE-phase-out-in-the-UK.pdf

[201] ChargePoint, *How Do Level 2 and DC Fast Fit in the Electric Vehicle Charging Landscape?* (2017), 2,4. http://info.chargepoint.com/rs/079-WYC-990/images/L2_DC_Report_WP_10_17_2017.pdf

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

[203] Brendan McEwen, *"EV Readiness" Requirements Framework,* prepared by McEwan Climate and Energy for the Natural Resources Canada Office of Energy Efficiency (2019), 4, 11. https://cleanairpartnership.org/cac/wpcontent/uploads/2019/10/NRCan-EV-Readiness-Requirements-Framework-Final-Report-4-11-2019-McEwen-Climate-and-Energy.pdf

[204] *Global EV Outlook 2020,* 104, 105, 107, 108, 113, 114, 118, 119.

[205] *Global EV Outlook 2021,* 59-60.

to neighbourhoods and workplaces.[206] As part of France's May 2020 *Automobile Support Plan: For a Green and Competitive Industry,* the government committed to a target of 100,000 public chargers by the end of 2021.[207] The European Union's Energy Performance of Buildings Directive "sets requirements for residential and non-residential buildings to improve access to charging points" and is being implemented by member states.[208] In the U.S., the California Energy Commission is funding the California Electric Vehicle Infrastructure Project, designed to expand public EV charging locations throughout the state.[209] More recently, the American Jobs Plan included a commitment to construct a national network of half a million electric vehicle chargers as of 2030, supported by an investment of US$15 billion.[210,211]

In Ontario, there are currently about 1,400 Level 2 public chargers and over 300 public DC fast chargers,[212] translating into a ratio of about one charger per 25 EVs on the road.[213] This compares unfavorably to more than 3,500 provincial gasoline stations[214] and the global ratio of about one charger per eight EVs on the road.[215]

The Sustainable Transportation Action Research Team has estimated that a public charger buildout that resulted in one charger for every two gasoline stations would increase EV market share by two percentage points as of 2040 and has said the policy

[206] *The Ten Point Plan for a Green Industrial Revolution,* 14.

[207] Ministere de L'Economie Des Finances et de la Relance, *Plan de Soutien a L'automobile* (2020). https://www.economie.gouv.fr/files/files/directions_services/covid19-soutien-entreprises/DP-Plan_soutien_automobile26052020.pdf, cited in *Global EV Outlook 2020*, 108.

[208] European Commission, "Questions & Answers on Energy Performance in Buildings Directive." https://ec.europa.eu/info/news/questions-answers-energy-performance-buildings-directive-2018-apr-17_en, cited in *Global EV Outlook 2021,* 59.

[209] Center for Sustainable Energy, "California Electric Vehicle Infrastructure Project." https://energycenter.org/program/california-electric-vehicle-infrastructure-project

[210] The White House, "Fact Sheet: The American Jobs Plan." https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

[211] The White House, "Fact Sheet: Biden Administration Advances Electric Vehicle Charging Infrastructure." https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-biden-administration-advances-electric-vehicle-charging-infrastructure/

[212] Natural Resources Canada, "Alternative Fuel Stations; Country: Canada; Province/Territory: Ontario," spreadsheet, March 2021. https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/electric-charging-alternative-fuelling-stationslocator-map/20487#/find/nearest

[213] Luke Sarabia, "Electric vehicle sales in Canada fell sharply in Q2 2020, at height of COVID-19 lockdown," August 26, 2020. https://electricautonomy.ca/2020/08/26/canadian-ev-sales-data-q2-2020/

[214] Government of Canada, "Businesses - Canadian Industry Statistics: Gasoline Stations - 447." https://strategis.ic.gc.ca/app/scr/app/cis/businesses-entreprises/447

[215] Ratio at the end of 2019. Source: *Global EV Outlook 2020,* 76.

scores well in terms of both public support and simplicity of administration and implementation.[216] The majority of Ontario's chargers are part of an EV network comprised of ChargePoint, Tesla, FLO, and SWTCH networks.[217] Recently, Ontario Power Generation (OPG) and Hydro One launched the Ivy Charging Network, which aims to be the largest and most connected network in Ontario, with funding support from the federal government.[218] Some of these networks have entered into roaming agreements, in which members can access one another's respective networks without additional complications or fees.[219,220]

In addition to public charging stations, funding for private charging is merited. Within Canada, British Columbia's Go Electric Home and Workplace Charger Rebates program provides 50% of the cost of single-family home chargers, to a maximum of $350 as well as 50% of the cost of workplace, apartment and condominium chargers, to a maximum of $2,000.[221,222] In Quebec, the Home Charging Station Rebate provides $600 for the purchase of a home charging station[223] and the Multi-unit Building Charging Station Rebate provides up to $5,000 for the purchase and installation of a charging station at a multi-unit building.[224] Funding for private charging stations is particularly important for

[216] *Canada's ZEV Policy Handbook,* 4, 33-34.

[217] "Alternative Fuel Stations; Country: Canada; Province/Territory: Ontario."

[218] Ontario Power Generation, "New Ivy Charging Network set to give electric vehicle drivers peace of mind," February 14, 2020. https://www.opg.com/story/new-ivy-charging-network-set-to-give-electric-vehicle-drivers-peace-of-mind/

[219] Electric Mobility Canada, "Flo and Chargepoint Announce First Ever Roaming Agreement in North America." https://emc-mec.ca/new/flo-and-chargepoint-announce-first-ever-roaming-agreement-in-north-america/

[220] Jasmin Legatos, "Major EV charging networks sign roaming agreement, opening door for more flexibility," July 16, 2021. https://electricautonomy.ca/2021/07/16/ev-charging-networks-roaming-agreement/

[221] British Columbia, "Go Electric Home and Workplace Charger Rebates." https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/clean-transportation-policies-programs/clean-energy-vehicle-program/charging-infrastructure

[222] The Province of British Columbia also funds the "EV charging rebates for apartment and condo buildings" program, which 'provides apartment and condo buildings with rebates not just for the EV chargers, but also for the technical upgrades needed to make the building EV Ready.' Source: BC Hydro, "EV charging rebates for apartment and condo buildings." https://electricvehicles.bchydro.com/incentives/charger-rebates/apartment

[223] Province of Quebec, "Home charging station rebate." https://vehiculeselectriques.gouv.qc.ca/english/rabais/domicile/programme-remboursement-borne-recharge-domicile.asp

[224] Province of Quebec, "Multi-unit building charging station rebate." https://vehiculeselectriques.gouv.qc.ca/english/rabais/multilogement/programme-remboursement-borne-recharge-multilogement.asp

Ontario residents who live in multi-unit residential buildings (MURBs) or who are "garage orphans" (residing in dwellings with no access to garages or driveways) and face unique difficulties with home charging. It is estimated that about one-third of Canadians live in MURBs or are "garage orphans".[225] Alternatively, there is potential for public charging to serve as a primary source of power for EV owners living in MURBs or who don't have access to a garage or driveway.[226]

EV-readiness requirements can ensure a baseline level of EV charging infrastructure in buildings. START has given EV readiness requirements high ratings in areas including public support, policy simplicity, and cost effectiveness, and has estimated that requirements for EV charger availability in all new residential buildings could increase EV market share by 4.5 percentage points as of 2040.[227] EV-readiness requirements can save money in the long run, as installation costs during initial construction are lower than the cost of retrofitting and therefore align with Ontario's efforts to fight climate change while saving taxpayers money. Until recently, the Ontario Building Code required EV-readiness for new residential construction.[228]

Recommendation #4: To increase widespread availability of EV-charging infrastructure, Ontario should amend the Ontario Building Code to require new residential buildings to be EV-ready. The Ontario government should also play a convening role, bringing stakeholders together to discuss best practices in retrofitting buildings for EV charging infrastructure.

Recommendation #5: To address "range anxiety," Ontario should invest in public charging-station availability, including Level 2 chargers and DC fast chargers.

[225] Government of Canada, "Zero-Emission Vehicle Charging in MURB and Garage-Orphans." https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/resource-library/zero-emission-vehicle-charging-murb-and-garage-orphans/21825

[226] *Global EV Outlook 2020*, 169.

[227] *Canada's ZEV Policy Handbook,* 35-36.

[228] City of Toronto, *City of Toronto Electric Vehicle Strategy: Supporting the City in achieving its TransformTO transportation goals,* prepared by Dunsky Energy Consulting (2019), 40. https://www.toronto.ca/wp-content/uploads/2020/02/8c46-City-of-Toronto-Electric-Vehicle-Strategy.pdf

5.5! Help Ontarians save on electric vehicle and private charging purchases

As noted previously, EVs are more expensive than comparable ICE models. The cost of private chargers adds to the upfront purchase price.

As of mid-2020, almost every major auto-producing region provided purchase incentives for electric vehicles. These incentives generally covered battery electric vehicles and plug-in hybrid electric vehicles. Incentives were generally in the range of $6,000C to $9,000C.[229]

California's Clean Vehicle Rebate Program provides up to US$7,000 on the purchase or lease of new electric vehicles including BEVs, PHEVs and FCEVs.[230] Recently, the U.K. announced a top-up to its Plug-in Car, Van, Taxi and Motorcycle grants with nearly 600 million pounds.[231]

EV purchase incentives are likely to be a more costly policy option. Nevertheless, the expense is offset by the policy's advantages. START gave financial-incentive policies high ratings for public support (noting that purchase incentives tend to be popular), policy simplicity (noting that monitoring is straightforward, and legislation is not required) and effectiveness. START estimated that financial incentives in existence at the time — ranging from $500 to $14,000 and funded through 2018 — could increase EV market share between 1.5 and 5 percentage points as of 2040. It estimated that a stronger version of the policy could increase EV market share by 15 to 20 percentage points.[232] START named sustained financial incentives as one of three policies "likely to have a large impact on ZEV sales, while being reasonably acceptable to the public."[233]

[229] From the International Energy Agency's 2020 Global EV Outlook, published in mid-2020.

US$4,500 to $6,800 converted to Canadian dollars using the 2020 Bank of Canada exchange rate.

[230] California Air Resources Board, "Clean Vehicle Rebate Program (CVRP)." https://ww3.arb.ca.gov/msprog/lct/cvrp.htm

[231] *The Ten Point Plan for a Green Industrial Revolution,* 14.

[232] *Canada's ZEV Policy Handbook*, 29-30.

[233] *Canada's ZEV Policy Handbook*, 9.

EVs are expected to achieve price parity with ICE vehicles by the mid-2020s[234] largely due to technological improvements and economies of scale.[235] EV incentives, therefore, can be phased out over time.[236]

It is important that EV incentive programs target populations that stand to benefit the most. Research by the ICCT has found that EV savings relative to income are significantly higher for households in lower income brackets, with those in the lowest-income quintile saving 7% of income annually as of 2030.[237] Lower-income households tend to spend larger proportions of income on vehicle ownership and operation than do median-income households, with the ICCT estimating shares of 50% and 16% respectively.[238] Additionally, research shows that wealthier households are more likely to purchase EVs without subsidization than lower-income households.[239,240]

Recommendation #6: To help Ontarians save on electric vehicle and private charging purchases, the province should introduce a new financial incentive program to reduce the upfront price difference between electric vehicles and comparable ICE vehicles. Subsidies can remain in place until price parity is achieved in the mid-2020s. Subsidies can be available for both businesses and fleet operators and individual consumers, with program-design considerations to increase EV accessibility for lower-income households and SMEs.

[234] BloombergBNEF, "Electric Vehicle Outlook 2020." https://about.bnef.com/electric-vehicle-outlook/

Colin McKerracher, "The EV Price Gap Narrows," June 25, 2021. https://about.bnef.com/blog/the-ev-price-gap-narrows/

[235] Peter Slowik and Nic Lutsey, *Evolution of Incentives to Sustain the Transition to a Global Electric Vehicle Fleet* (ICCT, 2016), iii-iv. https://theicct.org/sites/default/files/publications/EV Evolving Incentives_white-paper_ICCT_nov2016.pdf

[236] Carolyn Kim and Cedric Smith, *Building a zero-emission goods-movement system: Policy recommendations to strengthen Canada's ZEV freight sector* (Pembina Institute, 2020), 16. https://www.pembina.org/pub/building-zero-emission-goods-movement-system

[237] 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, 2021)." https://theicct.org/publications/EV-equity-feb2021

[238] 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* (2021), 2. https://theicct.org/sites/default/files/publications/EV-equity-feb2021.pdf

[239] Ben Sharpe and Gordon Bauer, "Low-income households could benefit the most from EVs, but we need policy fixes to make that happen," April 13, 2021, Electric Autonomy. https://electricautonomy.ca/2021/04/13/ev-equity-incentive-policies/

[240] Alan Jenn, Jae Hyun Lee, Scott Hardman and Gil Tal, *An Examination of the Impact That Electric Vehicle Incentives Have on Consumer Purchase Decisions Over Time* (University of California Institute of Transportation Studies 2018), 18. https://escholarship.org/uc/item/0x28831g

A complementary financial incentive program should be considered for the purchase of private EV chargers in homes, workplaces, and commercial facilities.

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6.! Conclusion

Only recently has Ontario gained a foothold in the EV manufacturing sector, with billions of dollars of investment being directed into new manufacturing capacity in Oakville, Windsor, and Ingersoll. Ontario's EV supply chain is also poised for growth, with the province benefiting from significant cobalt, copper, and nickel production, as well as aluminum processing and a nascent battery manufacturing and recycling sector.

To build on this foundation and expand its EV industry, Ontario must develop and operationalize a comprehensive strategy that includes supply-side and demand-side policy to drive growth and EV uptake. Currently Ontario's EV market share lags behind leading jurisdictions including Germany and China.

Our modeling estimates that, if Ontario were to grow its EV market to account for 100% of total light-duty automobile sales as of 2035, direct, indirect and induced economic benefits associated with EV manufacturing would include over 24,200 jobs, and over $3.4 billion in GDP in 2035. In this scenario, Ontario's EV charger and maintenance sectors can additionally benefit from nearly 23,200 jobs, and over $2.7 billion in GDP in 2035.

To maximize economic benefits from the transition to EVs, Ontario must take charge by investing in its domestic EV market though financial means as well as non-financial tools and strategies. The province should establish an Ontario Transportation Electrification Council and roadmap, build consumer awareness of the cost savings associated with EV ownership, mobilize private capital into ZEV infrastructure, increase widespread availability of EV charging infrastructure, increase the number of public charging stations in locations where they are most needed, and help Ontarians save on electric vehicle and private charging purchases.

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Appendix A.! Methodology: Economics and jobs potential

The economic and jobs potential of electric vehicle adoption in Ontario focuses on two main sectors: electric vehicle manufacturing and the production and installation of electric vehicle infrastructure. Economic benefits and job creation from the re-investment of electric vehicle operational savings into the economy and from increased use of electricity is not examined in this analysis.

As noted, the Government of Canada recently announced an accelerated target of ZEVs making up 100% of new light-duty car and passenger truck sales as of 2035. This paper's methodology examines the potential economic and jobs benefits that can accrue to Ontario if it hits a target of 100% of light-duty vehicles (including cars, passenger light trucks and freight light trucks) being electric by 2035. Reference scenario percentages are sourced from the Canada Energy Regulator's Energy Futures 2020 data.[241]

A.1! Forecasting EV sales and EV stock to 2035

Electric vehicles are split into the categories of "Passenger car" and "Light truck." Total vehicle sales for each are forecast across all fuel types to 2035 using a linear forecasting method. The targeted percentage of total new light-duty motor vehicle sales that are electric is set at 100% in 2035. The portion of electric vehicle sales that are battery electric (BEV) and plug-in hybrid electric (PHEV) are set through reference to the Boston Consulting Group's 2021 global EV projections to 2035.[242] As such, this paper assumes that plug-in electric vehicles (BEVs and PHEVs) will continue making up 100% of EV sales in Ontario from 2021 to 2035.

EV stock is calculated for 2011 to 2035 through the use of cumulative EV sales, adjusted for retirements. The assumption is made that EVs are on the road for 17 years.[243]

[241] Canada Energy Regulator, "Access and Explore Energy Futures Data." https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/access-explore/index.html

[242] Boston Consulting Group, "Why Electric Cars Can't Come Fast Enough." https://www.bcg.com/en-ca/publications/2021/why-evs-need-to-accelerate-their-market-penetration

[243] Canada Energy Regulator, "Towards Net Zero." https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/net-zero/index.html

A.2! Job creation and economic benefits in EV manufacturing

The cost of EV passenger cars and light trucks is based on *Update on electric vehicle costs in the United States through 2030* by the International Council for Clean Transportation.[244] It is assumed that the share of Ontario's EV market serviced by Ontario-based production reaches 25% by 2035.[245]

Input-output multipliers from Statistics Canada were used to calculate economic and jobs benefits.[246] The multipliers are for Ontario, measure benefits occurring within the province, and are for the industry "Automobile and light-duty motor vehicle manufacturing." This industry is defined as:

> "This Canadian industry comprises establishments primarily engaged in manufacturing light-duty vehicles and their chassis, for highway use. The manufacture of electric cars for highway use is included."[247]

Table 3, below, provides an overview of the multipliers used and the resulting direct, indirect, and induced EV manufacturing economic and jobs benefits from Ontario achieving an EV light-duty vehicle market share of 100% by 2035.

Table 3. EV manufacturing jobs and economic benefits (2035)

	Revenues	Multiplier	Benefit
Jobs	$8.9 billion	2.73 jobs per $1 million output	24,200 jobs
Gross domestic product		$0.39 per $1 output	$3.44 billion GDP

[244] Nic Lutsey and Michael Nicholas, *Update on electric vehicle costs in the United States through 2030* (International Council for Clean Transportation, 2019), 7. https://theicct.org/publications/update-US-2030-electric-vehicle-cost

[245] International Trade Administration, "Canada - Country Commercial Guide". https://www.trade.gov/knowledge-product/canada-automotive

[246] Statistics Canada, "Input-output multipliers, provincial and territorial, detail level." https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3610059501

[247] Statistics Canada, "336110 – Automobile and light-duty motor vehicle manufacturing." https://www23.statcan.gc.ca/imdb/p3VD.pl?CLV=5&CPV=336110&CST=01012012&CVD=118471&Function=getVD&MLV=5&TVD=118464

A.3! Jobs and economic benefits in EV charger manufacturing and installation

The installation and manufacturing cost of electric vehicle charging stations is taken from the 2020 study, *The impact of a 2030 ICE phase-out in the U.K.* by Cambridge Econometrics and Element Energy.[248] These include private level 2 chargers (home and work) and public level 2 and DC fast chargers.

Assumptions are made on current (2020) and future (2035) ratios of EV chargers to EVs on the road. The current ratio of public level 2 and DC fast chargers to EVs on the road is sourced from Natural Resources Canada's *Electric Charging and Alternative Fueling Stations Locator*.[249] The current ratio of private level 2 chargers to EVs on the road is taken from the International Energy Agency's *Global EV Outlook 2020*.[250] The future 2035 ratio of private and public level 2 and DC fast chargers to EVs on the road is based on the same publication.[251]

This paper calculates benefits from both the manufacturing and installation of EV chargers. Input-output multipliers from Statistics Canada are used.[252] The multipliers are for Ontario, and measure benefits occurring within the province.

For EV charger manufacturing, the industry "Other electrical equipment and component manufacturing" is used. This industry is defined as:

> "This industry group comprises establishments not classified to any other industry group, primarily engaged in manufacturing electrical power storage and transmission devices, and accessories for carrying current."[253]

[248] Jamie Pirie, Jon Stenning, Celine Cluzel, Tristan Dodson and Alessandro Zanre, *The impact of a 2030 ICE phase-out in the UK* (2020), prepared by Cambridge Econometrics, 33. https://www.greenpeace.org.uk/wp-content/uploads/2020/11/The-impact-of-a-2030-ICE-phase-out-in-the-UK.pdf

[249] Natural Resources Canada, "Electric Charging and Alternative Fueling Stations Locator." https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation-and-alternative-fuels/electric-charging-alternative-fuelling-stationslocator-map/20487#/analyze?region=CA-ON&country=CA&fuel=HY&ev_levels=dc_fast

[250] *Global EV Outlook 2020*, 74.

[251] *Global EV Outlook 2020*, 167.

[252] Statistics Canada, "Input-output multipliers, provincial and territorial, detail level." https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3610059501

[253] Statistics Canada, "3359 – Other electrical equipment and component manufacturing." https://www23.statcan.gc.ca/imdb/p3VD.pl?CLV=3&CPV=3359&CST=01012012&CVD=118467&Function=getVD&MLV=5&TVD=118464

For EV charger installation, the industry "Engineering construction" is used.

The simplifying assumption is made that 100% of EV chargers in Ontario are manufactured and installed in Ontario. As such, economic and jobs estimates will be optimistic, but will also make the case for continued growth in Ontario's EV charger sector.

Table 4, below, provides an overview of the multipliers used and the resulting direct, indirect, and induced EV charger manufacturing economic and jobs benefits from Ontario achieving an EV light-duty vehicle market share of 100% by 2035.

Table 4. EV charger manufacturing jobs and economic benefits (2035)

	Revenues	Multiplier	Benefit
Jobs	$1.22 billion	4.79 jobs per $1 million output	5,800 jobs
Gross domestic product		$0.55 GDP per $1 output	$0.67 billion GDP

Table 5, below, provides an overview of the multipliers used and the resulting direct, indirect, and induced EV charger installation economic and jobs benefits from Ontario achieving an EV light-duty vehicle market share of 100% by 2035.

Table 5. EV charger installation jobs and economic benefits (2035)

	Revenues	Multiplier	Benefit
Jobs	$2.23 billion	7.79 jobs per $1 million output	17,400 jobs
Gross domestic product		$0.91 GDP per $1 output	$2.03 billion GDP

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Appendix B.! Policy recommendation summary

Table 6. Policy recommendations — summary

Recommendation	Description	EV barrier addressed	Estimated cost (2022-2024)
Recommendation #1: Ontario Transportation Electrification Council	Ontario should establish a Council to lay out a long-term, co-ordinated, and holistic electrification strategy for the province.	Supports recommendations #2-6	NA
Recommendation #2: Raise awareness among consumers	Ontario should ensure that its current and future EV messaging and communications highlight longer-term EV savings.	Low consumer awareness of and concern for long-term operational savings from EVs	NA
Recommendation #3: Mobilize private capital into EV infrastructure	Ontario should issue a green bond to help fund EV infrastructure investments through private capital	Supports recommendation #5 Insufficient private sector capital in EVs	NA
Recommendation #4: EV readiness requirements	Ontario should amend the Ontario Building code to require new residential buildings to be EV-ready.	High costs of retrofitting existing buildings for EV infrastructure Range anxiety	NA
Recommendation #5: Public charging infrastructure buildout	Ontario should earmark funding for an increased number of public charging stations.	Range anxiety	$100 million
Recommendation #6.1: EV purchase incentive program	Ontario should implement a financial incentive program for EV purchases.	Higher upfront EV purchase prices relative to ICE vehicles	$250 million
Recommendation #6.2: Private EV charging incentive program	Ontario should introduce a financial assistance program for the purchase of private EV chargers.	Higher upfront EV purchase prices Range anxiety	$120 million