



## TOWARD A GREEN MOBILITY FUTURE

Drivers for Growth and  
Ontario's Strengths

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# INTRODUCTION

It is certain that the use of electric vehicles (EVs) brings significant benefits to societies, compared to the conventional internal combustion engine vehicles (ICEVs) we have mostly on our roads today. The development and adoption of EVs can help significantly reduce transportation emissions and reliance on fossil fuels as well as strengthening economies through creating more jobs, attracting investments, and establishing partnerships. In our previous report<sup>1</sup> of the specialized series, we discussed the different types of EVs and their charging infrastructure technologies, major benefits of adopting EVs, and current market dynamics of EV adoption globally and in Canada. This report is part 2 of a series on green mobility.

Despite the tangible progress of EV adoption worldwide over the past decade, it is still considered in its infancy. To start to reap the benefits of green mobility, the

number of EVs on roads has to surpass that of the conventional ICEVs. To achieve this, many steps have to be taken and several factors to be considered by all the players of the automotive and mobility ecosystem, including governments, industry, and researchers. **In this report, we focus on driving attention to the major drivers for growth to be considered for significantly elevating the adoption of EVs.**

As Ontario looks to transition to a more sustainable future, the province is working diligently on leveraging its resources to accelerate EV development and adoption in the province. **This report also sheds light on the major strengths of Ontario as a global leader and partner toward reaching a green mobility future.** Thanks to these numerous strengths, the world has been eyeing the province as a leading jurisdiction to partner with, learn from, and establish businesses at.

<sup>1</sup> The Ontario Vehicle Innovation Network (OVIN). (2021). Introduction to Electric Vehicles and Charging Infrastructure. Retrieved from

[https://www.ovinhub.ca/wp-content/uploads/2021/06/AVIN\\_Quarterly-Specialized-Report\\_June-2021.pdf](https://www.ovinhub.ca/wp-content/uploads/2021/06/AVIN_Quarterly-Specialized-Report_June-2021.pdf)

# FACTORS DRIVING GROWTH



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## Price Parity

One of the biggest hurdles facing the wide adoption of EVs is the purchase price difference between an EV and its ICEV counterpart. Consumers are tempted to save money and they go for the lower-priced option, which is still a winning point for ICEVs. Price parity between EVs and ICEVs is therefore a major driver for EV adoption growth. It is only when EVs are priced the same or very close to ICEVs that we will find vehicle consumers more motivated to switch to an EV option.

In an EV, the on-board battery is the most costly component, and it accounts for the higher EV price relative to its ICEV counterpart. To achieve the target of reaching price parity sooner than later, many original equipment manufacturers (OEMs) and battery manufacturers are currently focusing on using more cost-effective technologies for battery production to bring the cost of vehicle batteries, and subsequently EVs, down. Counting on this approach for reducing battery cost, the International Council on

Clean Transportation anticipates that price parity is likely to occur between 2024–2025 for shorter-range and 2026–2028 for longer-range EVs<sup>2</sup>.

Until we reach this price parity point, governments and some non-profit organizations worldwide have been investing in providing incentives to individuals in the form of subsidies to shrink the gap between EV and ICEV prices. For example, the Government of Canada, through its **Incentives for Zero-Emission Vehicles (iZEV) Program**, offers point-of-sale incentives for consumers who buy or lease a new EV<sup>3</sup>. There are two levels of incentives under this program:

- 1) Battery-electric, fuel-cell, and longer-range plug-in hybrid vehicles are eligible for up to C\$5,000, and
- 2) Shorter range plug-in hybrid electric vehicles are eligible for up to C\$2,500.

As an incentive for buyers of used EVs through the **Used Electric Vehicle Incentive** by the non-profit Plug'n Drive,

<sup>2</sup> International Council on Clean Transportation. (2019). Update on electric vehicle costs in the United States through 2030. Retrieved from [https://theicct.org/sites/default/files/publications/EV\\_cost\\_2020\\_2030\\_20190401.pdf](https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf)

<sup>3</sup> Transport Canada. Incentives for purchasing zero-emission vehicles. Accessed through <https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/incentives-purchasing-zero-emission-vehicles>

vehicle buyers in Ontario can qualify for C\$1,000 toward the purchase of a used fully electric vehicle<sup>4</sup>. This program is offered by Plug'n Drive in collaboration with Clean Air Partnership and with support from the M. H. Brigham Foundation. Brought by the same initiative and partners, the **Scrappage Incentive Program** offers C\$1,000 when a vehicle owner recycles an old ICEV and replaces it with a used EV<sup>5</sup>. This adds to the Used EV Incentive program, providing up to C\$2,000 in incentives combined.

Many other governments have offered similar subsidy programs. Germany, for example, has an EV incentive plan that stood out in Europe, offering about \$10,000 purchase discount per vehicle<sup>6</sup>. France has recently increased the state bonus for consumers buying EVs that cost up to \$50,000 to almost \$8,000, as part of the country's \$8.8 billion COVID-recovery package for the auto industry. Under the same initiative<sup>7</sup>, a consumer replacing an

old vehicle for a new EV could be eligible for up to \$13,500.

The impact of EV purchase incentives on consumer choice has been clearly emphasized by the fluctuations in the EV market in China and some European countries. The EV sales in China declined in July 2019 after the government rolled back purchase subsidies and planned to phase them out entirely<sup>8</sup>. In the United Kingdom<sup>9</sup>, sales of EVs went down 11.8 percent in June 2019, compared to June 2018, after the government stopped subsidies for hybrid vehicles and reduced subsidies for fully electric vehicles from £4,500 to £3,500.

For EV adoption to reach its turning point though, EV prices need to be competitive to those of the ICEVs without government support. Innovation and developments toward reducing battery costs will remain the main enabler for reaching the intended price parity, as further discussed in the following part.

<sup>4</sup> Plug'n Drive. Used Electric Vehicle Incentive. Accessed through <https://www.plugndrive.ca/used-electric-vehicles-incentive/>

<sup>5</sup> Plug'n Drive. Scrappage Incentive Program. Accessed through <https://www.plugndrive.ca/used-electric-vehicles-scrappage/>

<sup>6</sup> European Alternative Fuels Observatory. Germany Incentives. Retrieved from

<https://www.eafo.eu/countries/germany/1734/incentives>

<sup>7</sup> Sigal, P. (2020). France to help auto sector with measures worth \$8.8B. Retrieved from

<https://europe.autonews.com/automakers/france-help-auto-sector-measures-worth-88b>

<sup>8</sup> Barrett, E. (2021). China is rolling back the subsidies that fueled its electric-vehicle boom. Retrieved from

<https://fortune.com/2021/01/05/china-electric-vehicle-subsidies-sales-tesla/>

<sup>9</sup> Jolly, J. (2019). Subsidy cuts blamed for fall in UK sales of electrified vehicles. Retrieved from

<https://www.theguardian.com/business/2019/jul/04/subsidy-cuts-blamed-for-fall-in-uk-sales-of-electrified-vehicles>

# Battery Technology Breakthroughs

As mentioned above, getting battery production cost down is the top enabler for reducing the purchase price of EVs and, eventually, reaching price parity with ICEVs. Besides the EV purchase cost, the driving range anxiety is also one of the major barriers that keep consumers hesitant to switch to EVs. Consumers are concerned about the driving range offered by EVs compared to ICEVs, which is limited by the capacity of the battery on-board. According to a recent poll by KPMG, over 77 percent of Canadians will not consider buying an EV until it is guaranteed that the vehicle can go for a minimum of 400 km on a fully charged battery<sup>10</sup>. There is also a trade-off between the battery cost and its offered driving range. In other words, increasing battery capacity leads to increasing its production cost, which consequently results in increasing the overall vehicle price.

To tackle these limitations and challenges brought by the use of batteries, many

OEMs and battery manufacturers are currently focusing on research and development (R&D) targeting battery technology and material science breakthroughs that can reduce cost, while increasing the offered driving range.

**" Battery cell production is the fundamental rate-limiter slowing down a sustainable energy future."<sup>11</sup>**

Elon Musk, CEO of Tesla

<sup>10</sup> KPMG. (2021). Charging the Spark. Retrieved from <https://assets.kpmg/content/dam/kpmg/ca/pdf/2021/03/charging-the-spark-kpmg-in-canada.pdf>

<sup>11</sup> Elon Musk on Twitter. (2021). Retrieved from <https://twitter.com/elonmusk/status/1351044768030142464>

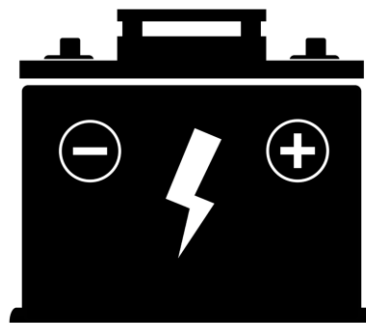


In addition to advancements in lithium-ion batteries, current investments in battery technology R&D are more inclined toward new lithium-silicon, nickel-based, and solid-state battery technologies<sup>12</sup>.

Currently, cobalt is commonly used due to its good stability, but it is one of the most expensive battery materials<sup>13</sup>. Replacing it with less expensive yet efficient materials is one of the biggest steps toward alleviating the EV battery challenges. It is anticipated that these new battery technologies and materials will increase battery capacity, cost less, charge faster, and last longer, which will significantly drive the growth of EV adoption and consumer satisfaction. In a recent study by the Boston Consulting Group (BCG)<sup>14</sup>, the company projects that battery pack costs

will drop to \$75 per kWh by 2030 and, consequently, the global market share of battery electric vehicles (BEVs) will rise to 28 percent.

As an example of these battery technology breakthroughs, an EV battery that is claimed to be charged in five minutes and has been developed by the Israeli company StoreDot and manufactured by Eve Energy in China. Compared to the conventional lithium-ion batteries that use graphite as an electrode, the StoreDot battery samples replace graphite with semiconductor nanoparticles that work faster. According to a recent press release<sup>15</sup>, the company expects to use silicon, which is cheaper, in its second-generation battery prototype to be launched by the end of 2021.



<sup>12</sup> Deloitte. (2021). Electric cars: let's look behind the buzz. Retrieved from <https://www2.deloitte.com/uk/en/blog/the-green-room/2021/electric-cars-lets-look-behind-the-buzz.html>

<sup>13</sup> Deng, J; Bae, C; Denlinger, A; and Miller, T. (2020). Electric Vehicles Batteries: Requirements and Challenges. Retrieved from <https://www.sciencedirect.com/science/article/pii/S254243512030043X>

<sup>14</sup> Boston Consulting Group. (2021). Why Electric Cars Can't Come Fast Enough. Retrieved from

<https://www.bcg.com/en-ca/publications/2021/why-evs-need-to-accelerate-their-market-penetration>

<sup>15</sup> Cision PR Newswire. (2021). StoreDot One Step Closer to Eliminating EV Charging & Range Anxiety with Launch of First Ever '5-Minute Charge' Li-ion Battery Samples. Retrieved from <https://www.prnewswire.com/news-releases/storedot-one-step-closer-to-eliminating-ev-charging--range-anxiety-with-launch-of-first-ever-5-minute-charge-li-ion-battery-samples-301210213.html>



Tesla also announced that it is exploring innovative methods to integrate treated silicon and nickel in its EV batteries. The company expects that, by using new treatment methods, it could increase the range of Tesla vehicles by 20 percent<sup>16</sup>.

Other EV battery advancements have also been seen in the past couple of years. For example, in March 2020, General Motors (GM) revealed new Ultium batteries, which could enable a GM-estimated range up to 400 miles or more on a full charge with 0 to 60 mph acceleration as low as 3 seconds<sup>17</sup>. This comes as part of GM's announced strategy to grow the company's EV sales. As another example, Martinrea International, a global automotive supplier headquartered in Ontario, has recently announced a joint venture, called VoltaXplore, with the Montreal-based graphene producer NanoXplore to develop EV batteries enhanced with graphene. Martinrea claims that the use of graphene will improve both vehicle charge time and driving range. VoltaXplore targets opening a demonstration facility near Montreal within the next year for the development

and production of these graphene-enhanced EV batteries<sup>18</sup>.

**Martinrea  
International,  
headquartered in  
Ontario, has  
announced a joint  
venture to develop  
EV batteries  
enhanced with  
graphene**

<sup>16</sup> Shieber, J. and Korosec, K. (2020). Tesla claims it can drive battery costs down even lower with new material science innovations. Retrieved from <https://techcrunch.com/2020/09/22/tesla-claims-it-can-drive-battery-costs-down-even-lower-with-new-material-science-innovations/>

<sup>17</sup> General Motors. (2020). GM Reveals New Ultium Batteries and a Flexible Global Platform to Rapidly Grow its EV Portfolio. Retrieved from <https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2020/mar/0304-ev.html>

<sup>18</sup> Martinrea International Inc. (2021). Martinrea International Inc. Announces Joint Venture with NanoXplore to Develop Electric Vehicle Batteries Enhanced with Graphene. Retrieved from <https://www.martinrea.com/news-release/martinrea-international-inc-announces-joint-venture-with-nanoxplore-to-develop-electric-vehicle-batteries-enhanced-with-graphene/>

# Regulatory and Policy Considerations

One of the major approaches that has deemed effective in terms of growing EV adoption is imposing enabling regulations and policies by governments. For example, some governments have set **tight regulations on tailpipe emissions**, which forced OEMs with sales in their jurisdictions to produce more EVs to meet these emission targets. Examples include the target of 90 percent cut in transport emissions set by the European Union for 2050 as part of the European Green Deal<sup>19</sup>. In the United States (US), President Biden has recently made a new commitment to cut greenhouse gas emissions in half by 2030, as part of rejoining the Paris climate agreement<sup>20</sup>. The Government of Canada has also recently announced increasing its targets for emissions reductions under the Paris agreement to 40-45 percent below 2005 levels by 2030<sup>21</sup>. In 2018, the

Canadian province of Quebec enforced a zero-emission vehicle (ZEV) standard<sup>22</sup>, requiring automakers to accumulate credits by bringing zero-emission vehicles or low-emission vehicles to the Quebec market and imposing targets on these accumulated credits. Numbers have shown that such regulatory requirements and mandates have affected how OEMs allocate EVs across jurisdictions. Outside of Quebec, British Columbia, and Ontario, fewer than 20 percent of dealerships have at least one EV on their lot<sup>23</sup>.

Many jurisdictions have also announced that they will **phase out ICEV sales** by certain dates, which also contributed to the expansion of EV production. Europe is leading in this regulatory approach, with Norway and the Netherlands having the most stringent timelines. The Canadian province of British Columbia joined the race and passed the ZEV Act<sup>24</sup> in May 2019, requiring automakers to meet increasing annual levels of EV sales reaching 10

<sup>19</sup> European Commission. (2020). European Sustainable and Smart Mobility Strategy. Retrieved from

[https://ec.europa.eu/transport/themes/mobilitystrategy\\_en](https://ec.europa.eu/transport/themes/mobilitystrategy_en)

<sup>20</sup> Lederman, J. and Chow, D. (2021). Biden commits to cutting U.S. emissions in half by 2030 as part of Paris climate pact. Retrieved from <https://www.nbcnews.com/politics/white-house/biden-will-commit-halving-u-s-emissions-2030-part-paris-n1264892>

<sup>21</sup> Natural Resources Canada. (2021). Zero Emission Vehicle Awareness Initiative. Retrieved from

<https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/electric-and-alternative-fuel-infrastructure/zero-emission-vehicle-awareness-initiative/22209>

<sup>22</sup> The Government of Quebec. The zero-emission vehicle (ZEV) standard. Retrieved from

<https://www.environnement.gouv.qc.ca/changementsclimatiques/vze/index-en.htm>

<sup>23</sup> House of Commons Canada. (2020). Standing Committee on Environment and Sustainable Development. Retrieved from

<https://www.ourcommons.ca/DocumentViewer/en/43-2/ENVI/meeting-8/evidence>

<sup>24</sup> Government of British Columbia. Zero-Emission Vehicles Act. Retrieved from

<https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/clean-transportation-policies-programs/zero-emission-vehicles-act>

percent of new light-duty vehicle sales by 2025, 30 percent by 2030, and 100 percent by 2040. At the national level, the Government of Canada had set the same targets that it has recently ambitiously changed to 100 percent by 2035<sup>21</sup>, but has not yet imposed a binding regulation.

To meet these mandates and avoid costly fines, many OEMs have planned to expand their EV production massively, with a growing number tending to phase out ICE powertrains altogether<sup>14</sup>. Jaguar Land Rover, for example, announced in February 2021 that it plans to be all-electric by 2025, with the aim to achieve net zero carbon emissions across its supply chain, products, and operations by 2039<sup>25</sup>. GM as well announced in January 2021 that it plans to be carbon-neutral by 2040, with an aspiration to eliminate tailpipe emissions from new light-duty vehicles by 2035. GM also plans to offer 30 fully electric models globally by mid-decade and have 40 percent of the company's offered US models be BEVs by the end of 2025<sup>26</sup>.

To further drive the EV uptake in Ontario, the provincial government has recently

announced establishing a **Transportation Electrification Council** to inform a Transportation Electrification Policy as part of phase 2 of its Driving Prosperity Plan<sup>27</sup>. Council discussions will support the government's efforts to electrify the mobility sector and identify opportunities in the areas of charging infrastructure, information and awareness, upfront cost, and supply of EVs in Ontario.

**The Government of  
Ontario has  
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<sup>25</sup> Jaguar Land Rover. (2021). Reimagine. Retrieved from <https://www.jaguarlandrover.com/reimagine>

<sup>26</sup> General Motors. (2021). General Motors, the Largest U.S. Automaker, Plans to be Carbon Neutral by 2040. Retrieved from <https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html>

<sup>27</sup> Ontario's Ministry of Economic Development, Job Creation and Trade. Driving Prosperity: The Future of Ontario's Automotive Sector. Accessed through <https://www.ontario.ca/page/driving-prosperity-future-ontarios-automotive-sector>

# Government Investments and Rebates

Government investments and rebates have a huge impact on EV developments and deployments. In addition to the EV purchase subsidies discussed earlier, other forms of government investments and monetary support have been also offered worldwide to both consumers and EV manufacturers to further boost the EV market.

In Canada, the federal and provincial governments have been in the forefront in terms of adopting this growth-driving approach and been investing heavily in programs and initiatives to ease purchase and manufacturing of EVs and their charging infrastructure. Since 2015, the Government of Canada has made an investment of over C\$1 billion toward a net-zero mobility future, including the continuous support of its iZEV purchase incentive program<sup>3</sup>. Most recently, in the 2021 budget<sup>28</sup>, the federal government announced that C\$17.6 billion will go

toward a “green recovery” for the country, which includes expedited decarbonization of the auto sector and development of a battery supply chain. This includes C\$9.6 million for establishing a Critical Battery Minerals Centre of Excellence at Natural Resources Canada and C\$36.8 million toward R&D in the mining and refining sectors. This also includes an additional C\$5 billion investment over seven years for the Net Zero Accelerator initiative<sup>29</sup>. This initiative is to support projects that can enable Canada to reduce its domestic greenhouse gas emissions, including those from the transportation sector. The budget also provides C\$56.1 million over five years to Measurement Canada to develop and implement, in accordance with international partners, a set of codes and standards for retail ZEV charging and fueling stations.

In July 2021, the federal government also announced a C\$12.7 million investment in six clean energy technology projects<sup>30</sup> for EVs that include: developing a pilot for heavy-duty electric truck charging stations in Ontario by Hydro One, implementing a smart charging platform for the Toronto

<sup>28</sup> Government of Canada. Budget 2021. Accessed through <https://www.budget.gc.ca/2021/report-rapport/p2-en.html>

<sup>29</sup> Innovation, Science and Economic Development Canada. Net Zero Accelerator Initiative. Accessed through <https://www.ic.gc.ca/eic/site/125.nsf/eng/00039.html>

<sup>30</sup> Natural Resources Canada. (2021). Canada Invests in Clean Technologies for Electric Vehicles. Retrieved from <https://www.canada.ca/en/natural-resources-canada/news/2021/07/canada-invests-in-clean-technologies-for-electric-vehicles.html>

Transit Commission's (TTC's) electric bus fleet, demonstrating a shared economy model for EV chargers by Opus One Solutions, developing and implementing an EV model for single-family and multi-unit residential buildings by Alectra, demonstrating an enhanced SmartCharge incentive system by Geotab, and testing a cost-effective vehicle-to-grid system by Blackstone Energy Services. These projects are funded through Natural Resources Canada's Green Infrastructure – Electric Vehicle Infrastructure Demonstration Program, which, to date, has supported over 20 demonstration projects across the country<sup>31</sup>.

In addition to those offered to make purchasing an EV affordable<sup>3</sup>, rebates are offered by many governments for the installation of private EV chargers at homes and workplaces as well. For example, in April 2020, China pledged more than \$1.4 billion to subsidize installing EV charging stations in order to further promote the ownership of EVs<sup>32</sup>. Some Canadian

provinces and municipalities have similar offerings<sup>33</sup>. For example, the province of British Columbia, in collaboration with BC Hydro and FortisBC, offers charging station rebates to both residential properties<sup>34</sup> and workplaces<sup>35</sup>.

More EV monetary support is also offered by the Government of Canada in the form of tax relief. The 2021 federal budget proposed a temporary measure to reduce corporate income tax rates for qualifying companies manufacturing ZEVs, their batteries, and/or charging systems<sup>36</sup>. The impacts of tax reductions have been clearly emphasized in other jurisdictions that have followed the same approach. For example, when Germany reduced the company car tax in early 2019, this succeeded in boosting the country's EV sales later that year<sup>37</sup>.

On the provincial side, the Government of Ontario is investing C\$56.4 million over the next four years to create the Ontario Vehicle Innovation Network (OVIN) and

<sup>31</sup> Natural Resources Canada. Electric Vehicle Infrastructure Demonstration (EVID) Program. Accessed through

<https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/electric-vehicle-infrastructure-demonstrations-evid/20467>

<sup>32</sup> McKinsey & Company. (2020). Electric mobility after the crisis: Why an auto slowdown won't hurt EV demand. Retrieved from <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/electric-mobility-after-the-crisis-why-an-auto-slowdown-wont-hurt-ev-demand>

<sup>33</sup> ChargeHub. (2021). Rebates for home EV chargers in Canada. Retrieved from

<https://chargehub.com/en/charging-stations-incentives-in-canada.html>

<sup>34</sup> The Government of British Columbia. CleanBC. Accessed through <https://goelectricbc.gov.bc.ca/#rebates>

<sup>35</sup> BC Hydro. EV charger rebate program for workplaces. Accessed through <https://electricvehicles.bchydro.com/incentives/charger-rebates/workplace>

<sup>36</sup> Government of Canada. (2021). Tax Measures - Supplementary Information. Retrieved from

<https://www.budget.gc.ca/2021/report-rapport/anx6-en.html>

<sup>37</sup> The International Council on Clean Transportation. (2019). Finally catching up: What powers the EV uptake in Germany? Retrieved from <https://theicct.org/blog/staff/germany-ev-uptake-market>

accelerate the development of next generation electric, connected, and autonomous vehicle and mobility technologies. More details on OVIN are mentioned later in the report.

In September 2020, both the Government of Ontario and the Government of Canada also announced contributions of C\$295 million each to build EVs at Ford's Oakville Assembly Complex, in addition to ICEVs<sup>38</sup>. In August 2021, the Government of Canada, through FedDev Ontario, has also announced a C\$5 million investment<sup>39</sup> for the Automotive Parts Manufacturers' Association (APMA) to support Project Arrow<sup>40</sup>, the first Canadian-made, zero-emission concept vehicle. The vehicle will be designed, engineered, and built exclusively by Canadian automotive manufacturers and post-secondary institutions. Through development of the prototype vehicle, Project Arrow will provide a platform to enable collaborations with Ontario innovators, demonstrating

Ontario's and Canada's automotive capabilities and innovation. Project Arrow is led by APMA in partnership with OVIN.

In the province of Quebec, the provincial and federal governments have recently announced investing C\$100 million as a joint funding to build an EV battery plant for Lion Electric, a global manufacturer of electric school buses and trucks. The company plans to establish an R&D innovation centre within its manufacturing plant as well. As a result of this investment, Lion Electric will be the first Canadian manufacturer to have automated battery-pack manufacturing facilities<sup>41</sup>.

Similar investments and support have been offered by governments in other countries as well. For example, as a major push toward growing EV adoption in the US, President Biden has recently announced investments of \$7.5 billion to build out a national network of EV chargers and \$5 billion in zero emission and clean buses<sup>42</sup>. As part of the country's \$146 billion COVID-

<sup>38</sup> Government of Ontario. (2020). Historic Ford Canada Investment Transforming Ontario into Global Electric Vehicle Manufacturing Hub. Retrieved from

<https://news.ontario.ca/en/release/58736/historic-ford-canada-investment-transforming-ontario-into-global-electric-vehicle-manufacturing-hub>

<sup>39</sup> Government of Canada. (2021). Government of Canada invests in first made-in-Canada electric vehicle. Retrieved from

<https://www.canada.ca/en/economic-development-southern-ontario/news/2021/08/government-of-canada-invests-in-first-made-in-canada-electric-vehicle.html>

<sup>40</sup> Automotive Parts Manufacturers Association (APMA). Project Arrow. Accessed through

<https://projectarrow.ca/>

<sup>41</sup> Cision. (2021). Major investments by Canada and Quebec in electric vehicle battery assembly. Retrieved from

<https://www.newswire.ca/news-releases/major-investments-by-canada-and-quebec-in-electric-vehicle-battery-assembly-847099290.html>

<sup>42</sup> The White House. (2021). Updated Fact Sheet: Bipartisan Infrastructure Investment and Jobs Act. Retrieved from

<https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/02/updated-fact-sheet-bipartisan-infrastructure-investment-and-jobs-act/>



19 economic recovery plan, Germany as well is investing \$2.8 billion in battery cell production and EV charging infrastructure<sup>43</sup>. After the pandemic hit, the French government as well announced a \$9.4 billion rescue plan for its automotive industry, which includes \$1.2 billion to provide grants of up to \$8,300 as EV purchase rebates. This French investment also includes \$1.2 billion directed into research and modernising production and a \$5.9 billion loan for Renault to develop vehicle batteries<sup>44</sup>.

## Charging Infrastructure Availability and Accessibility

In addition to the limited capacity of EV batteries, another cause of the range anxiety barrier is the limited availability and accessibility of EV charging stations, compared to the ICEV fueling stations. Motivated by the need for overcoming this barrier, one of the major focuses of governments, organizations, and

companies interested in growing EV adoption is to build more charging stations and make them well distributed such that EV owners would not worry about running out of electric charge far from a charging station while on the go. For example, as an approach to expand the availability of EV chargers in the country, in 2020, Germany announced new legislation that would require all gas stations to offer EV charging point(s)<sup>45</sup>.

Realizing this EV adoption barrier, the Government of Canada, through Natural Resources Canada, created the **Zero Emission Vehicle Infrastructure Program**<sup>46</sup>, which is a 5-year C\$280 million program aiming at increasing the availability of electric charging and hydrogen refuelling stations across Canada. According to Natural Resources Canada<sup>47</sup>, there are 15,191 EV chargers available at 6,574 stations across Canada to date. Among them, there are 1,722 EV charging stations with over 4,867 charging outlets in Ontario. There are many initiatives to further expand the EV charging networks in the

<sup>43</sup> Steitz, C. and Taylor, E. (2020). Germany will require all petrol stations to provide electric car charging. Retrieved from <https://www.reuters.com/article/us-health-coronavirus-germany-autos-idUSKBN23B1WU>

<sup>44</sup> BBC. (2020). Coronavirus: France announces €8bn rescue plan for car industry. Retrieved from <https://www.bbc.com/news/business-52814074>

<sup>45</sup> Steitz, C. and Taylor, E. (2020). Germany will require all petrol stations to provide electric car charging. Retrieved from

<https://www.reuters.com/article/us-health-coronavirus-germany-autos-idUSKBN23B1WU>

<sup>46</sup> Natural Resources Canada. Zero Emission Vehicle Infrastructure Program. Accessed through

<https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876>

<sup>47</sup> Natural Resources Canada. Electric Charging and Alternative Fuelling Stations Locator. Retrieved from <https://tinyurl.com/452jhr9e>



province. For instance, Ontario Power Generation (OPG), the largest energy provider in Ontario, is massively supporting EV charging offerings. In a joint venture with Hydro One, they have been developing the Ivy Charging Network<sup>48</sup>, Ontario's largest fast-charger network aiming for having more than 70 locations and 160 fast chargers across the province. Many other companies and organizations, such as Tesla, ChargePoint, Canadian Tire, Electrify Canada, and FLO, have been actively deploying national EV charging networks across Canada<sup>49</sup>. To further improve access to their charging networks and provide a seamless charging experience to EV owners, Greenlots, ChargePoint, EV Connect, and FLO have enabled roaming across their networks<sup>50</sup>. GM has also recently announced its plan to offer about 60,000 EV charging points across Canada and the US, in partnership with seven charging network providers<sup>51</sup>.

The accessibility and convenience to use public charging stations are also major enablers for encouraging people to switch

**In a joint venture  
with Hydro One,  
Ontario Power  
Generation (OPG)  
has been developing  
the Ivy Charging  
Network, Ontario's  
largest fast-charger  
network**

to EVs. Since level 2 charging, the most common one, takes a couple of hours to charge an EV battery, owners of EVs need to guarantee that they can do this conveniently. They need to guarantee access to a nearby place where they can rest, have a meal, and use available facilities and lavatories.

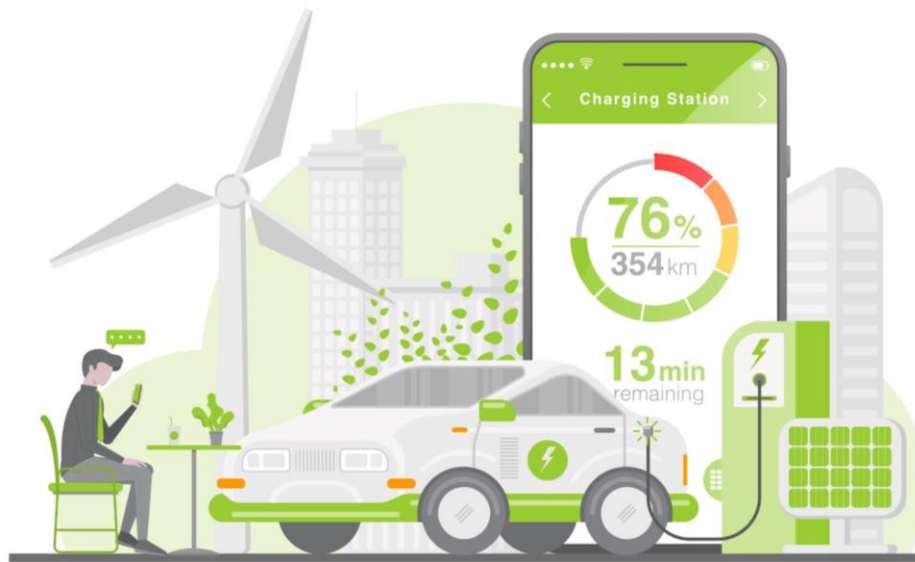
<sup>48</sup> Ontario Charging Network LP. Ontario, meet Ivy. Accessed through <https://ivycharge.com/>

<sup>49</sup> Electric Autonomy Canada. (2021). Canadian EV charging networks post double-digit growth since start of pandemic. Retrieved from <https://electricautonomy.ca/2021/02/04/canadas-ev-charging-networks-2021/>

<sup>50</sup> Archer, K. (2021). How Roaming Partnerships Can Reshape the EV Landscape. Retrieved from

<https://www.forbes.com/sites/forbestechcouncil/2021/07/12/how-roaming-partnerships-can-reshape-the-ev-landscape/>

<sup>51</sup> Reuters. (2021). GM partners up to offer about 60,000 EV charging points across Canada, U.S. Retrieved from <https://www.reuters.com/business/autos-transportation/gm-partners-up-offer-about-60000-ev-charging-points-across-canada-us-2021-04-28/>



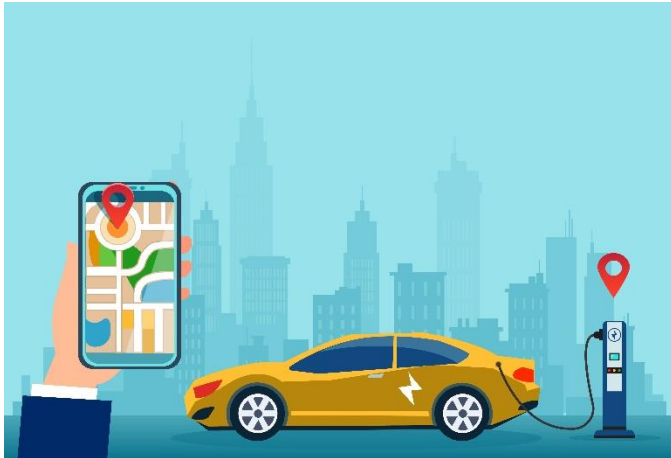
**" Drivers need to feel secure not just in their ability to find a charge, but also to access it easily and reliably. Hardware providers and network managers need to start thinking about how industry quality standards can help us further accelerate the electrification of transportation.<sup>52</sup> "**

Louis Tremblay, President and CEO of FLO

<sup>52</sup> Electric Autonomy Canada. (2020). Driving EV Adoption by Improving the EV Charging Experience. Retrieved from

<https://electricautonomy.ca/2020/11/06/improving-the-ev-charging-experience/>

Consumers also need to easily know where charging stations are located and what type of facilities are available at these locations. Fortunately, there are some mobile and web applications available to support searching for public charging stations. These applications display the location of these stations, and possibly, their wait times. The most popular app is PlugShare<sup>53</sup>, which shows the locations and details of more than 300,000 charging stations worldwide. It relies on users to supply up-to-date information about EV charging stations.



EV charging accessibility also includes accommodating the charging needs of multi-unit residential buildings. Compared to single-family houses where owners can install their own EV private chargers, these residential buildings lack this personal installation flexibility, and installations there usually require revisiting and adapting the whole building electricity capacity and equipment, which introduces a barrier to EV adoption by their residents. Therefore, it is now recommended that urban planners, building developers, and electrical-equipment suppliers accommodate EV charging infrastructure into standard building-design plans. Some municipalities have started to require that all new structures be built with EV charging offerings accommodated to avoid retrofitting costs in the future<sup>54</sup>. For example, the City of Orlando has recently passed an ordinance which will be effective in January 2022, and it requires EV charging stations to be installed/planned for at parking spaces in certain new developments in the city<sup>55</sup>.

<sup>53</sup> Recargo, Inc. PlugShare. Accessed through <https://www.plugshare.com/>

<sup>54</sup> Geotab. (2021). Addressing the barriers to EV adoption. Retrieved from <https://www.geotab.com/white-paper/barriers-to-ev-adoption/>

<sup>55</sup> The City of Orlando. (2021). Establishing an Electric Vehicle Readiness code. Retrieved from <https://www.orlando.gov/Our-Government/Departments-Offices/Economic-Development/City-Planning/Land-Development-Code-Amendments/Establishing-an-Electric-Vehicle-Readiness-code>

Some companies are also working on improving the EV charging experience through developing technologies and products that can offer fast charging on the go. For example, the Ontario-based GBatteries Energy Canada Inc. is working on an ultra-fast battery charging solution that can be used with off-the-shelf lithium-ion batteries. The company uses artificial intelligence to optimize the charging systems, and it claims that its solution allows users to charge a 60kWh EV battery pack with 119 miles of range in 5 minutes<sup>56</sup>. Another example is the California-based company FreeWire Technologies that offers fully integrated charging solutions. The company's Boost Charger is an ultrafast EV charging solution with integrated energy storage, power conversion technology, and software that lowers energy costs. Boost Charger can provide ultrafast charging that delivers up to 100 miles in 10 minutes<sup>57</sup>.

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Canada Inc. is  
working on an ultra-  
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potentially allow  
users to charge  
a 60kWh EV battery  
pack with 119 miles  
of range in 5  
minutes**

<sup>56</sup> Biggs, J. (2019). GBatteries let you charge your car as quickly as visiting the pump. Retrieved from <https://techcrunch.com/2019/01/15/gbatteries-let-you-charge-your-car-as-quickly-as-visiting-the-pump/>

<sup>57</sup> FreeWire Technologies. Boost Charger. Accessed through <https://freewiretech.com/products/dc-boost-charger/>

# Changing Consumer Sentiment

All the above drivers for growth will not help without actively working on changing consumer sentiment. It is very important to raise consumer awareness on the benefits of switching to EVs and how consumer concerns are being addressed by governments and EV manufacturers, especially as misconceptions about EVs are still common<sup>58</sup>.

Most importantly, consumers need to be taught that the total cost of ownership (TCO) of an EV is proved to be lower than an ICEV<sup>59</sup>. Since EVs use electricity instead of fossil fuels, the cost of using them is much lower than those of conventional ICEVs<sup>60,61</sup>. More savings can be gained when EV users charge their vehicles overnight at off-peak hours. EVs have

lower lifetime maintenance costs as well.

A recent analysis by Consumer Reports<sup>62</sup> finds that owners of EVs are spending half as much on maintenance and repair as the owners of comparable ICEVs.

Consumers should also be well informed about all privileges dedicated solely to EV drivers that some municipalities started to offer. As an example, in some cities in Germany, EV drivers can park their vehicles for free. Paris also offered EV drivers reduced toll and parking fees, while Oslo allowed EVs to drive in bus and taxi lanes so they can save time during rush hours<sup>63</sup>. In Ontario, the **Green Vehicle Licence Plate program**<sup>64</sup> provides EVs with ongoing access to high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes, which gives EV owners the privilege of moving faster and escaping traffic jams on regular lanes.

<sup>58</sup> MYEV. 10 Common Electric Car Myths Busted. Retrieved from <https://www.myev.com/research/ev-101/10-common-electric-car-myths-busted>

<sup>59</sup> Natural Resources Canada. Fuel Consumption Ratings Search Tool. Retrieved from <https://fcr-ccc.nrcan-rncan.gc.ca/>

<sup>60</sup> Plug'n Drive. Electric Car Benefits. Retrieved from <https://www.plugndrive.ca/electric-vehicle-benefits/>

<sup>61</sup> Boston Consulting Group. (2020). Who Will Drive Electric Cars to the Tipping Point? Retrieved from <https://www.bcg.com/publications/2020/drive-electric-cars-to-the-tipping-point>

<sup>62</sup> Consumer Reports, Inc. (2020). Electric vehicle owners spending half as much on maintenance compared to gas-powered vehicle owners, finds new CR analysis. Retrieved from

[https://advocacy.consumerreports.org/press\\_release/electric-vehicle-owners-spending-half-as-much-on-maintenance-compared-to-gas-powered-vehicle-owners-finds-new-cr-analysis/](https://advocacy.consumerreports.org/press_release/electric-vehicle-owners-spending-half-as-much-on-maintenance-compared-to-gas-powered-vehicle-owners-finds-new-cr-analysis/)

<sup>63</sup> McKinsey & Company. (2014). Electric vehicles in Europe: Gearing up for a new phase? Retrieved from <https://www.mckinsey.com/featured-insights/europe/electric-vehicles-in-europe-gearing-up-for-a-new-phase>

<sup>64</sup> Ontario's Ministry of Transportation. Ontario's Green Vehicle Licence Plate Program. Accessed through <http://www.mto.gov.on.ca/english/vehicles/electric/green-licence-plate.shtml>



In Canada, there are many helpful resources and initiatives that target changing consumer sentiment on EVs. For example, **Plug'n Drive**<sup>65</sup> is a Canadian non-profit organization committed to accelerating the adoption of EVs through being a source of information about EVs, charging stations, and the electricity sector. Programs offered by Plug'n Drive include an Electric Vehicle Discovery Centre, where visitors can learn about the environmental and economic benefits of EVs and take test drives in recent EV makes and models. Another offering by Plug'n Drive is the Mobile Electric Vehicle Education Trailer (MEET), which is a mobile

EV awareness hub that can be brought to public locations for weeks or months, equipped with informational displays on benefits of EVs, an EV test drive activity, and interactive learning tools.

Governments and OEMs as well play a major role in raising consumer awareness on EVs through, for example, running educational campaigns and events. A prominent example is the Government of Canada's **#EVWeekinCanada**<sup>66</sup>, which aimed mainly at promoting and highlighting the benefits of owning and driving ZEVs in the country and the investments provided to tackle all the adoption challenges. By switching their

<sup>65</sup> Plug'n Drive. Accessed through <https://www.plugndrive.ca/>

<sup>66</sup> Natural Resources Canada. (2021). **#EVWeekinCanada Highlights Zero-Emission Vehicle Investments Across the Country**. Retrieved from

<https://www.canada.ca/en/natural-resources-canada/news/2021/07/evweekincanada-highlights-zero-emission-vehicle-investments-across-the-country.html>





Photo courtesy of the Toronto Transit Commission

fleets to electric ones, governments contribute as well to increasing the consumer confidence in and appetite for these technologies.

OEMs can further boost consumer awareness by expanding advertisements of EVs and their advantages, in addition to facilitating EV test rides at their dealerships. This brings up the fact that education and awareness should also be

extended to auto dealers and salespeople<sup>67</sup>, as they have great influence on consumers' new vehicle purchase and choice. Some studies<sup>68</sup> showed lack of EV knowledge among some salespeople, which in many cases led them to direct buyers toward non EVs. Thus, the sooner and more dealers and salespeople get trained to communicate EV features and benefits and offer EV test rides, the more EV sales we would start to see<sup>69</sup>.

<sup>67</sup> House of Commons Canada. (2021). *The Road Ahead: Encouraging the Production and Purchase of Zero-Emission Vehicles in Canada*. Retrieved from <https://www.ourcommons.ca/Content/Committee/432/ENVI/Reports/RP11209745/envirp03/envirp03-e.pdf>

<sup>68</sup> Ipsos RDA. (2017). *Ipsos RDA Study Finds U.S. Dealerships Not Prepared for the EV Invasion*. Retrieved from

<https://www.ipsos.com/en-us/news-polls/rda-finds-us-dealerships-not-prepared-ev-invasion>  
<sup>69</sup> McDonald, L. (2018). *24 Factors That Will Affect the Rate of EV Adoption (Part 2)*. Retrieved from <https://evadoption.com/24-factors-that-will-affect-the-rate-of-ev-adoption-part-2/>



## Role of Electric Utilities

Electric utilities as well can play a significant role in driving the adoption of EVs. Through communicating with their customers, electric utilities have a great opportunity to lead in raising awareness of and promoting the use of EVs.

As providers of electricity, utilities can also offer incentives and monetary support to their customers to buy EVs and install EV chargers, in addition to offering load management and rewarding programs for reduced rates of electricity. As an example, California electric utilities, in collaboration with the California Air Resources Board, created the California Clean Fuel Reward program<sup>70</sup> that offers up to \$1,500 on the purchase or lease of an eligible new EV. This is a win-win approach given the tremendous stream of revenue expected for electric utilities from EV charging. A 2019 study by the Boston Consulting Group estimates that the rise of EVs could create \$3 to \$10 billion of new value for the average utility<sup>71</sup>. Electric utilities can also win in return from the support for grid

demand management that they can leverage through the use of vehicle-to-grid systems and programs.

Some electric utilities use load management and rewarding programs, such as SmartCharge Rewards<sup>72</sup> of Ontario's Geotab Energy, to incentivize EV customers. The SmartCharge Rewards program encourages EV owners to charge when it is best for them and their utility company and provides a platform to educate them on why it is important. Utility companies reward the EV owners in return to simply charge at off-peak hours.

**Geotab Energy's  
SmartCharge  
Rewards  
encourages EV  
owners to charge  
when it is best and  
educates them on  
why it is important**

<sup>70</sup> The California Clean Fuel Reward program. Make your best deal, then save up to \$1,500 more. Accessed through <https://cleanfuelreward.com/>

<sup>71</sup> Boston Consulting Group. (2019). Electric Vehicles Are a Multibillion-Dollar Opportunity for Utilities. Retrieved from

<https://www.bcg.com/publications/2019/electric-vehicles-multibillion-dollar-opportunity-utilities>

<sup>72</sup> Geotab. SmartCharge Rewards. Accessed through <https://www.geotab.com/smartchargerewards/>

# ONTARIO'S STRENGTHS TOWARD A GREEN MOBILITY FUTURE



Ontario is a global leader when it comes to its strengths toward driving a green mobility future. The province is poised to lead the future of EV, battery and charging infrastructure innovation and development, in addition to the adoption of these eco-friendly technologies.

## *In this section:*

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<i>Critical Minerals and Battery Production</i>	26
<i>Information Technology and Research Hub</i>	28
<i>Support for Business Innovation</i>	29

# Vehicle Manufacturing Facilities and Automotive Parts Suppliers

Ontario is the place where five of the top automakers - Ford, GM, Honda, Stellantis, and Toyota – carry out significant vehicle production every year. It is also a place where more than 700 automotive parts manufacturers, including top global suppliers such as Magna, Linamar, Martinrea, and Multimatic, as well as more than 500 tool, die and mold makers operate to produce high-quality automotive parts and components.

Many of these automotive manufacturers and suppliers are further expanding their presence and production in Ontario to include EVs and their needed components. In September 2020, Ford Canada announced a plan to build EVs at Ford's Oakville Assembly Complex in Oakville, ON, in

addition to ICEVs. This project is valued at C\$1.8 billion and will include contributions of C\$295 million from each of the provincial and federal governments<sup>73</sup>. In October 2020, Fiat Chrysler Automobiles (FCA), which recently merged with Groupe PSA as Stellantis, reached an agreement<sup>73</sup> on a C\$1.5 billion venture to build plug-in hybrid and fully electric vehicles in Windsor, ON. In January 2021, General Motors announced plans to invest C\$1 billion to manufacture the BrightDrop EV600 electric commercial vehicles at its CAMI plant in Ingersoll, ON<sup>74</sup>. In December 2020, Magna International, a global auto parts supplier headquartered in Aurora, ON, announced the launch of a joint venture with LG Electronics, tentatively called LG Magna e-Powertrain and valued at C\$1 billion, to make key components for EVs<sup>75</sup>. Dana, another global auto supplier, has widespread EV operations in Ontario, including a global battery R&D centre in Oakville and a manufacturing plant in Cambridge<sup>76</sup>.

<sup>73</sup> Cision. (2020). Deal with Fiat Chrysler secures \$1.5 billion electric vehicle investment. Retrieved from <https://www.newswire.ca/news-releases/deal-with-fiat-chrysler-secures-1-5-billion-electric-vehicle-investment-864517412.html>

<sup>74</sup> General Motors Canada. (2021). General Motors to Invest C\$1 billion to Convert CAMI into Canada's First Large-Scale Commercial Electric Vehicle Manufacturing Plant. Retrieved from [https://media.gm.ca/media/ca/en/gm/home.detail.html/content/Pages/news/ca/en/2021/Jan/0115\\_brightdrop.html](https://media.gm.ca/media/ca/en/gm/home.detail.html/content/Pages/news/ca/en/2021/Jan/0115_brightdrop.html)

<sup>75</sup> Reuters. (2020). LG and Magna announce billion dollar joint venture in electric car gear. Retrieved from <https://www.reuters.com/article/lg-elec-magna-intl-jv-idINKBN28X0EU>

<sup>76</sup> FMA Communications Canada, Inc. (2021). Canada jumps into electric vehicle industry. Retrieved from <https://www.canadianmetalworking.com/canadianmetalworking/article/mad-eincanada/canada-jumps-into-electric-vehicle-industry>

# Critical Minerals and Battery Production

Ontario is very rich in critical minerals and metals needed for EV battery production. The province is one of the main global producers of copper, nickel, cobalt, graphite, and lithium. In 2019 alone, the mining industry of Ontario produced more than C\$10 billion worth of minerals, accounting for 22 percent of Canada's total production<sup>77</sup>. There are also over 1,400 mining supply and service companies in Ontario, making its mining sector one of the strongest globally<sup>78</sup>.

Mining companies in Ontario, with support from the provincial and federal governments and in collaboration with global OEMs, are actively working on leading the extraction, processing, and production of minerals crucial for EV battery production globally and necessary for developing a North American EV supply chain<sup>79</sup>. For example, the Government of Canada and the Government of Ontario

announced in December 2020 investing C\$5 million each in the First Cobalt Corp., now called Electra Battery Materials, to accelerate domestic production of battery-grade cobalt sulfate, a required element needed to produce long-range EVs. This investment helps the company recommission and expand its cobalt refinery in North Cobalt, located in Northern Ontario. This refinery is expected to be the first and only facility of its kind in North America capable of producing 25,000 tonnes of battery-grade cobalt sulfate annually, which represents 5 percent of the global market for refined cobalt<sup>80</sup>.

In addition to cobalt, Ontario is a rich producer and supplier of other minerals crucial for EV battery production. For example, ZEN's Albany graphite deposit, west of Hearst, has an estimated open-pit life of 22 years and the potential to annually produce 33,000 tonnes of graphite. The company, ZEN Graphene Solutions, announced in March 2020 that it started scale-up and engineering studies at its Guelph R&D facility<sup>81</sup>. Another example is

<sup>77</sup> Ontario's Ministry of Energy, Northern Development and Mines. (2020). Ontario Brings Mineral and Mining Sector Back to the Forefront. Retrieved from <https://news.ontario.ca/en/statement/58970/ontario-brings-mineral-and-mining-sector-back-to-the-forefront>

<sup>78</sup> Ontario Mining Association. Facts and Figures. Retrieved from [https://oma.on.ca/en/ontario-mining/facts\\_figures.aspx](https://oma.on.ca/en/ontario-mining/facts_figures.aspx)

<sup>79</sup> The Pembina Institute. (2021). Taking Charge: How Ontario can create jobs and benefits in the electric vehicle economy. Retrieved from

<https://www.pembina.org/reports/taking-charge.pdf>

<sup>80</sup> Federal Economic Development Initiative for Northern Ontario. (2020). Government of Canada and Province of Ontario invest \$10 Million to establish North America's first cobalt refinery in Northern Ontario. Retrieved from <https://tinyurl.com/zy7ht7b2>

<sup>81</sup> Northern Ontario Business. (2020). Hearst-area graphite miner preparing to enter the market. Retrieved from <https://www.northernontariobusiness.com/industry-news/mining/hearst-area-graphite-miner-preparing-to-enter-the-market-2202431>

Ontario's Electric Avenue, which is a field in Northwestern Ontario known as so because of the size and quality of its lithium resource, which is used in batteries. In April 2021, Musk Metals announced that it entered into a project and agreement to acquire a 100 percent interest in the Pakeagama Lithium claims, located in the Electric Avenue. Frontier Lithium completed an economic assessment that outlines revenue of \$8.52 billion over 26-year total project life, and a chemical plant producing 23,174 tonnes of battery-quality lithium hydroxide monohydrate per year<sup>82</sup>. Frontier Lithium is developing a process to maximize lithium extraction and has recently received C\$363,000 from the Government of Ontario to demonstrate its extraction process. Frontier Lithium's demonstration could lead to the establishment of a commercial-scale lithium chemical plant in Northern Ontario<sup>83</sup>.

Ontario's Greater Sudbury is the world's second-largest nickel sulphide deposit site, and it is well-positioned as one of the few nickel suppliers to the EV battery industry<sup>84</sup>.

**"Our whole province will benefit as we leverage our natural resources to become a bigger player in electric vehicle parts and battery manufacturing supply chain."<sup>80</sup>**

The Honourable Victor Fedeli, Minister of  
Economic Development, Job Creation and Trade,  
Government of Ontario

<sup>82</sup> Musk Metals Corp. (2021). Musk Metals Acquires the Pakeagama Lithium Claims in the "Electric Avenue" Pegmatite Field, Northwestern Ontario. Retrieved from <https://tinyurl.com/rrsb9mn5>

<sup>83</sup> Ontario's Ministry of Energy, Northern Development and Mines. (2021). Ontario Supports Innovation in Critical Minerals Sector. Retrieved from

<https://news.ontario.ca/en/release/1000195/ontario-supports-innovation-in-critical-minerals-sector>

<sup>84</sup> Invest Ontario. (2021). Where is the future hub for battery electric vehicles? Greater Sudbury. Retrieved from <https://www.investontario.ca/spotlights/where-future-hub-battery-electric-vehicles-greater-sudbury>

Building on this fact, in February 2021, Canada Nickel, a miner headquartered in Toronto, held talks with the US government about potentially supplying nickel for EV battery production<sup>85</sup>. There is interest for greater cross-border integration as the US government is interested in securing North American supplies of critical minerals, especially those used in EV batteries, and Ontario's resources and supplies are at the forefront. This interest in a cross-border EV supply chain is strengthened by the US-Canada Joint Action Plan on Critical Minerals Collaboration pledged by Canada's Prime Minister Justin Trudeau and the US' President Joe Biden<sup>86</sup>.

## Information Technology and Research Hub

The province of Ontario is the second largest IT hub in North America after Silicon Valley, with more than 20,000 IT companies, 46 colleges and universities, and about 40,000 yearly graduates in fields of science, technology, engineering, and

mathematics (STEM). The combination of these world-leading companies, top academic institutions, and great talent has resulted in a thriving ecosystem where researchers, developers, policy makers, and entrepreneurs interact to create innovative solutions and products in diverse hot industries, including the automotive and mobility industry.

Several research centres and programs have been established across the province to leverage its diverse natural resources in addition to the world-class talent for world-leading EV innovations. An example is the Centre for Hybrid Automotive Research and Green Energy (CHARGE) at the University of Windsor that aims at promoting innovation, partnerships, and knowledge sharing to enhance the EV research landscape<sup>87</sup>. This research centre focuses on many major research areas for EVs that include electric machine design and testing, electric charging, and EV simulation and testing. The centre also helps facilitate collaboration between EV researchers and automotive companies. Another example is the McMaster Automotive Resource Centre

<sup>85</sup> Lewis, J. Canada Nickel held talks with U.S. government on supplying metal for EV batteries. Retrieved from

<https://www.reuters.com/article/us-mining-canadanickel-idUSKBN2A812L>

<sup>86</sup> Natural Resources Canada. (2020). Canada and U.S. Finalize Joint Action Plan on Critical Minerals Collaboration. Accessed through

<https://www.canada.ca/en/natural-resources-canada/news/2020/01/canada-and-us-finalize-joint-action-plan-on-critical-minerals-collaboration.html>

<sup>87</sup> University of Windsor. Centre for Hybrid Automotive Research and Green Energy (CHARGE) Lab. Accessed through <https://www.uwindsor.ca/engineering/research/383/test>



(MARC)<sup>88</sup>. Led by Dr. Ali Emadi, Canada Excellence Research Chair in Hybrid Powertrain Program, researchers at MARC focus on pioneering sustainable energy-efficient solutions from advanced power electronic converters and electric motor drives to electric, hybrid electric, and plug-in hybrid electric vehicles. To further enrich and cultivate Ontario's talent in automotive and mobility, Ontario Tech University, for example, offers master's programs in Automotive Engineering that provide students with a detailed understanding of advanced technologies and processes related to automotive systems, including manufacturing and powertrains, electrical power/control systems, and others<sup>89</sup>. These are only a few examples of the province's world-leading research centres and university programs in mobility electrification.

## Support for Business Innovation

The province is investing heavily in supporting start-ups and small- and

medium-sized enterprises (SMEs) to fund and grow their businesses and commercialize their products. Supporting business innovation in the automotive and mobility industry in particular is among the Government of Ontario's top priorities and investment allocations.

As a key component of its Driving Prosperity plan<sup>27</sup>, in Spring 2021, the Government of Ontario committed C\$56.4 million over the next four years to create the **Ontario Vehicle Innovation Network (OVIN)**<sup>90</sup> initiative to continue to support business funding, talent development, technology acceleration, and testing and demonstration sites. OVIN targets accelerating the development and commercialization of next generation electric, connected, and autonomous vehicle and mobility technologies as well as supporting Ontario's role as a leading vehicle manufacturing hub. OVIN supports business innovation and collaboration in the auto industry in addition to the battery sector, including critical minerals development in Ontario's North and facilitating partnerships and

<sup>88</sup> McMaster University. McMaster's leading hybrid electric vehicle research. Retrieved from

<https://www.eng.mcmaster.ca/engphys/spotlight/research/mcmasters-leading-hybrid-electric-vehicle-research>

<sup>89</sup> Ontario Tech University. Automotive Engineering (Master's program). Accessed through

<https://ontariotechu.ca/programs/graduate/engineering-and-applied-science/masters-automotive-engineering/index.php>

<sup>90</sup> Government of Ontario. (2021). Ontario's Action Plan: Protecting People's Health and Our Economy. Retrieved from <https://budget.ontario.ca/2021/pdf/2021-ontario-budget-en.pdf>



connections between battery innovators and automakers across the province.

OVIN is supported by the Ontario Ministry of Economic Development, Job Creation and Trade (MEDJCT) and the Ontario Ministry of Transportation (MTO) and led by the Ontario Centre of Innovation (OCI). OVIN supports SMEs to develop, test, and commercialize new automotive and transportation products and technologies, and cultivate the capacity of a province-wide network to drive future mobility solutions. OVIN offers an **R&D Partnership Fund** to help SMEs grow their businesses and leverage partnerships for the development, testing, demonstration, validation, and commercialization of technologies in the automotive and mobility sector. The R&D Partnership Fund includes three streams:

- 1) connected and autonomous vehicle and smart mobility stream,
- 2) WinterTech stream, and
- 3) electric vehicle and battery technology stream.

OVIN's **Regional Technology Development Sites (RTDSs)** are physical sites across the province that bring together post-secondary institutions, regional innovation centres, incubators/accelerators, municipal and regional resources, industry, and other

#### OVIN's Research and Development (R&D) Partnership Fund

OVIN contributes one-third of eligible projects up to a maximum of C\$1,000,000 for each project up to 2 years in duration. The remaining project costs must be covered by project partners.

In order to be eligible, SME applicants will be required to have operations in the Province of Ontario with a proposal to conduct all project activities in the Province of Ontario. Corporate partners may have global operations and may utilize an OVIN project to establish a footprint in the province.

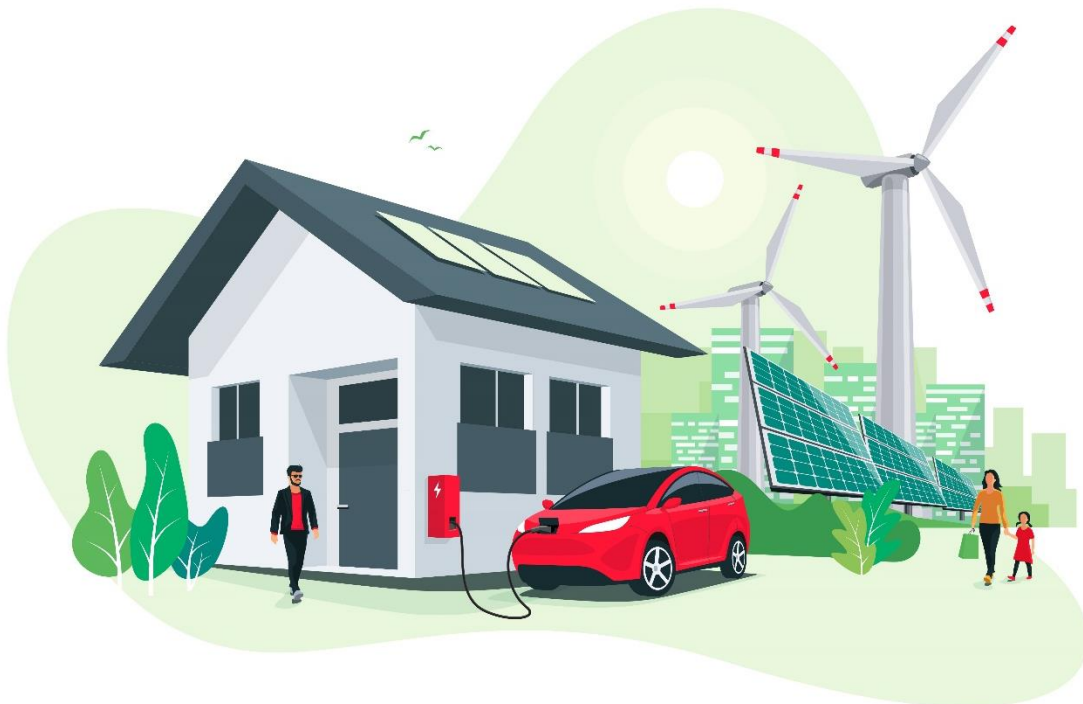
#### OVIN's R&D Partnership Fund SME Financing

regional collaborators to support SMEs in the automotive and mobility sector through providing access to specialized equipment, hardware and software, and business and technical advisory services.

OVIN will also offer a **Demonstration Zone**, where SMEs can validate, demonstrate, and pilot technologies in live scenarios and weather conditions; a **Talent Development** program that provides students and recent graduates in Ontario with real-world industry experience to solve industry

problems related to automotive and mobility technologies; in addition to supporting **Project Arrow** highlighted earlier.

The Government of Ontario's business support also includes a C\$10 million investment for the automotive supply chain through MEDJCT's **Ontario Automotive Modernization Program (O-AMP)**<sup>91</sup>. The program aims at helping automotive SMEs upgrade their capabilities and adopt advanced manufacturing processes to compete in the global market.



<sup>91</sup> Ontario's Ministry of Economic Development, Job Creation and Trade. Ontario Automotive Modernization Program. Accessed through <https://www.ontario.ca/page/ontario-automotive-modernization-program>

# HIGHLIGHTS FROM ONTARIO

## UNIVERSITY OF TORONTO'S ELECTRIC VEHICLE (UTEV) RESEARCH CENTRE

**The University of Toronto Electric Vehicle (UTEV) Research Centre** is a university-industry partnership, focused on next generation of EV technologies. Engineers and researchers at UTEV have been working with industry on new ways to make EVs more affordable and efficient for consumers, including wireless and robotic charging.

**Link:** <https://utev.utoronto.ca/>

## CANADA NICKEL

**Canada Nickel**, headquartered in Toronto, is advancing the next generation of high-quality, high-potential nickel-cobalt projects to deliver the metals needed to power the electric vehicle revolution and feed the high growth stainless steel market.

**Link:** <https://canadanickel.com/>

## FRONTIER LITHIUM

**Frontier Lithium** is an emerging lithium mineral and chemicals company based in Greater Sudbury, ON. The company is aiming to produce battery-grade lithium hydroxide and other chemicals to the growing electric vehicle and energy storage markets as well as being a premium mineral concentrates supplier for high quality glass manufacturers.

**Link:** <https://www.frontierlithium.com/>

## AVALON ADVANCED MATERIALS

**Avalon Advanced Materials** is a Canadian mineral development company headquartered in Toronto, ON. Avalon specializes in critical metals and minerals with growing demand in new technologies. Avalon's Separation Rapids Lithium Project has the potential to produce high purity lithium compounds for two distinct markets: an industrial mineral product for glass-ceramics and lithium chemicals for energy storage.

**Link:** <https://www.avalonadvancedmaterials.com/>

Note: The companies highlighted above are only a few examples of the success stories in Ontario in the vehicle electrification space.

# CONCLUSIONS

Electric vehicle adoption is a major part of a broader set of measures needed to achieve a green mobility future. This report is part 2 of a series of reports on achieving green mobility via EV adoption. In this part, we have shed light on different factors that have major potential on driving the future of EV adoption. We have discussed the role of governments, OEMs, and utility companies in growing EV development and adoption. We have also highlighted the major strengths of Ontario toward driving and reaching a green mobility future.

It is real that most of the early adopters of EVs were motivated to opt to green mobility by environmental concerns and personal desire to help in fighting climate change. However, such motivations have not been enough to drive more vehicle users to switch to an eco-friendly option. We believe that reaching price parity with ICEVs and securing EV charging stations as dense and fast as the existing ICEV fueling stations will be when we see the tipping point of EV adoption. It is still uncertain though when we will reach this point, but it is certain that the more collaborations

we see among all players of the automotive and mobility ecosystem, including governments, industry, and researchers, the faster we will hit this point. All collaborators will reap the advantages of having more EVs on roads and help deliver tangible and lasting benefits to their people. Adoption of green mobility helps address climate change concerns, reduce air pollution, create jobs, and strengthen countries' economy.

Ontario is very well-positioned to globally lead developing EV battery and charging technologies that can tackle all the current hurdles facing the fast growth of EV adoption, and the world is taking notice. With its abundant resources, great talent, and welcoming business environment, the province is at the forefront as a sought-after host, supplier, collaborator, and leader in the green mobility innovation ecosystem. Ontario's EV leadership has prompted Australia's BHP Group Ltd. to move its exploration headquarters for nickel and copper to Toronto, and more yet to come.

# MEET THE OVIN TEAM



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# ABOUT OVIN

The **Ontario Vehicle Innovation Network (OVIN)** is a key component of Driving Prosperity, the Government of Ontario's initiative to ensure that the automotive sector remains competitive and continues to thrive. The Government of Ontario has committed \$56.4 million for OVIN over the next four years to support research and development (R&D) funding, talent development, technology acceleration, business and technical support, and testing and demonstration sites. OVIN programs support small- and medium-sized enterprises (SMEs) to develop, test, and commercialize new automotive and mobility products and technologies, and cultivate the capacity of a province-wide network to drive future and green mobility solutions, reinforcing Ontario's position as a global leader.

OVIN, led by Ontario Centre of Innovation (OCI), is supported by the Government of Ontario's Ministry of Economic Development, Job Creation and Trade (MEDJCT) and Ministry of Transportation (MTO).

The initiative comprises five distinct programs and a central hub. The OVIN programs are:

- Research and Development Partnership Fund
- Talent Development
- Regional Technology Development Sites
- Demonstration Zone
- Project Arrow

The OVIN Central Hub is the driving force behind the programming, province-wide coordination of activities and resources, and Ontario's push to lead in the future of the automotive and mobility sector globally. Led by a dedicated team, the Central Hub provides the following key functions:

- A focal point for all stakeholders across the province;
- A bridge for collaborative partnerships between industry, post-secondary institutions, broader public sector agencies, municipalities, and the government;
- A concierge for new entrants into Ontario's thriving ecosystem; and
- A hub that drives public education and thought leadership activities and raises awareness around the potential of automotive and mobility technologies and the opportunities for Ontario and for its partners.

## OVIN has five objectives:

01

Foster the development and commercialization of Ontario-made advanced automotive technologies and smart mobility solutions

02

Showcase the Province of Ontario as the leader in the development, testing, piloting and adoption of the latest transportation and infrastructure technologies

03

Drive innovation and collaboration among the growing network of stakeholders at the convergence of automotive and technology

04

Leverage and retain Ontario's highly skilled talent, and prepare Ontario's workforce for jobs of the future in the automotive and mobility sectors

05

Harness Ontario's regional strengths and capabilities, and support its clusters of automotive and technology

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*We would like to thank the Government of Ontario for  
supporting OVIN programs and activities.*

*We would also like to thank the partner organizations that work  
with OCI to deliver OVIN programs.*

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