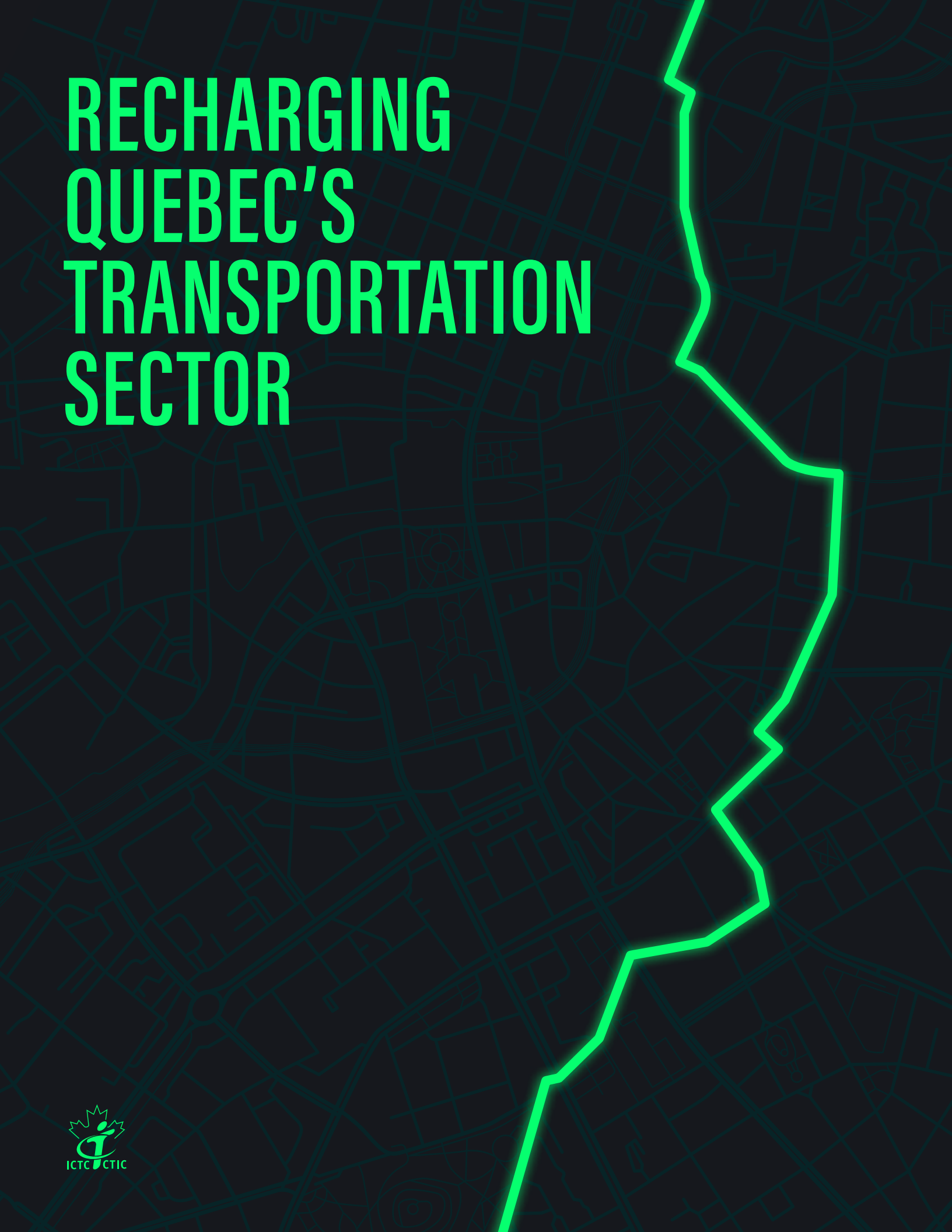
RECHARGING QUEBEC'S TRANSPORTATION SECTOR



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Research by

The Information and
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PREFACE

The Information and Communications Technology Council (ICTC) is a not-for-profit, national centre of expertise for strengthening Canada's digital advantage in a global economy. Through trusted research, practical policy advice, and creative capacity building programs, ICTC fosters globally competitive Canadian industries enabled by innovative and diverse digital talent. In partnership with an expansive network of industry leaders, academic partners, and policy makers from across Canada, ICTC has empowered a robust and inclusive digital economy for 30 years.

Propulsion Québec, the cluster for electric and smart transportation, catalyzes the entire sector around joint projects with the objective of positioning Quebec among the world leaders in developing and implementing smart and electric modes of ground transportation, for the benefit of Quebec's economy and environment. Created in 2017, as of January 2022 Propulsion Québec supports more than 250 members, from startups to large companies, including Quebec institutions, research centres and mobility operators, and deploys its resources across six distinct working groups to develop and support innovative projects. The cluster receives financial support from the Government of Quebec, the Government of Canada, Communauté métropolitaine de Montréal (CMM), AttriX, Desjardins Group, Fonds de solidarité FTQ, Hydro-Québec, and Québecor.

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ABSTRACT

Digitization, coupled with a focus on transitioning to a low-carbon future, inevitably means a shift in operations and outputs across sectors. Over the years, Québec has become a significant player in the Canadian electric vehicle industry, and recent advances also point to the province's ability to compete internationally. Yet, with industry change comes workforce evolution and changing labour market realities and needs. This report reviews some of the labour dynamics associated with Québec's emerging electric vehicle (EV) industry and identifies current and future labour demand and skill needs. Although some employment displacement is likely to occur, this shift will be offset by new jobs created by the growth of this industry, and further focus on sustainability and a "green transition." At the same time, many existing workers will also see skill shifts, leading to the need for workforce development solutions, training, reskilling, and upskilling.

In this publication, we use the term "Canadians" to include all residents of Canada.

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EXECUTIVE SUMMARY

In 2020, the Quebec government launched its *2030 Plan for a Green Economy,* making the electrification of the transportation sector a major priority. This transition will enable more sustainable economic growth, usher in high quality investment, and support the creation of jobs.

Quebec has done well to position itself for the rapidly emerging electric vehicle (EV) industry. It is especially prominent in the commercial vehicle market, producing EV garbage trucks, school buses, heavy equipment, and utility vehicles. This competitive niche has already begun to pay dividends, exemplified by the recent partnership between Lion Electric and Amazon.[1] Moreover, the province is home to leading-edge research institutions like the Centre of Excellence in Electrification and Energy Storage, and Mila, embedding innovation into a highly competitive market. Its access to raw materials and affordable energy also makes it a promising destination for battery manufacturing, attracting international companies like BASF and General Motors. A green future for Quebec is approaching, with EVs playing a central role.

Growing automation and digitization, central components of the EV industry, have significant impacts on the labour force. The demand for STEM (science, technology, engineering, and mathematics)-educated workers has accelerated, and knowledge of software, electronics, and electrochemistry has scaled. Moreover, Quebec EV employers have made significant investments into new technologies and processes, which in turn have created new jobs in areas like product development, manufacturing, business operations, and sales and marketing. Many technical roles like mechanical and electrical engineers, full stack developers, embedded software developers, and machine learning specialists are in demand in Quebec's EV businesses, followed by others like technical sales specialists and business development managers.

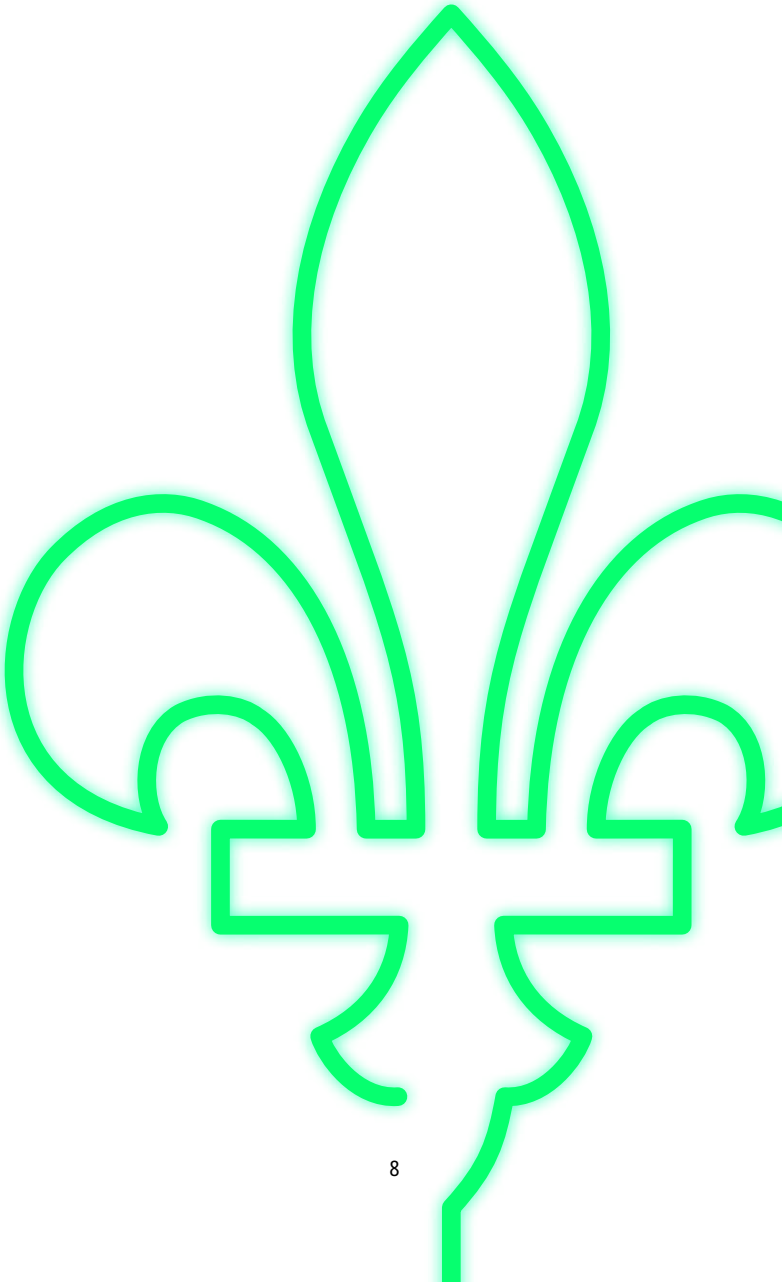
Fully transitioning away from combustion engines also means that, alongside the addition to new jobs, existing workers will also need to shift. Although some displacement is inevitable, many existing workers possess transferable skills to aid the transition. In analyzing job postings from mature EV ecosystems, like those of Tesla and Rivian, ICTC identified several emerging in-demand roles, including firmware engineers, quality assurance (QA) engineers, data platform engineers,

[1] *Carrie Hampel. "Huge order for Lion Electric trucks from Amazon," Electrive.com, published on January 11th, 2021. https://www.electrive.com/2021/01/11/huge-order-for-lion-electric-trucks-from-amazon/*

service technicians, process technicians, and infotainment product engineers. Combining this with data on jobs most at risk of displacement identified a plethora of transferable skills. For example, auditors and accountants have a number of data skills linked to emerging EV roles, and likewise, operations managers possess a blend of industrial, data, and software skills linked to them.

Undoubtedly, a commitment to a green transition and the evolution of Quebec's EV industry will usher new and changing labour market needs. Quebec's EV leaders hold an optimistic labour market outlook. Many had already recognized this impending shift and have begun mobilizing to develop internal training programs to upskill or reskill their workforce. With these plans firmly in place, no consulted EV employers plan to terminate existing worker.

As Quebec seeks to rapidly build a competitive EV industry, leveraging existing assets and assisting workers who may be negatively affected by this structural change is essential. A multi-faceted focus on talent—sourcing new entrants and upskilling and retraining existing workers—will enable the province's EV businesses to better compete, engage a more diverse talent pool, and entrench Quebec as a recognized player in the global EV ecosystem.



INTRODUCTION

Governments around the world are currently planning a "green recovery" to drive sustainable, and resilient economic growth while improving the well-being of citizens in the wake of the COVID-19 pandemic. Given the auto industry's impact on emissions,[2] immediate action to reduce greenhouse gases is necessary to meet international environmental targets. Over the past two years, policymakers have implemented hard targets and measures to decarbonize the economy. To date, 17 countries have announced 100% zero-emission vehicle targets and the phase-out of internal combustion engine vehicles through 2050.[3] In June 2021, the Government of Canada announced that 100% of car and passenger truck sales are to be zero emission by 2035, ahead of the previous 2040 goal.[4]

Quebec is one of Canada's leaders in positioning for a low-carbon future. The provincial government announced in November 2020 that it intends to ban the sale of gasoline-powered cars by 2035 and revealed a green recovery plan, supported by $6.7 billion over the next five years.[5] Among other elements, the plan includes the electrification of cars, trucks, and transit in the province and a goal to put 1.5 million electric vehicles on the road by 2030.[6] Numerous private investments are being made to achieve this goal, including the Lion Electric-Amazon partnership announced in January 2021.[7] Specific attention is also being given to developing a supply of critical minerals needed for electric vehicles (EVs).[8] The global shift toward a greener auto industry will have a disruptive impact on numerous areas of the economy, including manufacturing and material extraction, supply chains, production processes, and fuelling infrastructure.

This shift signifies a notable impending workforce transition for the industry, and Quebec is beginning to plan and prepare for this. Quebec's "2030 Plan for a Green Economy," for example, prioritizes the training of a skilled workforce.[9] Yet, the skills and positions needed within the EV industry are not EV exclusive, and companies will

[2] *Transport accounted for 25% of national emissions in 2019; "Greenhouse Gas Emissions," Environment and Climate Change Canada, last modified in November 2021. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html.*

[3] *Other regions like the State of California which have traditionally led in this area and by proxy also set regulatory standards for Canada are enacting new regulations (at state or city/county level) on zero emission vehicles (both personal and commercial duty vehicles) as well as for net zero emission buildings; "Global EV Outlook 2020," International Energy Agency, published in 2020, https://www.iea.org/reports/global-ev-outlook-2020.*

[4] *The Government of Canada will pursue a combination of investments and regulations to help Canadians and industry transition to achieve the 100 percent zero-emission vehicle sales by 2035. It will work also with partners to develop interim 2025 and 2030 targets, and additional mandatory measures that may be needed beyond Canada's light-duty vehicle greenhouse gas emissions regulations.*

[5] *Selena Ross. "Quebec promises to ban sale of gas cars – but first, will spend $6.7 billion of five-year green recovery plan," CTV News, published on November 16th, 2020. https://montreal.ctvnews.ca/Québec-promises-to-ban-sale-of-gas-cars-but-first-will-spend-6-7-billion-on-five-year-green-recovery-plan-1.5190786*

[6] *Benjamin Shingler. "Quebec's push to go electric won't get province to emission reduction targets, experts say," CBC, published on November 16th, 2020. https://www.cbc.ca/news/canada/montreal/Québec-green-plan-1.5802976#:~:text=Put%201.5%20million%20electric%20vehicles%20on%20the%20road%20in%20Québec,heating%20for%20buildings%20by%202030.*

[7] *Tim Kiladze. "Canadian EV Maker Lion Electric Partners with Amazon, gives retailer right to buy 15.8 per cent of the company," The Globe and Mail, published on January 7th, 2021. https://www.theglobeandmail.com/business/article-canadian-ev-maker-lion-electric-partners-with-amazon-gives-retailer/*

[8] *"Minerals for the Future," Government of Quebec, accessed November 24th, 2021. https://www.quebec.ca/en/agriculture-environment-and-natural-resources/mining/critical-and-strategic-minerals/.*

[9] *"2030 Plan for a Green Economy," Government of Quebec, accessed November 24th, 2021. https://www.quebec.ca/en/government/policies-orientations/plan-green-economy.*

need to compete for talent. The international nature of labour competition—further fuelled in part by the pandemic[10]— adds to this context. Ultimately the shift to more environmentally friendly vehicles, "greener" production processes, and advanced automation and digitization will fundamentally alter skill demand; the best way to meet this change is to prepare for it.

This report analyses market shifts, labour market needs, and other considerations for Quebec's growing EV industry. It highlights in-demand jobs and evolving skills, while identifying solutions to minimize labour market displacement and capitalize on Quebec's existing advantages and strengths.

[10] *"Covid-19's Impact on the American Economy," Envoy. https://research.newamericaneconomy.org/wp-content/uploads/sites/2/2021/06/NAE-Envoy-Report-V2.pdf*

THE EV INDUSTRY IN CANADA AND QUEBEC

The Role of Climate Change and EV Advancement

Canada's EV industry has developed largely in response to the urgent need to scale back carbon emissions and mitigate the effects of climate change. Annual average land temperatures in Canada have increased by approximately 1.7°C since 1948. This increase is nearly double the global average and means that Canada is warming twice as fast as the rest of the world.[11] Due to latitude and configuration, northern Canada is experiencing warming at three times the global average.[12]

Canada first recognized the need for environmental protection with the signing of the Kyoto Protocol in 1997, and several recent commitments have been made to achieve a net-zero economy by 2050. The transport sector is an area of key focus as it is the second largest emitter in the Canadian economy, producing 186 megatonnes of carbon dioxide in 2019 (~25% of the total).[13] The federal government has invested over $1 billion since 2015 to decarbonize this sector, largely focusing on EVs and charging infrastructure.[14]

Despite this investment, EV sales remain low: during the first quarter of 2021, only 3.34% of total vehicle sales were EVs, and the majority occurred in British Columbia (9.48%) and Quebec (5.51%) in part due to existing provincial incentives.[15] Limited charging infrastructure, challenges of battery performance in colder climates, and the relatively high cost of EVs dampen uptake.[16] Indeed, when surveying 2,200 consumers across the United States, the Consumer Technology Association found only 36% felt that EVs are becoming affordable.[17] Ensuring that all vehicles are zero emissions by 2035[18] will require remedies to these factors.

[11] *Canada's Minister of Environment, The Honourable Jonathan Wilkinson, Globe 2020 Keynote.*
[12] *The Canada's Changing Climate Report states that since 1948 annual average temperatures in Canada have increased by 1.7°C and 2.3°C in Northern Canada, whereas the average global temperature on Earth has increased by approximately 0.8°C since 1880*
[13] *2 "Greenhouse Gas Emissions," Environment and Climate Change Canada, https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html*
[14] *"Natural Resources Canada Zero Emission Vehicle Infrastructure Program," Government of Canada, https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876*
[15] *In the third quarter of 2020, 3.5% of total new vehicles registered in Canada were zero-emission vehicles (ZEVs). In this period, 54,353 new ZEVs were registered in Canada, 95.4% of which were in British Columbia, Quebec and Ontario. British Columbia and Québec lead in EV market share, at 8.4% and 6.4% respectively; "StatsCan data for Q1 2021 shows rise in EV adoption to 4.6 per cent, as sales of hybrids double," Electric Autonomy, published on July 27th, 2021. https://electricautonomy.ca/2021/07/27/canadian-ev-sales-data-q1-2021/*
[16] *"Survey finds that electric vehicle charging infrastructure and consumer incentives are critical to boosting rural and suburban adoption," Canadian Vehicle Manufacturers Association, published on June 15th, 2021. https://www.cvma.ca/statement/survey-finds-electric-vehicle-charging-infrastructure-consumer-incentives-critical-boosting-rural-suburban-adoption/*
[17] *"Electric Vehicle Landscape and Consumer Sentiment Research," Consumer Technology Association, published December 2021. https://cdn.ces.tech/ces/media/pdfs/2022/electric-vehicle-landscape-exec-sum.pdf*
[18] *Stephanie Taylor. "Liberals say by 2035 all new cars, light-duty trucks sold in Canada will be electric," Financial Post, published on June 29th, 2021. https://financialpost.com/commodities/energy/electric-vehicles/liberals-say-by-2035-all-new-cars-light-duty-trucks-sold-in-canada-will-be-electric*

Growth of Battery Electric Vehicle Registration Across Canada

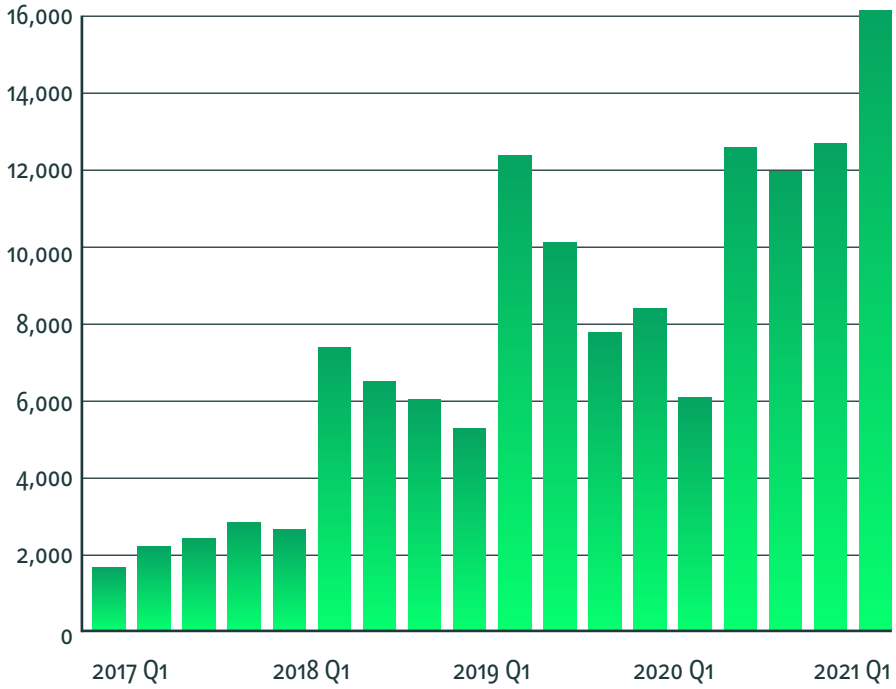


Figure 1. *Number of Battery Electric Vehicles Registered in Canada from 2017–2021. Source: Statistics Canada, 2021.*

Defining Electric Vehicles and Their Supply Chain

In casual conversation, the term "electric vehicle" is often used interchangeably with Battery Electric Vehicles (BEVs). There are, however, two other increasingly popular types of electric vehicles: Plug-in Hybrid Electric Vehicles (PHEVs) and Fuel Cell Electric Vehicles (FCEVs). These three EVs all use electric motors but differ in terms of how the motors are powered. PHEVs receive their power from an electrical outlet as well as from a combustion generator that feeds an electrical motor.[19] FCEVs, on the other hand, produce power by having hydrogen react with oxygen, creating a reaction where electrons are used to develop an electrical circuit that powers an electrical motor.[20] Although BEVs are the most well-known, between 2016 to 2020, hybrid and plug-in hybrid electric vehicles accounted for a larger share of new vehicle registrations in Canada.[21] EVs are further categorized by their gross vehicle weight ratio (GVWR). GVWR consists of eight weight classes, and three weight categories: Light (Class 1–3), Medium (Class 4–6), and Heavy (Class 7–8) Duty Vehicles.[22]

[19] *"Explaining Electric & Plug-In Hybrid Electric Vehicles," Environmental Protection Agency. https://www.epa.gov/greenvehicles/explaining-electric-plug-hybrid-electric-vehicles#PHEVs*
[20] *"Fuel Cells," Department of Energy – US. https://www.energy.gov/eere/fuelcells/fuel-cells*
[21] *"New motor vehicle registrations," Statistics Canada, published in July 2021. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101.*
[22] *"Truck Classification Explained," Badger Auto Group. https://www.badgertruck.com/heavy-truck-information/truck-classification/*

Value chains of BEVs, PHEVS, and FCEVs differ in important ways. Key differences include the number of component manufacturers along the supply chain and the type of fuelling infrastructure required. For instance, BEVs have no electric generator, resulting in a smaller supply chain relative to PHEVs, and FCEVs require hydrogen fuelling stations rather than plug-in outlets.[23] These value chains overlap with several adjacent industries, including rail transportation, combustion engine vehicles, alternative applications of information and communication technology (ICT) services, different applications of metal fabrication, and various applications of electrical component manufacturers.

This paper focuses on the BEV value chain, as these vehicles are the most prevalent in the Quebec market. Definitions of the BEV industry differ based on activity. A study by Marcon prepared for Propulsion Quebec defines the EV value chain as "mobility services, Tier 1,2,3 suppliers, Original Equipment Manufacturers (OEMs), infrastructure manufacturers (e.g., charging stations), and vehicle technology (e.g., smart technology like drive assist or self-driving vehicles)."[24] The Advanced Energy Economy expands on this definition by including companies involved in the "wholesale distribution, retail sale, installation, research and development, and maintenance/repair of EV vehicles and equipment."[25] For the purposes of this study, the ICTC includes the following activities in the EV value chain:

- Design and Engineering Services
- Tier 1 Supplier (e.g., electrical motors, batteries, chassis systems)
- Tier 2 Supplier (e.g., manufacturers of electrical cables, circuit boards, metal manufacturing)
- Tier 3 Supplier (e.g., plastic producers, raw material processors, and other suppliers of materials needed to manufacturer Tier 2 products)
- Artificial intelligence (AI) and Software developers (includes mobility services, embedded software, drive assist/self-driving software and others)
- Original Equipment Manufacturers
- Wholesale distribution, retail sales and maintenance/repair services
- Recycling services (e.g., Battery and electronic recyclers)

[23] *"Electric Cars 101: The Answers to All Your EV Questions," Consumer Reports, published on November 5th, 2020. https://www.consumerreports.org/hybrids-evs/electric-cars-101-the-answers-to-all-your-ev-questions-a7130554728/*

[24] *"Horizon 2050 and Labor and Training Needs in the Electric and Smart Transportation Sector in Quebec," Propulsion Quebec, published in July 2020. https://propulsionquebec.com/wp-content/uploads/2020/12/Sommaire_Maindoeuvre_formation_EN.pdf?download=1.*

[25] *Philip Jordan. "Electrifying California: Economic Potential of Growing Electric Transportation," Advanced Energy Economy, published in April 2021. https://info.aee.net/hubfs/AEE%20CA%20ET%20Supply%20Chain%20Report.pdf.*

Canada and the Global EV Industry

The global EV ecosystem is currently dominated by three key players: China, the United States, and Germany. In 2018, approximately 99% of all EV manufacturing took place in 10 countries with the top three above accounting for nearly 80% of production.[26] The United States and Germany have always been global leaders in the auto industry, but China has been a fast-growing force due to manufacturing capacity, raw material supply and the production of EV batteries, all underpinned by strong industrial strategy. China currently produces almost all EV batteries supplied to the global market,[27] but expanding battery production is key to the growth of the EV industry, and other nations, including Canada, are beginning to make major investments in this space.[28]

Canada is the eighth largest producer of EVs in the world, a similar industry size as France, Japan, South Korea, and Sweden.[29] Canada is also the only country in the western hemisphere that has all the required critical minerals for manufacturing EVs. The "Great Lakes supercluster," the common name for Canada's automotive industry hub, is based in Ontario and home to the largest concentration of automotive assembly plants and R&D facilities in North America. It has five global OEMs (Fiat Chrysler, Ford, General Motors, Honda, and Toyota) that assemble more than two million vehicles each, and it is part of a larger system of 700+ parts suppliers, including major Canadian companies such as Magna (Aurora), Linamar (Guelph), Multimatic (Markham) and Martinrea (Vaughan).[30]

As Canada's second largest export, the auto industry contributed $74.2 billion of GDP in 2020 and accounted for 12.1% of total sales within the Canadian economy.[31] Moreover, the industry is rapidly gearing up to adapt to the consequences of climate change and the need to decarbonize the transport sector. Ford, for example, has committed that by 2030, 40% of all sales will be EVs,[32] and GM has stated that 50% of assembly plants will be dedicated to producing EVs by 2030.[33] These commitments auger well for the Canadian EV industry, signalling future investments from these and other industry players, many that are further supported by government funding to accelerate these changes while protecting Canadian jobs and economic growth.[34]

[26] *Ben Sharpe, Nic Lutsey, Cedric Smith, and Carolyn Kim. "Power Play: Canada's Role in the Electric Vehicle Transition," The International Council on Clean Transportation 9 (ICCT), Published in April 2020. Accessed November 24th, 2021 https://theicct.org/wp-content/uploads/2021/06/Canada-Power-Play-ZEV-04012020.pdf - Pg: 11*

[27] *"Turning Talk into Action: Building Canada's Battery Supply Chain," Clean Energy Canada, published in May 2021. https://cleanenergycanada.org/wp-content/uploads/2021/05/Turning-Talk-into-Action_Building-Canadas-Battery-Supply-Chain.pdf*

[28] *Reguly, E. "China is buying up the critical green-revolution minerals sector in Canada and elsewhere. Enough already," Globe and Mail, published December 17th, 2021. https://www.theglobeandmail.com/business/commentary/article-china-is-buying-up-the-critical-green-revolution-minerals-sector-in/*

[29] *Ben Sharpe, Nic Lutsey, Cedric Smith, and Carolyn Kim. "Power Play: Canada's Role in the Electric Vehicle Transition," The International Council on Clean Transportation 9 (ICCT), Published in April 2020. https://theicct.org/wp-content/uploads/2021/06/Canada-Power-Play-ZEV-04012020.pdf.*

[30] *"Canadian Automotive Industry," Government of Canada, last modified July 7th 2021. https://www.ic.gc.ca/eic/site/auto-auto.nsf/eng/home.*

[31] *"Important Facts," Canadian Vehicle Manufacturers Association. https://www.cvma.ca/industry/facts/*

[32] *Mich Dearborn. "Ford to lead America's shift to electric vehlcles with new mega campus in Tennessee and twin battery plants in Kentucky; $11.4B investment to create 11,000 jobs and power new line-up of advanced EVs," Ford Media Center, published on September 27th, 2021. https://media.ford.com/content/fordmedia/fna/us/en/news/2021/09/27/ford-to-lead-americas-shift-to-electric-vehicles.html.*

[33] *Kristen Korosec. "GM Says it will double revenue by 2030, take EV market share from Tesla," TechCrunch, published on October 6th, 2021. https://techcrunch.com/2021/10/06/gm-says-it-will-double-revenue-by-2030-take-ev-market-share-from-tesla/#:~:text=To%20hit%20that%20mark%2C%20GM,sale%20and%20financing%20of%20EVs.*

[34] *"Government unveil details of $590M investment to help Ford Oakville plant make electric cars," CBC News, published on October 8th, 2021. https://www.cbc.ca/news/business/ford-oakville-government-1.5754974*

Developing an EV industry is the natural next step for Canada's auto industry, and while a notable portion of this transition will concentrate in Ontario, provinces like Quebec and Manitoba are also well positioned to benefit from this opportunity and boost their role as suppliers for Ontario's assembly lines.

Quebec's Electric Vehicle Industry: An Ecosystem Overview

The Quebec automotive industry is the second largest in Canada and is made up of manufacturers of automotive parts, recreational vehicles, heavy-duty vehicles, buses, and specialty vehicles. Although the province has no major automobile manufacturer, it is an established global leader in the transport equipment industry, which employs over 32,000 individuals at over 620 companies.[35] Quebec's auto sector has leading original equipment manufacturers and small to medium sized enterprises (SME) suppliers, some of which have developed their own dedicated line of limited series vehicles. The province has also developed expertise in electrification and in light electric transportation and is a leader in AI and photonic optics, two areas of relevance to automated and connected vehicles.[36] Many Quebec companies also provide specialized parts and systems manufacturing for hybrid and electric vehicles, such as lightweight materials, fuel systems, electric motors and batteries.

Prominent Technology Verticals and Business Lines

Quebec's EV industry is one of Canada's fastest growing and most innovative. Participating businesses mainly operate in business-to-business sales and play a minor role in what might be called the "traditional" consumer EV market (B2C). The Quebec EV industry is known for producing vehicles like garbage trucks, buses, utility vehicles, heavy equipment vehicles, and assisting other organizations in electrifying their operations with software solutions.[37]

In terms of overall industry composition, Quebec's EV companies are primarily smaller sized firms, employing less than 50 people, except for a few larger players like Lion Electric, Demers Ambulances, Effenco, and Dana TM4. Using data from Pitchbook, Traxcn, and Propulsion Quebec, ICTC has identified 133 companies that operate in Quebec's EV industry (see Methodology for more details). The top areas of focus for these companies are "transportation," "software," and "commercial products and services," while others span several verticals. Alstom Canada Inc., for example, designs EV services, manufactures components for trains, and develops software for digital mobility solutions.[38]

[35] *"Impulsion Montreal 2021," Propulsion Quebec, published in 2021. https://propulsionquebec.com/impulsionmtl/en/partner/quebec/.*
[36] *In 2015, the Québec industry employed 7,400 workers, generated $4 billion in sales and exported over $3.1 billion in motor vehicles and related products, with 32% of those exports consisting of motor vehicle parts; "Government of Canada Support Growth in Quebec's Automotive Industry," GlobeNewswire, published on January 10th, 2017. https://www.globenewswire.com/news-release/2017/01/10/1162978/0/en/Government-of-Canada-supports-growth-in-Québec-s-automotive-industry.html.*
[37] *ICTC Key Informant Interview, August 2021.*
[38] *"A Complete Range of Mobility Solutions," Alstom. https://www.alstom.com/our-solutions.*

Company Core Product and Service Lines

To get a more granular understanding of core products and service lines, ICTC analyzed company descriptions.[39] The top five product and service lines listed from highest density to lowest are: Original Equipment Manufacturers (e.g., Lion Electric, Taiga Motors); Tier 1,2,3 Suppliers; Engineering and Design Services (e.g., prototyping services); Smart Tech (e.g., fleet management software); and Charging Infrastructure.[40]

Quebec EV Companies by Core Product and Service Line

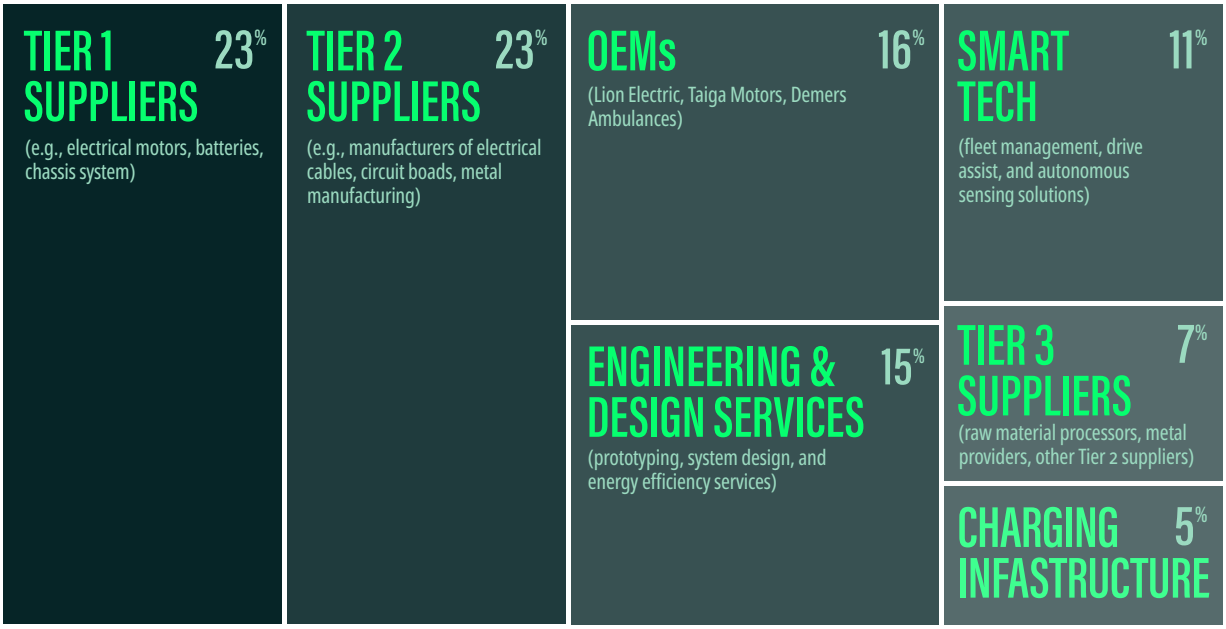


Figure 2. *Quebec EV companies (%) by core product and service line. Source: Pitchbook, Traxcn, Propulsion Québec, ICTC analysis, 2021.*

More research is necessary to determine key differences between core products and service lines in each province. To provide some context, however, Ontario's EV industry features a robust manufacturing sector, supported by Tier 1, 2, and 3 Suppliers as well as early leadership in charging infrastructure supply and installation.[41] [42] [43] In contrast to Quebec's focus on commercial EVs, Ontario's manufacturing hub is home to international OEMs such as, Toyota, Honda, GM, Ford, and Fiat Chrysler and focuses on manufacturing consumer EVs.[44] [45]

[39] *The following analysis should be read as a starting point for future research, rather than a comprehensive analysis of Quebec's EV industry.*
[40] *Data was difficult to source for other categories including wholesale distribution, retail sales, and maintenance/repair services, and recycling services were not included. Infrastructure manufacturers were combined with electrical component manufacturers.*
[41] *Carolyn Kim. "Ontario well positioned to lead in the global electric vehicle market," Pembina Institute, published on July 8th, 2021. https://www.pembina.org/pub/ontario-well-positioned-lead-global-electric-vehicle-market*
[42] *"5 reasons Ontario is poised to lead the future of electric vehicle production," Invest Ontario, published May 14th, 2021. https://www.investontario.ca/spotlights/5-reasons-ontario-poised-lead-future-electric-vehicle-production*
[43] *Greg Da Re. "Ontario: A Smart Choice for Electric Vehicle and Battery Manufacturing," Invest Canada. https://www.investcanada.ca/blog/ontario-smart-choice-electric-vehicle-and-battery-manufacturing*
[44] *"Driving Prosperity: Ontario's Automotive Sector," Government of Ontario. https://files.ontario.ca/auto-strategy-en.pdf.*
[45] *Alison Jones. "Premier Doug Ford pitching Ontario as electric vehicle leader, but not reintroducing rebate," Globe and Mail, published December 13th, 2021. https://www.theglobeandmail.com/business/industry-news/energy-and-resources/article-premier-doug-ford-pitching-ontario-as-electric-vehicle-leader-but-not/*

Company Size and Number of Employees

Company size is one indicator that can be used to determine the overall maturity of a business. ICTC analyzed companies by size, recognizing that most companies (76%) are small to medium sized enterprises with under 200 employees. Altogether 43% of the companies assessed have fewer than 50 employees, and 87% of companies employ fewer than 500 people. Moreover, most companies whose main business lines are rooted in "newer" industries such as software, AI, or OEM's that exclusively manufacture EVs as a final product (as opposed to EVs just being one part of their overall business) tend to employ fewer than 200 workers. The main business lines of all companies employing over 1,000 workers are based in more established industries, such as component manufacturing.

Quebec EV Companies by Number of Employees

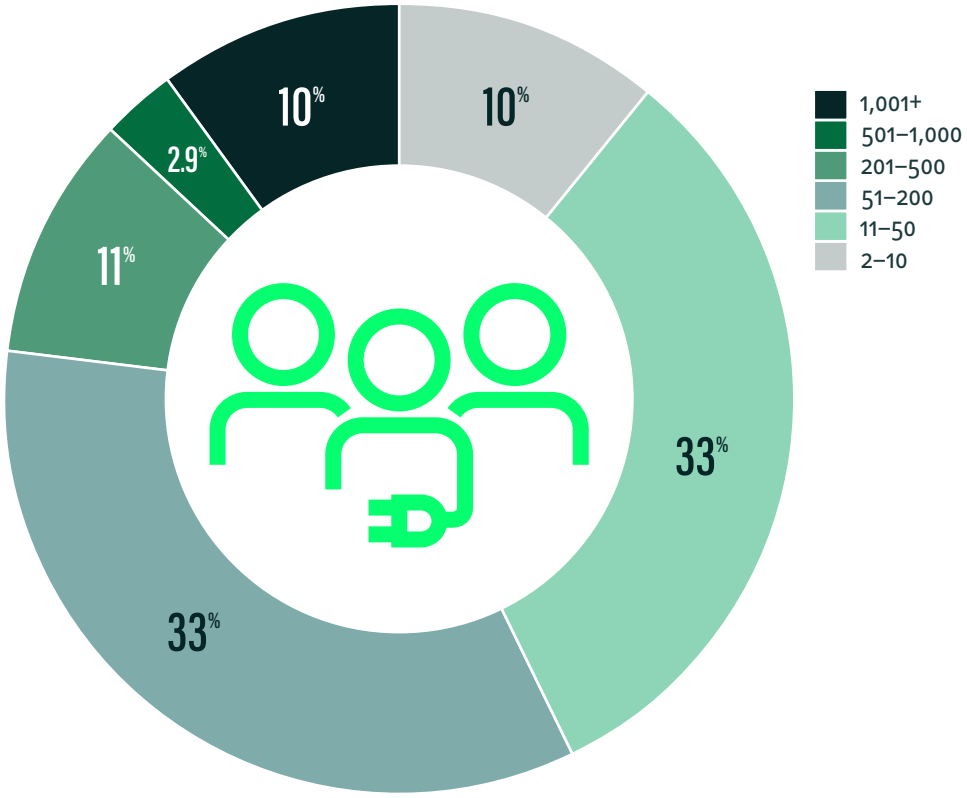


Figure 3. *Quebec EV companies (%) by total number of employees. Source: Pitchbook, Traxcn, Propulsion Québec, ICTC analysis, 2021.*

COMPANY PROFILE

Lion Electric

Headquartered in Saint-Jérôme, Quebec, Lion Electric is a Canadian-based electric bus manufacturer. Lion primarily produces yellow school buses and specializes in battery electric powertrains. The company has also developed all-electric Class 6 and Class 8 commercial urban trucks.

In November 2020, Lion announced a collaboration with vehicle-to-grid technology company Nuvve Corporation; the two companies have already partnered on projects demonstrating feasibility of vehicle-to-grid opportunities in California and New York.

In January 2021, Amazon and Lion Electric entered into an agreement worth $1.1 billion, in which Amazon agreed to purchase up to 2,500 buses of the Lion 6 and Lion 8 models by 2025.

To support their manufacturing plants in Saint-Jérôme, Lion Electric will invest approximately $185 million to build a battery production plant in Mirabel, Quebec. The provincial and federal governments are supporting this investment by providing $100 million, and the plant is expected to produce 135 direct jobs and hundreds of indirect jobs. The plant intends to produce five gigawatt hours of battery storage per year and enough batteries for 14,000 medium and heavy-duty vehicles. Notably, the highly automated plant is expected to produce one battery module every 11 seconds and a full battery pack every five minutes,[46] and these batteries are to be imported from South Korea.[47]

COMPANY PROFILE

Demers Ambulances

Demers Ambulances has been manufacturing ambulances and other emergency vehicles for over a century and is the oldest ambulance manufacturer in North America.[48] In 2016, Demers and Lion Electric partnered to create the eFX Ambulance, Demers' electric powered ambulance. The assembly process will be divided between the two companies.[49] Demers is scheduled to begin commercialization of the electric ambulance in the second half of 2022.[50]

Demers aims to deploy 1,500 new ambulances across North America before 2026. They currently operate across 43 different countries and intend to market the electric ambulance outside of Canada.[51] Estimated to cost $500,000 per vehicle, the eFX ambulance has a range of 200km on a single charge, produces 340HP, and is powered by an 800V battery pack.[52]

This project came to fruition thanks to funding provided by the Government of Quebec and the National Research Council of Canada Industrial Research Assistance Program.[53] This project and is s a strong step forward for emergency vehicle electrification in Quebec.

[46] *"Lion Electric Selects YMX International Aerocity of Mirabel as Location for Its Battery Manufacturing Plant and Innovation Center in Quebec," Lion Electric, published on June 3rd, 2021. https://thelionelectric.com/documents/en/Battery-Plant-Location.pdf*

[47] *Gabriel Friedman. "Biggest shakeup in auto industry's history chance for Canada to climb on top," Financial Post, published on June 17th, 2021. https://financialpost.com/commodities/energy/electric-vehicles/biggest-shakeup-in-auto-industrys-history-chance-for-canada-to-climb-on-top*

[48] *"History," Demer Ambulances. https://www.demers-ambulances.com/about/history/*

[49] *Mehanaz Yakub. "The zero-emission Demers eFX Ambulance will be completely manufactured in Quebec and be in service by fall 2022," Electric Autonomy, published on October 26th, 2021. https://electricautonomy.ca/2021/10/26/demers-lion-electric-ambulance/*

[50] *Ibid.*

[51] *Ibid.*

[52] *Anthony Capkun. "Meet the Demers eFX 100% electric, purpose-built ambulance," Electrical Business, published on October 26th, 2021. https://www.ebmag.com/meet-the-demers-efx-100-electric-purpose-built-ambulance/*

[53] *Ibid.*

A Provincial Strength: Quebec's Battery Supply Chain

The growing adoption of EVs presents a major opportunity for Quebec to leverage its provincial strengths and secure a key role in the international EV supply chain. Access to raw materials, leading research expertise, and affordable clean energy make it an attractive destination for EV battery manufacturing.

Currently, most EV batteries are produced by suppliers in Asia: 80% of the world's batteries are produced in Japan, South Korea, and China. China alone is responsible for the majority of global battery material processing and cathode production, giving it significant influence over pricing and supply chain flows.[54] Many countries are beginning to explore options for energy independence, and the European Union is taking action to diversify supply. In 2017, the European Battery Alliance was established to strengthen domestic capacity to produce batteries; to date, it has attracted €100 billion in both private and public investment commitments. The Alliance expects that battery production will meet European demand by 2025.[55] Canada and the United States are also attempting to secure a North American battery supply chain for a similar reason. Both nations have signed a joint action plan on critical mineral collaboration,[56] and the U.S. Infrastructure Investment and Jobs Act has earmarked $6 billion to bolster battery research and production, build a reliable supply of critical minerals,[57] and support private companies to develop the resources needed to produce batteries.[58]

Sustainability versus the cost of energy has been a major point of contention as jurisdictions attempt to reconcile the need for a green future while ensuring the availability of affordable energy. Quebec is one of a few places in the world that offers a solution to this problem via its legacy hydroelectricity assets. Quebec is home to the most affordable electricity in all of Canada, valued at 7.3 ¢/kWh in March 2021.[59] Affordable electricity is a major benefit for battery manufacturing and other industries that are energy intensive. Additionally, Hydro-Québec, the main power provider in the province, possesses critical battery expertise through facilities such as the Centre of Excellence in Transportation Electrification and Energy Storage. This facility has been stimulating innovation in battery materials, material processing, and has focused on energy storage solutions for over 40 years.[60] Subject matter expertise, affordable clean energy, and access to raw materials puts Quebec in a strong position to develop a globally competitive battery manufacturing hub.

These and other variables are already attracting investment. Stromcore Energy Inc, an assembler of lithium-ion batteries for forklifts, has announced preliminary plans to build Canada's first large-scale lithium-ion battery cell factory in Quebec

[54] *"Turning Talk into Action: Building Canada's Battery Supply Chain," Clean Energy Canada, published in May 2021. https://cleanenergycanada.org/wp-content/uploads/2021/05/Turning-Talk-into-Action_Building-Canadas-Battery-Supply-Chain.pdf*
[55] *"European Battery Alliance," European Commission. https://ec.europa.eu/growth/industry/strategy/industrial-alliances/european-battery-alliance_en*
[56] *"Canada and U.S. Finalize Joint Action Plan on Critical Minerals Collaboration," Government of Canada, published on January 9th, 2020. https://www.canada.ca/en/natural-resources-canada/news/2020/01/canada-and-us-finalize-joint-action-plan-on-critical-minerals-collaboration.html*
[57] *Ashley Murray. "Battery Manufacturers Look to Grants in Infrastructure Bill," Government Technology, published on November 16th, 2021. https://www.govtech.com/policy/battery-manufacturers-look-to-grants-in-infrastructure-bill*
[58] *Fred Lambert. "Tesla is in talks with Quebec Govt amid multi-billion investment into battery production," Electrek, published on November 8th, 2021. https://electrek.co/2021/11/08/tesla-talks-with-quebec-govt-amid-multi-billion-investment-into-battery-production/*
[59] *"Electricity Prices in Canada 2021," Energy Hub. Last updated on March 11th, 2021. https://www.energyhub.org/electricity-prices/*
[60] *"Reinventing Energy for the Future," Hydro-Québec. https://www.hydroquebec.com/ce-transportation-electrification-energy-storage/*

under a subsidiary company called StromVolt Americas Inc.[61] This plant will initially build a 250-megawatt hour plant, is using battery technology licensed from Delta Electronics, a Taiwanese conglomerate, and will be collaborating closely with Delta to train the personnel needed to operate this facility.[62]

In planning for the emerging green economy, the province has launched two initiatives: Quebec's strategy for developing a battery industry,[63] and the Quebec Plan for the Development of Critical and Strategic Minerals.[64] These initiatives signal a focus on building a niche within the EV value chain as a key battery and energy storage manufacturer and fulfill the government's determination "to make Quebec a preferred haven for critical and strategic minerals value enhancement, including localized cleantech development and manufacturing."[65]

Cost of Electricity in Canadian Provinces and Territories

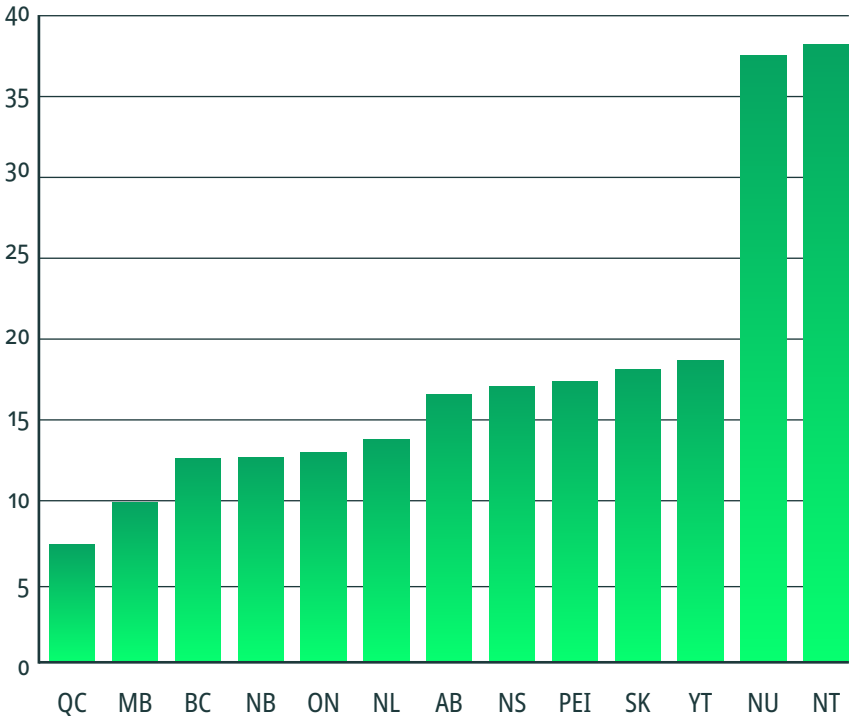


Figure 4. *Cost of electricity by Canadian provinces and territories (CAD/kWh). Source: Energy Hub, March 2021.*

[61] *Gabriel Friedman. "Canada could see its first lithium-ion battery cell factory open soon — on the back of the humble forklift," Financial Post, published on October 20th, 2021. Accessed on November 24th, 2021. https://financialpost.com/commodities/energy/electric-vehicles/canada-could-see-its-first-lithium-ion-battery-cell-factory-open-soon-on-the-back-of-the-humble-forklift*

[62] *Ibid.*

[63] *"La Stratégie québécoise de développement de la filière batterie," Government of Québec. https://www.economie.gouv.qc.ca/index.php?id=25706*

[64] *"Minerals for the Future," Government of Quebec, last updated October 5th, 2021. https://www.quebec.ca/en/agriculture-environment-and-natural-resources/mining/critical-and-strategic-minerals.*

[65] *Rudiger Tscherning and Brady Chapman. "Western Canadian Lithium as a Critical and Strategic Mineral for Clean Tech Battery Storage Technologies," ABlawg, published on November 25th, 2020. http://ablawg.ca/wp-content/uploads/2020/11/Blog_RT_BC_Lithium_CSM.pdf*

IMPACTS OF EV SHIFT ON LABOUR

Employment Impact of Automation, Digitization, and the EV Shift

International and National Employment Impacts

The shift to EV from internal combustion engine (ICE)-powered vehicles will yield mixed employment impacts, including job losses and gains. Research shows that job loss is expected in several related industry areas, including oil and gas production, design, manufacturing, marketing, accounting, repair and sales, and retail sale of automotive fuel.[66] For example, in Germany, estimates indicate that electrifying the automotive industry will result in a drop in employment between 11% and 35%.[67] In the U.S., Ford Motor Company similarly acknowledged that the product simplification EVs afford can lead to a 50% reduction in capital investment and a 30% reduction in labour hours per unit compared to standard ICE production.

On the other hand, job gains can be expected in electricity generation and management, battery manufacturing, electrical parts and machinery, and through the creation of EV charging infrastructure and data management and analysis.[68] According to a recent study, transport electrification in the E.U. could create 200,000 new jobs along the automotive value chain, under the assumption that 35% of new cars sold in the region will be EVs.[69] The buildout of accompanying charging infrastructure is also likely to create jobs, particularly in installation and charging access.[70]

Rapid advances in robotics and novel applications of software will further impact employment.[71] [72] Indeed, a study by the Brookings Institute indicates that around

[66] *"The Future of Work in the Automotive Industry: The need to invest in people's capabilities and decent and sustainable work," International Labour Organization (ILO), Issues paper for the Technical Meeting on the Future of Work in the Automotive Industry, published in 2020. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_741659.pdf.*

[67] *Wilhelm Bauer, et al. "Die Wirkungen der Fahrzeugelektrifizierung auf die Beschäftigung am Standort Deutschland," Fraunhofer IAO, published in 2018. http://publica.fraunhofer.de/starweb/servlet.starweb?path=epub.web&search=N-520883.*

[68] *"The Future of Work in the Automotive Industry: The need to invest in people's capabilities and decent and sustainable work," International Labour Organization (ILO), Issues paper for the Technical Meeting on the Future of Work in the Automotive Industry, published in 2020. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_741659.pdf.*

[69] *Alyssa Pek, et al. "Powering a New Value Chain in the Automotive Sector – The Job Potential of Transport Electrification," EuropeOn, published in February 2020. https://europe-on.org/wp-content/uploads/2020/02/EuropeOn-Powering-a-new-value-chain-in-the-automotive-sector-the-job-potential-of-transport-electrification.pdf.*

[70] *Anke Mönnig, et al. "Electromobility 2035 - Economic and labour market effects through the electrification of powertrains in passenger cars," Institute for Employment Research (IAB), published in 2019. https://ideas.repec.org/p/iab/iabdpa/201908.html; René Bormann, et al., "The Future of the German Automotive Industry - Transformation by disaster or by design?" WISO Diskurs, October, 2018. https://library.fes.de/pdf-files/wiso/14450.pdf; Lutz Sommer. "Industrial Revolution 4.0: Are German Manufacturing SMEs the First Victims of this Revolution?" Journal of Industrial Engineering and Management, published in 2015. http://www.jiem.org/index.php/jiem/article/view/1470.*

[71] *"The Future of Work in the Automotive Industry: The need to invest in people's capabilities and decent and sustainable work," International Labour Organization (ILO), Issues paper for the Technical Meeting on the Future of Work in the Automotive Industry, published in 2020. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_741659.pdf.*

[72] *Yvette Rogier. "The Future Success of the Automotive Industry is in its Workforce," Randstad, published in 2020. https://www.randstad.com/workforce-insights/future-of-work/future-success-automotive-industry/.*

65% of jobs in the auto industry are based on tasks that can be largely automated over the next decade.[73] [74] Industrial robots reduce the need for human labour in various manufacturing tasks, including quality inspection, machine tending, material removal, and parts transfer.[75] Yet, increases in AI-powered virtual testing systems, for example, can produce approximately 8,000 km of test data per hour, dramatically reducing the 20 days of in-person driving currently necessary to produce the same amount of data.[76] A recent report from Tubaro and Casilli asserts that consumer demand for automation in automobile OEM will jumpstart the growth of "micro-workers," namely humans performing labelling tasks (of raw images sourced from sensors and other devices), to help the machines learn.[77] Job gains are further expected in technology-centric roles such as electrical, mechanical, and software engineers.

Although the shift to EV and the integration of new technologies will continue to impact the entire supply chain (including upstream mineral extraction), the parts of the ICE value chain facing the highest risk of job loss are retail, repair, and manufacturing.

Retail: Automotive Dealerships Employ 138,207 Canadians.[78]

In a 2020 KPMG survey of global automotive executives, most believed that 20–30% of automotive retail outlets in North America will be undergo significant restructuring due to digitization.[79] Coupled with pandemic-driven digitization acceleration, some predict that a much larger quantity of retail outlets will shrink in size and number of services offered.[80] Increasing levels of software integration in vehicles, coupled with the rising popularity of adaptable automotive contracts (e.g., monthly subscription models)[81] and virtual customer support systems, accelerate this shift.[82] Advanced software integration, the study asserts, makes consumers more likely to have "one go-to support organization," fully dedicated to in-vehicle software—an area far removed from the comfort zone of the traditional retailer we know today."[83] While traditional independent retailers may offer flexible vehicle subscriptions, research indicates that vehicle purchases direct from manufacturers is more likely to occur, shrinking the need for physical retail shops and their employees.[84] Porsche, Audi, Volvo, and Lexus, for example, all currently offer online vehicle subscription services.[85] Finally, while it is unlikely that virtual customer support systems, such as chatbots, will entirely replace the need for human labour, increases in virtual customer service can impact a reduction of in-person staff needed at physical automotive retail shops.[86] [87]

[73] *Mark Muro. "Digitalization and the American Workforce," Brookings Institute, published in 2017. https://www.brookings.edu/research/digitalization-and-the-american-workforce/.*
[74] *Sara Brown. "A New Study Measures the Actual Impact of Robots on Jobs. It's Significant," MIT Sloan, published on July 29th, 2020. https://mitsloan.mit.edu/ideas-made-to-matter/a-new-study-measures-actual-impact-robots-jobs-its-significant.*
[75] *"Top 10 Applications of Robotics in the Automotive Industry," Analytic Insight, published on December 19th, 2021. https://www.analyticsinsight.net/top-10-applications-of-robotics-in-the-automotive-industry/.*
[76] *Markus Winkler, et al. "Accelerating automotive's AI transformation: How driving AI enterprise-wide can turbo-charge organizational value" Capgemini. https://www.capgemini.com/ca-en/research/accelerating-automotives-ai-transformation/.*
[77] *Paola Tubaro and Antonio A. Casilli. "Micro-Work, Artificial Intelligence and the Automotive Industry," Journal of Industrial and Business Economics, published in 2019. https://ideas.repec.org/a/spr/epolin/v46y2019i3d10.1007_s40812-019-00121-1.html.*
[78] *The use of "Canadians" includes all residents of Canada.*
[79] *Mirosław Michna and Przemysław Szywacz. "Global Automotive Executive Survey," KPMG, published on July 1st, 2020. https://home.kpmg/pl/en/home/insights/2020/07/kpmg-international-report-global-automotive-executive-survey-2020.html*
[80] *KPMG. "Global Automotive Executive Survey."*
[81] *Clifford Atiyeh "Car Subscription Services: The Complete Guide To Getting The Car You Want," Forbes Wheels, published on March 2nd, 2021. https://www.forbes.com/wheels/advice/car-subscription-services/.*
[82] *KPMG. "Global Automotive Executive Survey"*
[83] *KPMG. "Global Automotive Executive Survey"*
[84] *KPMG. "Global Automotive Executive Survey"*
[85] *Atiyeh. "Car Subscription Services: The Complete Guide to Getting The Car You Want"*
[86] *Tatcha Sudtasan and Pantaree Pitivaranun. "Complements and Substitutes between Chatbots and Humans: Corporate Perspectives International Telecommunications Society (ITS), published in 2019. https://ideas.repec.org/p/zbw/itse19/205215.html.*
[87] *ICTC Key Informant Interview.*

Repair and Maintenance: Automotive Repair and Maintenance Shops Employ 106,239 Canadians.

The shift to electric powered vehicles combined with an increasing reliance on data for repair and maintenance services will likely impact the need for traditional business models in this space.[88] For instance, since EV powertrains deteriorate at a slower pace than ICE powertrains and have fewer parts, EVs require less maintenance over time.[89] [90] In addition, the ability and desire to optimize vehicle repair and maintenance through data and analytics is growing.[91] Companies such as Carfit,[92] for example, offer AI-powered predictive maintenance services that disrupt the typical prevention repair model consisting of regularly scheduled maintenance.[93] Further, the introduction of IoT monitoring of vehicles connects data from various sensors that monitor fuel usage or engine temperature and provide real-time data on parts to identify mechanical failures as they happen.[94] A decrease in over-maintenance and "no-fault-found events" means that repair and maintenance workers will inevitably be impacted.[95]

Manufacturing: Motor Vehicle, Motor Vehicle Parts, as well as Body and Trailer Manufacturers Employ 121,495 Canadians.

Building propulsion sources for EVs is far less labour-intensive than for ICE vehicles. This shift will create major changes to the manufacturing process, which in turn, has ramifications for the workforce. The production of EV motors often use fewer materials and is less complex than ICE manufacturing.[96] ICEs have fuel-injection systems, pistons, and complicated transmissions that transfer power to the wheels through a sequence of gears.[97] Electric motors use a single-speed gearbox to move the vehicle's wheels.[98] Some studies estimate that the switch to EV manufacturing will cause a 30% labour reduction, compared to traditional ICE manufacturing,[99] with the ability to produce more vehicles with fewer parts creating an additional impact on parts suppliers, and their labour and skill demands.[100]

The introduction of new Additive Manufacturing (AM) technologies and robotics will likely also impact the demand for certain types of manufacturing workers. For example, according to international researchers, AM can "reduce the amount of production steps, inventory being held, and the amounts of distinct parts needed for

[88] *Anmol Soni. "Driving Green: Employment Effects, Policy Adoption, and Public Perceptions of Electric Vehicles," Georgia State University and Institute of Technology, published in August 2020. https://smartech.gatech.edu/bitstream/handle/1853/63612/SONI-DISSERTATION-2020.pdf?sequence=1&isAllowed=y.*

[89] *Bill Canis. "Electrification May Disrupt the Automotive Supply Chain," Congressional Research Service, published on February 8th, 2019 https://sgp.fas.org/crs/misc/IF11101.pdf.*

[90] *Anmol Soni. "Driving Green: Employment Effects, Policy Adoption, and Public Perceptions of Electric Vehicles," Georgia Tech, published on June 3rd, 2020. https://smartech.gatech.edu/handle/1853/63612.*

[91] *Marta Chopei. "How to Get the Most of Predictive Maintenance in the Automotive Industry," N-IX, published on February 4th, 2021. https://www.n-ix.com/predictive-maintenance-automotive-industry/.*

[92] *"Predicting Maintenance Needs by Listening to Your Car," CARFIT. https://car.fit/en/.*

[93] *KPMG. "Global Automotive Executive Survey"*

[94] *N-IX. "How to Get the Most of Predictive Maintenance in the Automotive Industry."*

[95] *N-IX. "How to Get the Most of Predictive Maintenance in the Automotive Industry."*

[96] *Chris Isidore. "Electric Vehicles Pose a Major Threat to Autoworkers Jobs," CNN Business, published on September 4th, 2019. https://www.cnn.com/2019/12/04/business/electric-car-job-threat/index.html.*

[97] *Ibid. "Electric Vehicles Pose a Major Threat to Autoworkers Jobs"*

[98] *Ibid. "Electric Vehicles Pose a Major Threat to Autoworkers Jobs"*

[99] *Ibid. "Electric Vehicles Pose a Major Threat to Autoworkers Jobs"*

[100] *Anke Mönnig, et al. "Electromobility 2035 - Economic and labour market effects through the electrification of powertrains in passenger cars," Institut für Arbeitsmarkt- und Berufsforschung (IAB), published in 2019. https://ideas.repec.org/p/iab/iabdpa/201908.html; Jim Barrett and Josh Bivens. "The stakes for workers in how policymakers manage the coming shift to all-electric vehicles," Economic Policy Institute, published on September 22nd, 2021. https://www.epi.org/publication/ev-policy-workers/.*

assembly work."[101] Research also links high levels of robotics in automotive assembly lines—namely in completing tasks like painting, welding, material manipulation and part transfer—to job loss in manufacturing. Robot density (the number of operational industrial robots per 10,000 employees), in Canada's automotive sector stood at 1475 in 2019, exceeding that of the U.S. at 1311.[102]

Local Employment Impacts

Despite some anticipated negative employment impacts compared to the traditional ICE industry, experts assert that the potential for job creation far outweighs job loss in the transition to EV for Quebec's automotive industry. As the President of an EV organization told ICTC: *"Most combustion engine manufacturers have already left Quebec. The overall employment growth from the transition to EV will be positive, and any combustion engine employees can be reskilled into EV positions."*

ICTC's survey respondents echoed this belief, stating that the integration of new technologies in Quebec's EV industry will not cause substantial job loss. Although survey respondents relayed plans to invest in technologies that support and accelerate their work, none drew a correlation between this and worker displacement. In fact, the EV companies surveyed noted that they did not let go of any workers in the past two years, nor did they have plans to do so in the coming years. Most interviewees from EV companies similarly noted that introducing new technologies would not lead to job losses and that the demand for labour in Quebec's EV industry would remain strong for the foreseeable future.

"We are a growing company... Two years ago we had 15 employees. Now we're probably at 30. Next year we'll be at 40 or more. There is no consideration of layoffs or job closures. It may be that the roles of some employees will change... but there will be no closing of positions of any kind." — CEO, EV Company

"We're keeping them all! We are preparing to hire [more] because we have too much work." — Business Development Manager, EV Company

Changing Roles and In-Demand Skills

From ICE to EVs: Acceleration of Routine Cognitive Work

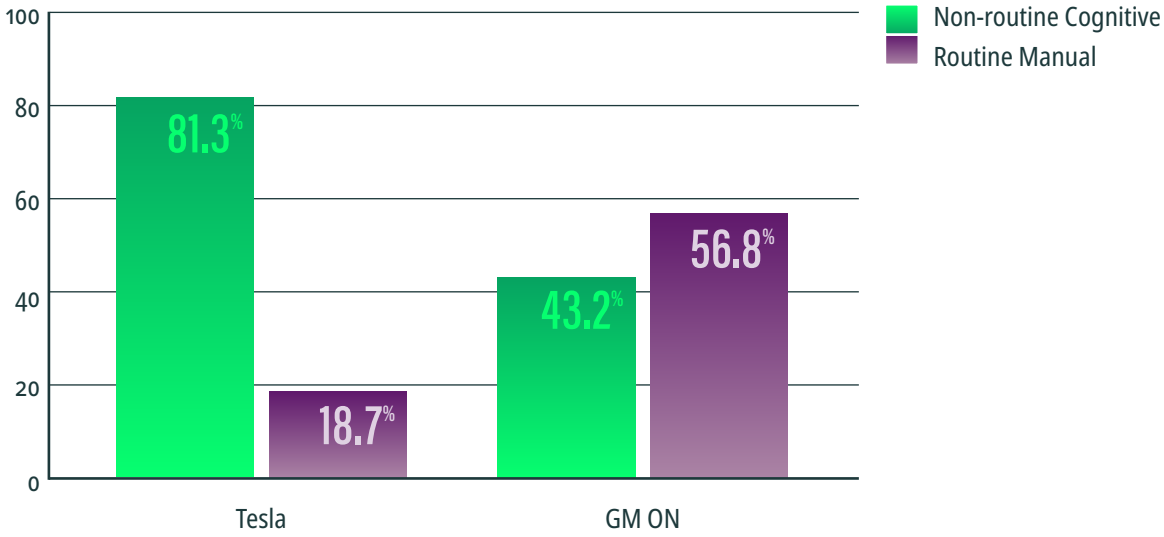
Electrifying the automotive industry to meet climate goals will have a strong labour market impact and is likely to increase the demand for high-skilled workers. A study by Marin and Vona (2019), for example, finds that climate change policies have skill-biased effects similar to globalization and automation in that the demand for manual workers tends to decline and the demand for abstract professions (e.g., engineers, designers, etc.) tends to increase.[103] In general, traditional occupations with a relatively high share of automatable tasks are expected to decline with

[101] *Shruti Sarvankar and Sanket Yewale. "Additive Manufacturing in Automobile Industry," IJRAME, published in 2019. https://ijrame.com/wp-content/uploads/2019/04/V7i401.pdf.*
[102] *"Canada's Automation and Robotics Landscape," NGen, published on April 14th, 2021. https://www.ngen.ca/blog/canadas-automation-and-robotics-landscape*
[103] *Giovanni Marin, and Francesco Vona. "Climate Policies and Skilled-biased Employment Dynamics: Evidence from EU Countries," Journal of Environmental Economics and Management 98, published on August 12th, 2019. https://doi.org/10.1016/j.jeem.2019.102253.*

increasing automation and digitization, while occupations with a relatively high share of abstract technical tasks will become more dominant.[104] Research shows that STEM fields will become increasingly important and, next to multi-skilled engineers, workers will need to possess skills related to electronics, mechatronics and electrochemical competencies (mechatronics in this instance refers to the meshing of disciplines—particularly electrical, mechanical, and software).[105] Over the past few years, the fastest growing occupations in the U.S. auto industry have been computer network specialists and software developers. In contrast, the two fastest shrinking occupations were drilling and boring machine operators and sheet metal workers.[106]

The change in skill requirements through a shift from traditional ICE manufacturing to EV manufacturing can be illustrated by comparing employee skill profiles of a pure EV Original Equipment Manufacturer (OEM) with that of a traditional Ontario-based OEM. Applying an established framework that distinguishes occupations by skill requirements allows us to determine the respective shares of higher skilled (i.e., non-routine cognitive) versus middle-skilled (i.e., routine manual) occupations.[107] Figure 5 displays a comparison of Tesla employees compared to GM's workforce in Ontario using this framework. As can be seen, around 81% of Tesla's current workforce consists of non-routine cognitive occupations compared to around 43% of GM's Ontario-based workforce. Although routine manual occupations still account for the majority of GM's Ontario workforce (the figure below highlights disruption faced by OEMs only), a transition to EVs across provinces is likely to shift skill requirements from routine manual to routine cognitive occupations.

Employment Share in High-Skilled Versus Middle-Skilled Occupations



[104] *Ibid. "Climate Policies and Skilled-biased Employment Dynamics: Evidence from EU Countries."*
[105] *Hao Wu, et al. "New Market. New Entrants. New Challenges - Battery Electric Vehicles," Deloitte, published in 2019. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/manufacturing/deloitte-uk-battery-electric-vehicles.pdf; "Die Automobilindustrie im Wandel – Beschäftigungspolitische Implikationen des Automobilsektors für die chemische, die gummi- und kunststoffverarbeitende Industrie," Fraunhofer Institute for Microstructures of Materials and Systems IMWS, published in October, 2019. https://www.arbeit-umwelt.de/wp-content/uploads/191101_au-feinenblick_automobilit%C3%A4t_en.pdf; "Impact of Electrically Chargeable Vehicles on Jobs and Growth in the EU," FTI Intelligence, published in 2018. https://www.fticonsulting.com/emea/-/media/files/us-files/insights/articles/2018/jul/impact-electrically-chargeable-vehicles-jobs-growth-eu.pdf?rev=ab69890727d844df96fad9cf4a64fece&hash=258D8861A044B0D43A0EABCD3195BFF3.*
[106] *Mark Muro and Robert Maxim. "What GM's layoffs reveal about the digitalization of the auto industry," Harvard Business Review, published on December 4th, 2018. https://hbr.org/2018/12/what-gms-layoffs-reveal-about-the-digitalization-of-the-auto-industry.*
[107] *David H. Autor, Frank Levy, and Richard Murnane. "The Skill-Content of Recent Technological Change: An Empirical Investigation," Quarterly Journal of Economics, published in June 2001. https://www.nber.org/papers/w8337.*

Figure 5. Employment share in non-routine cognitive vs. routine manual skilled occupations (%) in Tesla and GM's workforce in Ontario. Source: ICTC, 2021.

Quebec's EV Industry Employment Demand

The findings from ICTC's survey of Quebec's EV companies reflect an increasing demand for high-skilled workers. Indeed, survey respondents note that workforce impacts have been predominantly positive, and over half note that investments in new technologies and processes have created new roles and possibilities.[108] When asked which business lines experienced the most employment growth, respondents identify product development and research. In particular, the roles most positively impacted in these areas (seeing strong demand) include general engineers, followed by software engineers, software designers, and electrical engineers. These roles overlap with the most in-demand roles for Quebec's EV companies over the next five years such as mechanical, electrical, and chemical engineers, full stack developers, frontend and backend developers, embedded developers, mobile software designers, AI/machine learning specialists, and a variety of STEM technicians and designers. This correlation between roles positively impacted by new technologies and future hiring solidifies the expectation that new technologies will continue to create numerous jobs and opportunities.

Workforce Impact of Tech Investment in Quebec EV Companies

Figure 6. Experienced and anticipated workforce impacts of tech investment in Quebec EV companies from 2019 to 2023 (%). ICTC Survey, 2021.

[108] *These positive responses are likely influenced by the respondent base being invested in electric vehicles already.*

Future Hiring Areas for Quebec EV Companies

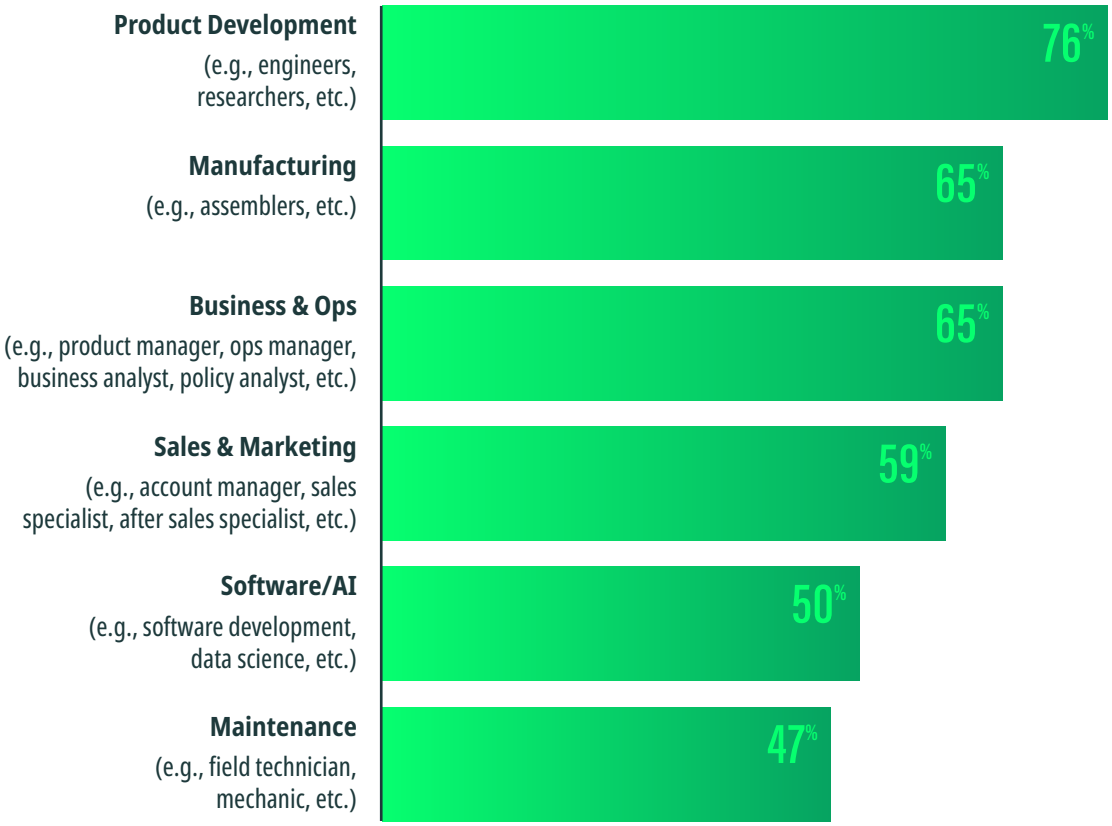


Figure 7. *Future hiring areas for Quebec EV companies (%). ICTC Survey, 2021.*

Recruiting Skilled Talent to Quebec's EV Industry

In-Demand Roles and Skills

A shortage of talent, coupled with the rapid pace of industry growth means that many EV companies face recruitment and retention challenges. ICTC's survey found that most EV companies find it "very difficult" or "somewhat difficult" to hire skilled talent for in-demand roles. According to respondents, the most in-demand and difficult to source roles are software developers and data scientists, followed by engineers and researchers. Maintenance workers were the easiest occupations to source, but these are the very occupations likely to see shrinking labour demand and/or changing skill needs as the industry evolves and digitization accelerates.

Expected Difficulty Hiring for Quebec EV Companies

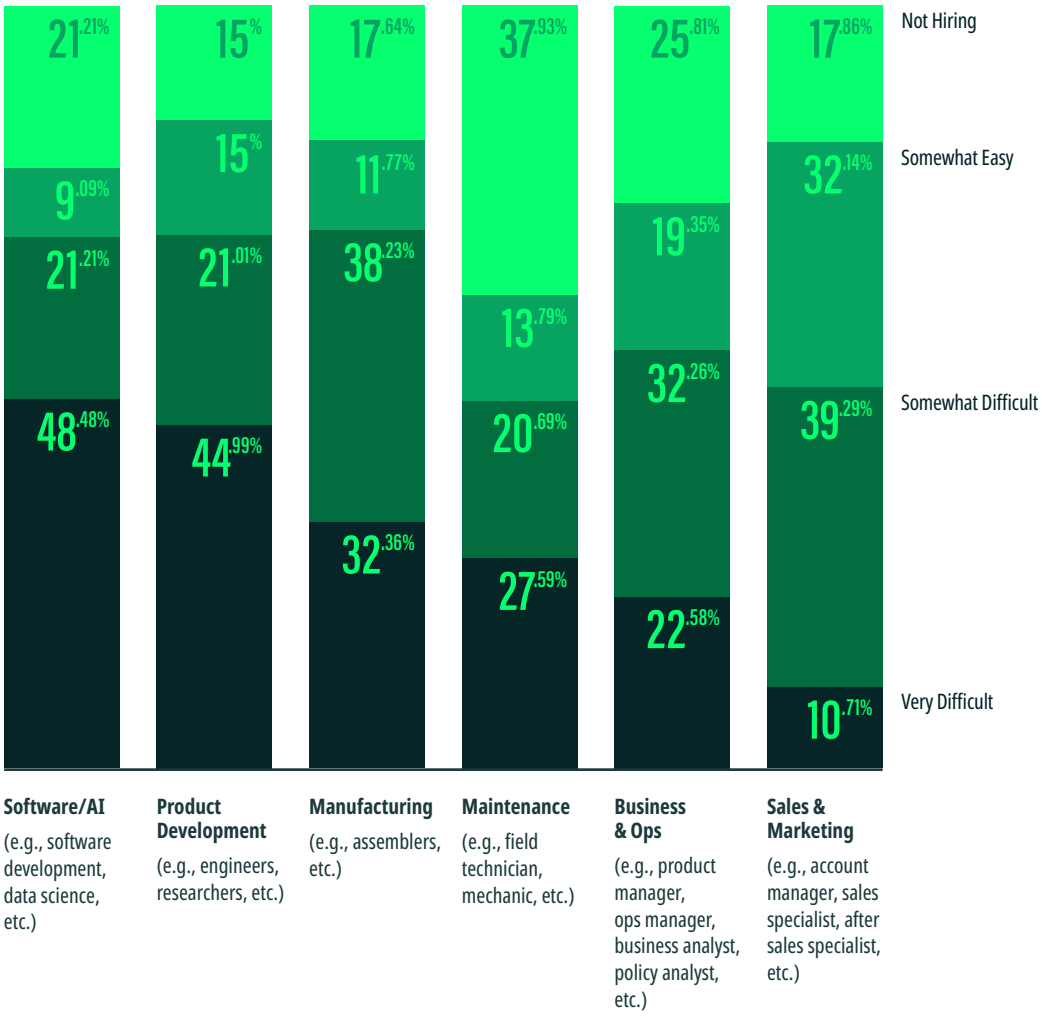


Figure 8. *Anticipated difficulties recruiting for specific roles in Quebec EV Companies (%) in the next few years. ICTC Survey, 2021.*

Engineers and Software Developers

Electric vehicle companies in Quebec find it difficult to recruit engineers and software developers across all organizational levels. According to interviewees, senior-level roles are the most difficult to source for various types of engineers, including electrical, mechanical, and software, as well as senior software developers. Several interviewees, for example, described long wait times to find key senior engineering and software development roles, and even stated that hiring candidates with engineering or software development skills and EV domain knowledge is "near to impossible." As a result, many companies in Quebec are turning to new graduates to fill these senior talent shortages. Interviewees note, however, that some new graduates are being offered senior positions due to the talent shortage in Quebec, something that accelerates existing skill gaps and makes it further difficult to source junior roles.

SPOTLIGHT

Electrical Engineer

In the EV supply chain, electrical engineers primarily work in research, design, and manufacturing.[109] According to the U.S. Bureau of Labor, electrical engineers "are responsible for designing the electrical circuitry that allows a gas engine to charge the battery and distribute the electricity from the battery to the electric motor."[110] Other key responsibilities include working with vehicle lighting, displays, temperature regulating systems, and developing wire harnesses for EV charging.[111] [112] Typically, these engineers have at least an undergraduate degree in electrical engineering, however, upskilling to master new applications of emerging technologies relevant to the EV industry is becoming increasingly common.[113]

Business and Sales Expertise

Aside from engineers and developers, interviewees note that business and sales roles are also difficult to source, particularly technical sales specialists, and project managers. Although these roles do not require the same technical EV expertise as developers or engineers, interviewees suggest that a solid understanding of EV technology is necessary for these occupations, which is difficult to find. EV sales specialists lacking comprehensive technical knowledge are less effective at selling the product in question for various reasons, including poor communication of product benefits and inability to find custom-tailored solutions to consumer issues.[114]

SPOTLIGHT

Technical Sales Specialist

Technical sales specialists support existing EV sales networks and expand sales opportunities for products, including electric chargers, all-terrain electric vehicles, and related software.[115] They are often responsible for developing account strategies to establish connections in new verticals or geographies to further the reach of their client. Specialists work to develop relationships with a variety of customers, including electrical fleet owners, EV manufacturers, consultants, and utilities organizations. Key to developing these relationships is technical knowledge of the niche market in question.[116] Because technical sales require specialized knowledge, job postings often indicate requirements for degrees in engineering, business, and commerce.[117]

[109] *Choube. "Opportunities for Electrical Engineers in E-Vehicle (EV) Industries," Dr. D. Y. Patil Institute of Technology, published on May 18th, 2021. https://engg.dypvp.edu.in/blogs/opportunities-for-electrical-engineers-in-e-vehicle-ev-industries.*
[110] *James Hamilton. "Careers in Electric Vehicles," U.S. Bureau of Labor Statistics, accessed December 2021. https://www.bls.gov/green/electric_vehicles/.*
[111] *U.S. Bureau of Labour Statistics."Careers in Electric Vehicles."*
[112] *"How to Make a Career in the Electric Vehicle Industry," EVreporter, May 5th, 2020. https://evreporter.com/career-in-the-electric-vehicle-industry/.*
[113] *U.S. Bureau of Labour Statistics."Careers in Electric Vehicles."*
[114] *Simon Ouellette. "Trained Sales Consultants Key to Selling More EVs," Canadian Auto Dealer, published on July 29th, 2020. https://canadianautodealer.ca/2020/07/trained-sales-consultants-key-to-selling-more-evs/.*
[115] *"Technical Sales Electric Vehicle," Indeed, accessed November 2021. https://ca.indeed.com/Technical-Sales-Electric-jobs-in-Ontario?vjk=1377adb5ded03ba8.*
[116] *Ouellette. "Trained Sales Consultants Key to Selling More EVs."*
[117] *Indeed. "Technical Sales Electric Vehicle."*

Traditional Vehicle Industry to EV: Understanding Skill Matches and Gaps

With Quebec's EV industry rapidly evolving out of the traditional vehicle industry, it is critical to understand which occupations are in decline and how individuals in those roles can be mapped to in-demand roles. Doing so necessitates an analysis of skills required for emerging jobs in established EV industries to identify skill gaps and critical skill shortages in Quebec's EV labour market.

Emerging Jobs in Advanced EV Ecosystems

Although some in-demand occupations were identified in the ICTC's survey, Quebec's EV industry is currently in the early phases of its development. To understand future long-term trends and labour needs, ICTC collected data on emerging jobs from established North American pure-play EV manufacturers: Tesla and Rivian. Job postings for Tesla and Rivian were collected from major job boards and the validated against the company websites. Top jobs and in-demand technical skills are categorized according to six areas: software, data, industrial, service, process, and product.[118] The following is an overview of the most cited in-demand skills per category, their job post frequency (how often the skills occur in the associated job postings), and the occupations most often associated with the skills.

SOFTWARE

JOB POST FREQUENCY	TOP TECHNICAL SKILLS	TOP JOBS ASSOCIATED WITH TOP TECHNICAL SKILLS
52%	Python	Process Engineer
40%	C	Process Technician
39%	C++	Process Development Engineer
39%	Continuous integration software	Process Controls Engineer
32%	Database and user interface software	Production Process Engineer
27%	React	
26%	Software development environment	
26%	JavaScript	
25%	UX/UI	
24%	Linux	
22%	AWS	
22%	Git	
21%	Oracle Java	
19%	Web platform development software	
17%	HTML	

Table 1. *Top technical software skills by job post frequency (%) and top associated jobs. Source: ICTC, 2021.*

[118] *"ICTC's analysis focuses on in-demand technical skills, but other non-technical skills are also important for the development of Quebec's EV industry.*

DATA

JOB POST FREQUENCY	TOP TECHNICAL SKILLS
86%	Python
65%	SQL
62%	Apache Spark
55%	Database user interface and query software
54%	AWS
51%	Continuous integration software
45%	Apache Kafka
39%	Informatica Big Data
38%	Tableau
37%	Amazon Redshift
32%	Adeptia ETL Suite
31%	Amazon Simple Storage Service S3
31%	Data warehouse software
30%	NoSQL
28%	R

TOP JOBS ASSOCIATED WITH TOP TECHNICAL SKILLS
Data Engineer
Data Scientist
Data Platform Engineer
Data Analyst
Data Dev/Ops Engineer

Table 2. *Top technical data skills by job post frequency (%) and top associated jobs. Source: ICTC, 2021.*

INDUSTRIAL

JOB POST FREQUENCY	TOP TECHNICAL SKILLS
56%	Microsoft Excel
26%	Microsoft Office
26%	SQL
22%	Tableau
21%	Microsoft Visual Basic
21%	Simulation software
20%	Discrete event simulation software
13%	Microsoft Visio
9%	MATLAB
9%	Data visualization software
9%	CAD
9%	Python

TOP JOBS ASSOCIATED WITH TOP TECHNICAL SKILLS
Industrial Engineer
Industrial Design Manager
Industrial Designer

Table 3. *Top technical industrial skills by job post frequency (%) and top associated jobs. Source: ICTC, 2021.*

SERVICE

JOB POST FREQUENCY	TOP TECHNICAL SKILLS
39%	Microsoft Excel
21%	Amazon Simple Storage Service S3
20%	Microsoft Office
14%	Development environment software
1.5%	R
1.5%	C
1%	SAP
1%	Python
1%	SQL
1%	Business intelligence software
1%	Tableau
1%	JIRA
0.5%	Web design software
0.5%	CSS
0.5%	System architecture software

TOP JOBS ASSOCIATED WITH TOP TECHNICAL SKILLS
Service Technician
Service Advisor
Mobile Service Technician
Service Manager
Service Installer

Table 4. *Top technical service skills by job post frequency (%) and top associated jobs. Source: ICTC, 2021.*

PROCESS

JOB POST FREQUENCY	TOP TECHNICAL SKILLS
27%	Microsoft Excel
19%	SAS JMP
19%	Python
18%	SQL
15%	Tableau
13%	Minitab
12%	MySQL
10%	R
9%	Statistical software
7%	Microsoft PowerPoint
7%	Microsoft Office
6%	JIRA
6%	Microsoft Visio
4.5%	Simulation software
4.5%	SAP

TOP JOBS ASSOCIATED WITH TOP TECHNICAL SKILLS
Process Engineer
Process Technician
Process Development Engineer
Process Controls Engineer
Production Process Engineer

Table 5. *Top technical process skills by job post frequency (%) and top associated jobs. Source: ICTC, 2021.*

PRODUCT

JOB POST FREQUENCY	TOP TECHNICAL SKILLS	TOP JOBS ASSOCIATED WITH TOP TECHNICAL SKILLS
41%	UX/UI	Product Manager
17%	Python	Product Engineer
14%	SQL	Technical Product Engineer
14%	SaaS	Infotainment Product Engineer
14%	Development environment software	
12%	Tableau	
12%	Linux	
9.5%	C++	
9.5%	C	
7%	Phase Forward InForm GTM	
7%	Confluence	
7%	JIRA	
5%	C#	
5%	Microsoft Office	
5%	Perl	

Table 6. *Top technical product skills by job post frequency (%) and top associated jobs. Source: ICTC, 2021.*

Declining Jobs

Although ICTC's survey and available job data do not clearly identify specific declining jobs in Quebec's traditional vehicle industry, the World Economic Forum highlights the following jobs expected to see shrinking demand as the automotive industry changes.

Declining Roles: Automotive, Aerospace, Supply Chain & Transport

41% OF EMPLOYMENT IN 2018	Assembly and Factory Workers
	Data Entry Clerks
	Client Information and Customer Service Workers
	Accountants and Auditors
	Accounting, Bookkeeping and Payroll Clerks
	Administrative and Executive Assistants
	Material-Recording and Stock-Keeping Clerks
26% OF EMPLOYMENT IN 2022	General and Operations Managers
	Business Services and Administration Managers

Table 7. *Declining Roles in automotive, aerospace, supply chain, and transport industries from 2018 to 2022. Source: World Economic Forum, The Future of Job, Centre for the New Economy and Society Insight Report, Geneva, 2018.*

The above declining jobs represent a material source of potential talent for the emerging job demand in Quebec's EV ecosystem as it matures and grows. Cross-referencing the above declining jobs with O*Net identifies the following transferable skills technical skills that are a fit for emerging EV jobs.

Identifying Declining Jobs to Transferable Skills for Emerging EV Jobs

DECLINING JOB	TRANSFERABLE SKILLS FOR EMERGING EV JOBS
Assembly and Factory Workers	Microsoft Office
	Microsoft Excel
	Microsoft Word
	CAD
	SolidWorks
	Data entry
Data Entry Clerks	Accounting software
	CRM
	Microsoft Access
	Microsoft Outlook
	ERP
	Microsoft Office
	Microsoft PowerPoint
	Microsoft Excel
	Microsoft Word
	Data entry
Client Information and Customer Service Workers	Citrix
	QuickBooks
	iShip
	Microsoft Teams
	Zoom
	VPN
	Microsoft Office
	Microsoft PowerPoint
	Microsoft SharePoint
	Microsoft Excel
	Facetime
	Microsoft Word

GENERAL TECHNICAL SKILLS
SOFTWARE SKILLS
DATA SKILLS
INDUSTRIAL

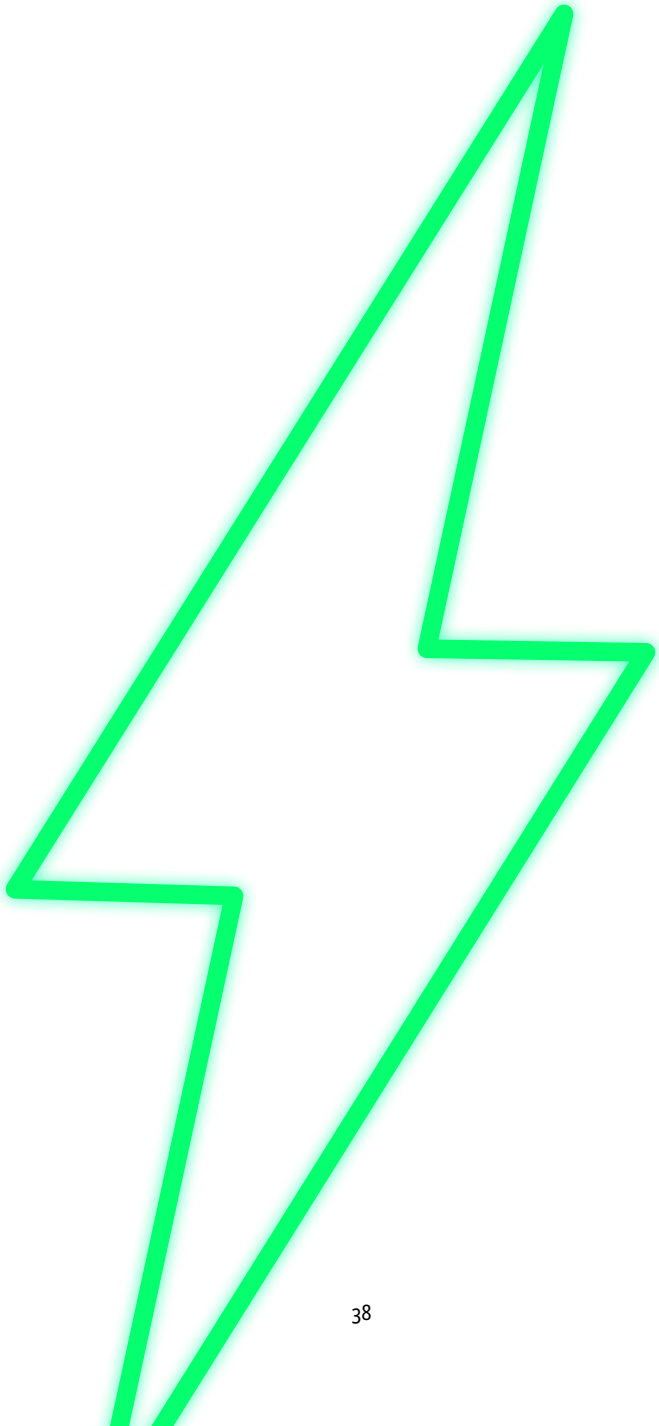
Accountants and Auditors	QuickBooks
	SAS
	SPSS
	Tableau
	Qlink
	Intrax ProcedureNet
	CRM
	Salesforce
	SAP
	Teradata
	SAP Crystal Reports
	Data mining
	Microsoft Visual Basic
	Oracle e-business Suite
	Microsoft Visio
	LexisNexis
	R
	Microsoft Office
	Microsoft PowerPoint
	Microsoft Project
	Microsoft Excel
	Tax software
	Payroll software
	Symantec
	Zoom
Accounting, Bookkeeping and Payroll Clerks	QuickBooks
	IBM Cognos Impromptu
	Intrax ProcedureNet
	CRM
	Salesforce
	SAP Crystal Reports
	LexisNexis
	Microsoft PowerPoint
	Microsoft Project
	Microsoft SharePoint
	Microsoft Excel

	Payroll software
	SAP
	ADP Workforce Now
	SCADA
Administrative and Executive Assistants	QuickBooks
	Microsoft Access
	Airtable
	CRM
	Salesforce
	Adobe Acrobat
	Oracle e-business Suite Financials
	LexisNexis
	Microsoft PowerPoint
	Microsoft SharePoint
	Microsoft Excel
	SAP
	Zoom
Material-Record Keeping and Stock-Keeping Clerks	CRM
	Microsoft Access
	ERP
	Microsoft Excel
	Inventory software
General and Operations Managers	Quickbooks
	Microsoft Access
	CRM
	Salesforce
	Adobe Acrobat
	Oracle e-business Suite Financials
	LexisNexis
	Microsoft PowerPoint
	Microsoft Project
	Microsoft SharePoint
	Microsoft Excel
	SAP
	Zoom

	SAS
	SPSS
	IBM Cognos Impromptu
	Autodesk AutoCAD
	CNC Mastercam
	JIRA
	SAP Crystal Reports
	Airtable
	ADP Workforce Now
	Inventory software
Business Services and Administration Managers	QuickBooks
	Microsoft Access
	Airtable
	CRM
	Salesforce
	Adobe Acrobat
	Oracle e-business Suite Financials
	LexisNexis
	Microsoft PowerPoint
	Microsoft Project
	Microsoft SharePoint
	Microsoft Excel
	SAP
	Zoom
	SAS
	SPSS
	JIRA
	Autodesk AutoCAD
	Teradata
	Microsoft Visio
	ADP Workforce Now
	SCADA
	SAP Crystal Reports

Table 8. *Transferable Skills. Source: National Centre for O*NET Development, O*NET Online Occupation Summaries, accessed October 2021.*

The skills of individual workers from the declining job categories will vary widely, but the above represents O*NET data that has been standardized at the aggregated occupation level. With many in-demand roles experiencing high demand in part due to difficulties sourcing workers, filling this gap for some Quebec employers means looking to workforce upskilling and retraining. ICTC's survey found that just under 50% of respondents have already re-trained existing workers to take on new responsibilities or new roles, and most employers believe that in the future, more workers should and will be trained to take on new responsibilities in areas like data analysis, battery thermal management, embedded software design and development, AI engineering, digital marketing, product management, business development, and sales. Also notable is the gap in expertise for product development and research, as well as ecosystem considerations in terms of the technical knowledge needed for those involved in the buying and selling of EVs.



THE ROLE OF PUBLIC POLICY IN QUEBEC'S EV LABOUR MARKET

Global and National Policy Context

Overall employment impacts of the shift to EVs can be positive, especially when measures are taken to capitalize on regional speciality and develop EV supply chains, where this direction is feasible and additive.[119] Research demonstrates that the electrification of the auto industry will lead to a change in skill demand and the nature of work. In line with previous experiences around automation and digitization, a shift toward EVs is likely to spur skill-biased technological change favouring higher skilled workers, including those with a STEM education as well as those with expertise in project management, business development and sales, and other areas.

As such, the role of public policy in facilitating this shift and ensuring that the transition is inclusive in the context of a green recovery is twofold. First, direct support is necessary for the development of a domestic EV supply chain, including a complete battery value chain. In this context, governments may also consider R&D investments to rapidly accelerate the deployment of a variety of EV-adjacent industries, including the sourcing and recycling of critical minerals, the development of alternative battery technologies, and the consideration of end-of-life battery management.[120] According to articles in the Washington Post and others newspapers, the creation of a functioning EV industry requires an active industrial policy to generate the full potential benefits from this transition.[121] This might, where necessary, include supply-side policies such as research and development funding, loan guarantees, and tax breaks for manufacturing as well as domestic manufacturing requirements for the procurement of public transit vehicles to increase production of electric buses in Canada.[122] Additionally, improving

[119] *Adam Radwanski. "Less talk, more action: Canada gets a reality check on its dreams of being an EV powerhouse," Globe and Mail, published on May 19th, 2021. https://www.theglobeandmail.com/business/commentary/article-less-talk-more-action-canada-gets-a-reality-check-on-its-dreams-of/*

[120] *Karla Walter, et al. "Electric Vehicles Should Be a Win for American Workers," Center for American Progress, published on September 23rd, 2020. https://www.americanprogress.org/article/electric-vehicles-win-american-workers/.*

[121] *Jeanne Whalen. "Biden wants to create millions of clean-energy jobs. China and Europe are way ahead of him," Washington Post, published February 11th, 2021. https://www.washingtonpost.com/technology/2021/02/11/us-battery-production-china-europe/.*

[122] *Dan Woynillowicz. "Electric vehicle assembly deals put Canada in the race," Electric Autonomy Canada, published on October 20th, 2020. https://electricautonomy.ca/2020/10/20/ev-supply-chain-canada/*

SME access to finance through, for example, loan guarantees and start-up grants might help those in the supply chain industry to better manage the transition.[123] Opportunities for technology adoption, particularly government procurement "house in order" programs at all three levels of government, and programs that foster private sector adoption can help de-risk adoption, particularly for earlier stage technologies. Quebec already has helpful scaffolds in place such as Investissement Québec (which to date has supported lithium mining and EV manufacturing),[124] a low corporate tax rate, and R&D support.[125] Moving quickly upon Quebec's existing strategies for battery and energy storage manufacturing, as well as other areas of EV-adjacent opportunity, will be particularly critical in light of the recent "Buy American Act," which proposes significant tax credits for EVs made in the U.S.[126] Rapidly mobilizing to support and position Quebec-based industry and supply chain advantages can reduce the risk of capital and projects flowing south to the U.S. Tellingly, Lion Electric has announced it will build North America's largest production site for zero emission and heavy-duty vehicles in Joliet, Illinois—with an anticipated 745 new jobs.[127]

The second aspect is preparing for the change in skill requirements triggered by the electrification of the auto industry. As noted, this change is likely to accelerate skill demand toward higher skilled workers. A crucial role for public policy in this context is to facilitate the transition of workers whose jobs might be displaced into alternative and emerging roles. To reduce frictions and enable smoother transitions, focus can include improving the availability and quality of labour market information—especially with regard to skill requirements—which can in turn help to inform opportunities to prepare the existing workforce and address precarity.[128] Additionally, partnerships between the public and private sector and employment service providers can be developed to improve access to and uptake of existing training opportunities as well as inform new curricula commensurate with evolving industry directions. Apart from the need to retrain some employees now, the pace of digitization and automation will also increase the requirements for lifelong learning, which necessitates the creation and maintenance of appropriate and ongoing training infrastructure.[129]

[123] *ILO. "The future of work in the automotive industry: The need to invest in people's capabilities and decent and sustainable work."*

[124] *Insofar as supply chain developments, in 2018 Investissement Québec (IQ) announced an investment of $95 million into Nemaska Lithium Inc. which at the time was advancing a lithium mine and electrochemical plant in the province. Nemaska filed for creditor protection in 2019, however other companies have been continuing to explore the opportunity for provincial lithium production.. IQ has also invested millions into Nouveau Monde to advance a graphite mine in the province. These directions are of consequence given the role of critical and strategic minerals in EV battery production, however many questions remain about how cost competitive hard rock mining lithium - the form Canadian lithium would take - is in comparison to brine pond lithium, which is the dominant form of production globally.*

[125] *"Electric and Smart Vehicles A Specialized Ecosystem," Investissement Quebec, published in July 2019. https://www.investquebec.com/documents/int/publications/VehiculesElectriques_EN_Juillet2019.pdf.*

[126] *Alexander Panetta. "Canada Urged Biden to drop a 'BuyAmerican' idea. Seems he's sticking to it," CBC News, published on October 28th, 2021. https://www.cbc.ca/news/world/canada-us-ev-credit-1.6228356*

[127] *"Lion Electric Announces U.S. Manufacturing Facility in Illinois, the Largest All-Electric Medium and Heavy-Duty Vehicles Plant in the U.S.," Newswire, published May 7th, 2021. https://www.newswire.ca/news-releases/lion-electric-announces-u-s-manufacturing-facility-in-illinois-the-largest-all-electric-medium-and-heavy-duty-vehicles-plant-in-the-u-s--895587101.html*

[128] *Anthony Mantione. "LMI Most Wanted by Canadians: Wages and Skills," Labour Market Information Council (LMIC), LMI Insights no. 8, published in February 2019. https://lmic-cimt.ca/wp-content/uploads/2019/02/LMI-Insights-No-8.pdf.*

[129] *Tony Bonen and Matthias Oschinski. "Mapping Canada's Training Ecosystem: Much Needed and Long Overdue," Institute for Research on Public Policy (IRPP), published on January 6th, 2021. https://irpp.org/research-studies/mapping-canadas-training-ecosystem-much-needed-and-long-overdue/.*

In support of these points, a 2020 study by Walter et al. outlines workforce transition policy measures that can help account for worker precarity.[130] The authors stress that transition and related programming should be structured to ensure that EV opportunities do not expressly deskill or erode existing occupations and that this can be addressed through providing support for workforce retraining and placement in "quality jobs for existing workers, as well as for dislocated and disadvantaged workers, including women, people of colour, returning citizens, and workers with disabilities." The authors also suggest that industry will need to lead in terms of assigning and retraining the workforce and that collaboration is critical to address the systemic workforce disruption that is underway. In support, programs can "provide unions, employers, and educational institutions with grants for workforce training; allow grant recipients to use funds to pay a portion of employee wages or provide training stipends"; "prioritize labour-management partnerships, registered apprenticeship programs, and apprenticeship readiness programs; and require that funds target dislocated and disadvantaged workers."[131]

Rapidly building a functioning and competitive EV industry that leverages existing assets and helping to transition workers who are negatively affected by this structural change would allow Quebec-based SMEs (as well as incumbents) to better compete, hire qualified and more diverse talent, and train existing staff, which would benefit the domestic industry and workforce, as well as to future labour capacity. To this last point, it is worth noting that advances in automation and digitization coupled with electrification also means that the auto industry will increasingly have to compete for talent with other industries—both at home and abroad—as digital skills are more transferable compared to the skills sets in traditional auto manufacturing. What is needed to broaden the talent base is collaboration between industry, governments, and service providers to facilitate a faster integration and technical training of newcomers, youth, and other underrepresented and underserved communities.[132] Quebec's existing immigration quota (unique among the Canadian provinces) allows for the province to specify the terms under which it welcomes skilled workers.[133] [134] This flexibility and its nascent EV skills training program[135] offer strengths to build upon.[136] Other areas of potential leverage include exploring skill-building partnerships with entities like Mitacs, ICTC, Magnet, Eco Canada, EcoTech Québec, and the Future Skills Centre (which is increasingly focused on skills needed for the green transition and youth), as well as Quebec's new $300 million program youth action plan, which includes a component for skills and training.[137]

[130] *Kayla Walter, et al. "Electric Vehicles Should Be a Win for American Workers," Center for American Progress, published on September 23rd, 2020. https://www.americanprogress.org/issues/economy/reports/2020/09/23/489894/electric-vehicles-win-american-workers/.*

[131] *Recommendations are also made for grants to be directed to train a wide range of workers (including manufacturing workers, vehicle and infrastructure maintenance workers, and oil and gas workers).*

[132] *"The Future of the Manufacturing Labour Force in Canada," Canadian Manufacturers & Exporters (CME) and Canadian Skills Training & Employment Coalition (CSTEC), published in January 2017. http://cstec.ca/sites/cstec/files/reports/The%20Future%20of%20the%20Manufacturing%20Labour%20Force%20in%20Canada.pdf.*

[133] *Immigration will become increasingly crucial in meeting acknowledged workforce gaps and recruitment challenges and integration gaps will need to be addressed.*

[134] *The immigration quota target for 2022 is 70,000, of which skilled workers are expected to make up between 23,500 and 25,600 admissions. QC has introduced the use of a points-based system using the Arrima expression of interest bank, which seeks to better align the needs of the QC labour market and immigration; "New step in the launch of the declaration of interest system based on invitation criteria in Arrima," Immigration, Francisation, et Integration Quebec, published in 2021. http://www.immigration-quebec.gouv.qc.ca/en/informations/news/news-2021/new-step-invitations-arrima.html*

[135] *"Electric and Hybrid Vehicles," CPA Montreal. https://www.cpamontreal.ca/en/ev-skill-program/*

[136] *Kayla Walter, et al. "Electric Vehicles Should Be a Win for American Workers," Center for American Progress, published on September 23rd, 2020. https://www.americanprogress.org/issues/economy/reports/2020/09/23/489894/electric-vehicles-win-american-workers/.*

[137] *Marian Scott. "Legault announces $300-million action plan to help Quebec's youth," Montreal Gazette, published June 13th, 2021.*

As an overarching consideration—as alluded to throughout this report—is that North America's direction on EVs and batteries will be increasingly shaped by the U.S. Administration's intent to build domestic EV manufacturing capacity and battery supply, however how this explicitly unfolds remains to be seen. The fact remains that countries such as China are far ahead in securing the supply chains required to lead in EV manufacturing and are already reaping the rewards of well-planned industrial-side policy in this space.[138] Given the need for swift policy action to enable a proper transition from ICE auto manufacturing to preparing for the production of EVs in Quebec, the below policy opportunities noted in the Federal Budget 2021 would benefit this shift.

CANADA'S FEDERAL BUDGET 2021

The 2021 Federal Budget earmarks significant (more than $1.4 billion) workforce funding support for Employment and Social Development Canada (ESDC), which suggests the importance of aligning workforce-focused strategies with one or more of the following funding streams falling under ESDC:

The new Sectoral Workforce Solutions Program, which will design and deliver training and recruitment relevant to the needs of businesses. This suggests the potential to identify and build upon major business training and recruitment needs as identified through the ICTC and survey.

The new Apprenticeship Service, which includes support for apprentices in manufacturing Red Seal trades and construction, which suggests apprenticeship training as a parallel consideration in workforce policy recommendations.[139]

The Community Workforce Development Program, which will support communities in identifying high potential growth organizations and connect them with training providers. This initiative is intended to upskill and reskill job seekers, and is particularly relevant, given both the national program stream focused on priorities like decarbonization and just transition, as well as the regional program stream. Quebec's work and interest in this area plays both into national-level priorities around decarbonization in the transport sector, as well as regional interests around job growth and economic development. This said, additional thought and emphasis needs to be placed on ensuring that workforce diversity and inclusion are a paramount consideration in any related effort, as these goals are key to federal-level support in this area.

https://montrealgazette.com/news/local-news/legault-announces-youth-policy

[138] *Overall, and as in Europe, the domestic labour impact of EV production at this point in time is thought to highly depend on whether the U.S. can increase the proportion of EV content produced domestically, and in particular production of EV batteries and lithium-ion cells, which comprise 25 to 30% of the value of the parts of an EV.*

[139] *Employers would be eligible to receive up to $5,000 for all first-year apprenticeship opportunities to pay for upfront costs such as salaries and training. In addition, to boost diversity in the construction and manufacturing Red Seal trades, this incentive will be doubled to $10,000 for employers who hire those underrepresented, including women, racialized Canadians, and persons with disabilities.*

Federal funding support is also provided to Innovation, Science and Economic Development Canada to scale-up proven, industry-led, third-party delivered approaches to upskill and redeploy workers to meet the needs of growing industries.[140] This suggests the value of exploring and developing relationships with active third-party service providers, for example, in replicating the approach of Iron & Earth in Alberta to upskill oil and gas workers into the renewable energies industry.[141]

Budget 2021 also contains several initiatives that relate to technology deployment and innovation, like an additional $7.2 billion for the Strategic Innovation Fund (SIF) to support innovative projects ($2.2 billion) including in the automotive industry, and for the Net Zero Accelerator ($5 billion) to scale projects that can decarbonize heavy industry, support clean technologies, and meaningfully reduce greenhouse gas (GHG) emissions by 2030. Part of the latter fund is allocated to battery supply chain development, though some stakeholders have argued for more significant investment in this area.[142] In June 2021, the federal Minister for Innovation noted that the government has a specific role to play in supporting battery manufacturing innovation.[143]

These announcements and developments suggest there is existing and future support available for large-scale projects working to strategically shift existing sectors to respond to environmental disruption. The auto industry, in addition to being specifically mentioned, is an excellent fit in terms of decarbonization potential, clean technology support and GHG emission reduction and inroads can be made to both SIF and the Net Zero Accelerator to consider positioning regional projects (e.g., QC Lion Electric battery manufacturing) as part of an overarching sectoral strategy in this area. This area is also explicitly supported by reduced tax rates (up to 50%) for companies manufacturing zero emission vehicles (ZEV) technologies, which makes explicit reference to EV manufacturing companies.

The federal budget also provides support for critical minerals, ZEV fuelling measurement, and the reduced tax rates mentioned for companies manufacturing ZEV technologies, which in addition to EV manufacturing also includes fuel cells, charging systems and energy storage. This suggests that overarching initiatives in this area could tap system-wide and supply chain-oriented supports that are both in place and emerging for EVs in Canada. Recent U.S. emission reduction commitments could conceivably favour regions and initiatives that demonstrate greener supply chain activity. Quebec's support for a "battery passport" pilot to trace metals and minerals from mining and processing through to their use in batteries represents a forward-looking strategy that aligns provincial strengths with emerging global trends on EV supply chain traceability.[144] This trend may become increasingly relevant given emerging discussions around Border Carbon Adjustment Mechanisms.[145] [146]

[140] Including $162.2 million over ten years, starting in 2021-22, to help retain and attract top academic talent across Canada—including in Alberta, British Columbia, Ontario, and Quebec. This programming will be delivered by the Canadian Institute for Advanced Research. A further $48 million over five years, starting in 2021-22, will be provided to the Canadian Institute for Advanced Research to renew and enhance its research, training, and knowledge mobilization programs.

[141] Rachel Samson, et al. "Alberta has a chance to kick-start clean growth," Canadian Institute for Climate Choices, published on April 6th, 2020. https://climatechoices.ca/alberta-has-a-chance-to-kick-start-clean-growth/

[142] Adam Radwanski. "Less talk, more action: Canada gets a reality check on its dreams of being an EV powerhouse," Globe and Mail, published on May 19th, 2021. https://www.theglobeandmail.com/business/commentary/article-less-talk-more-action-canada-gets-a-reality-check-on-its-dreams-of/.

[143] Gabriel Friedman. "Biggest shakeup in auto industry's history chance for Canada to climb on top," Financial Post, published on June 16th, 2021. https://financialpost.com/commodities/energy/electric-vehicles/biggest-shakeup-in-auto-industrys-history-chance-for-canada-to-climb-on-top.

[144] Carolyn Kim, Nikki Skuce, Karen Tam Wu. "Closing the Loop," Pembina Institute, published in December 2021. https://www.pembina.org/reports/closing-the-loop-battery-recycling.pdf

[145] These areas (in terms of regional development) are generally supported by the ongoing Canada-U.S.-Mexico trade agreement adds a 2.5 per cent tariff if more than 25 per cent of a vehicle's core parts, including the battery, are made outside of North America

[146] "Government Launches Consultations on Border Carbon Adjustments," Government of Canada, published on August 5th, 2021. https://www.canada.ca/en/department-finance/news/2021/08/government-launches-consultations-on-border-carbon-adjustments.html

In the longer term, it would be prudent to nest EV industry policy recommendations in the greater context of an overarching strategy encompassing critical minerals, batteries, alternative fuels including hydrogen, energy storage, and the like.[147] One opportunity to explore is conceptualizing Canada's contribution to a North American EV manufacturing hub, via the formation of a dedicated industrial development strategy to identify and strengthen clusters of expertise (e.g., B.C. fuel cells, MB heavy-duty manufacturing, ON parts manufacturing, QC CRM minerals/data/AI). Notably, a recent national-level consortium formed for a zero-emission supply chain alliance has representation from several Quebec entities, including Lion Electric, Dunsky Energy and Propulsion Québec. This initiative may offer a useful platform to leverage in this specific area.[148]

Finally, the support earmarked for regional development agencies to foster green recovery and inclusion outcomes are of relevance. East Montréal is cited in the 2021 Federal Budget as a key anchor opportunity both for innovative resources and for business opportunities, which could be explored in collaboration with the regional development agency going forward.

Quebec's Policy Context

In 2020, the Province of Quebec announced its goal to reach carbon neutrality by 2050. Electrification of the transportation sector will be a key element of achieving this target, as this sector is by far the largest contributor to the province's carbon footprint (43%). Quebec's historical policy support for EV development, including its long-standing activity in developing charging infrastructure coupled with its clean grid and renewed investment through its new climate plan, position the province well to continue building its capabilities and market in this area.

Since 2012, the Quebec government has provided over $576 million to support the sale of electric and plug-in hybrid vehicles through its Roulez vert program and currently the province represents the second largest consumer market for EVs in Canada after British Columbia. In late 2020, Quebec launched the *2030 Climate Plan for a Green Economy,* which places continued focus on the electrification of buildings, transportation, and industrial activities, as well as the expansion of renewable energy sources, including bioenergy, green hydrogen, and renewable natural gas. Major components of this plan include an investment of $3.6 billion in the transportation sector and $401 million to support new businesses in strategic and innovative fields. This latter includes support for the development of an industrial ecosystem for electric vehicles, charging infrastructure, and batteries. Notably, a substantial and unprecedented investment of $15.8 billion will be directed to public transportation via the *2020–2030 Quebec Infrastructure Plan.*

[147] *Parallel trends around the development of hydrogen, and particularly green hydrogen potential in Québec, suggest that attention also needs to be directed to how this potential future fuel could impact the province's electric vehicle directions, particularly in the development and support of Fuel Cell Electric Vehicles.*
[148] *Accelerating Canada's ZEV Industry," AccelerateZEV.ca. https://acceleratezev.ca/*

EV-related targets and supporting measures include:

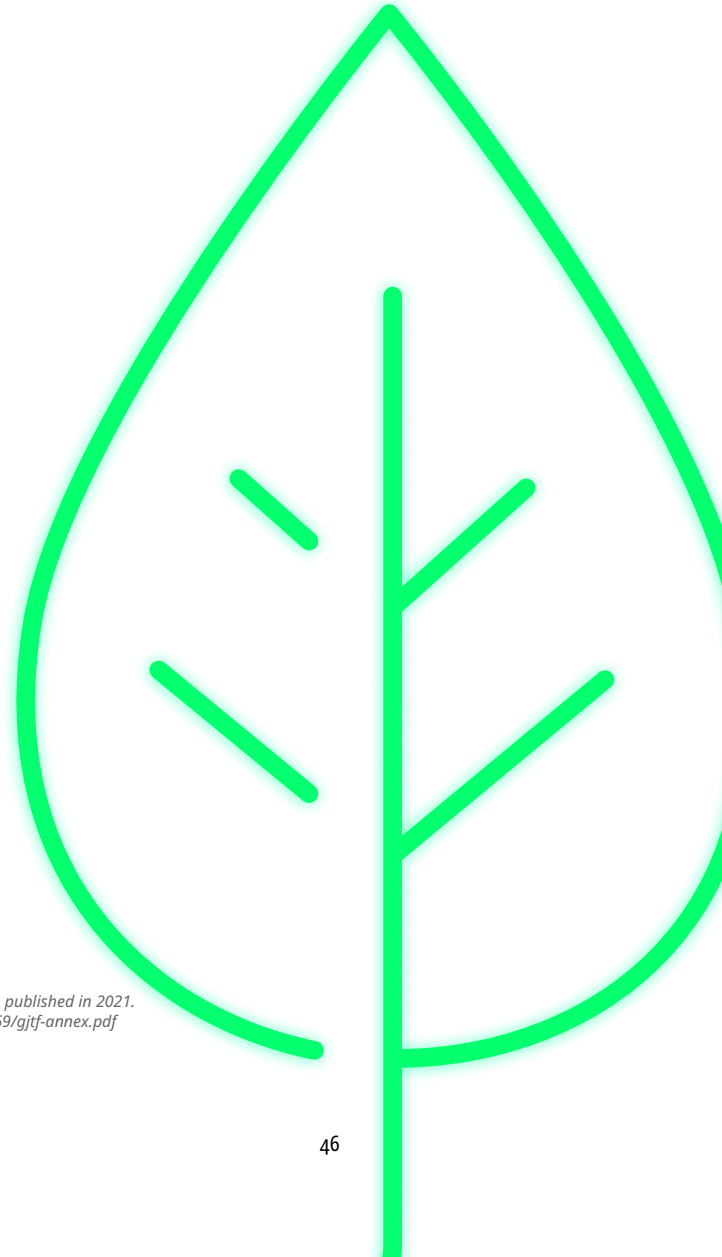
- No sales of new gasoline-powered vehicles as of 2035.
- Accelerating deployment of fast-charging stations and standard charging stations by Hydro-Québec. Hydro-Québec was the entity behind creation of Canada's first public charging network in 2012, Electric Circuit. At 3,100 charging stations today, Electric Circuit is the largest public charging network in Quebec and one of the largest in Canada.[149]
- Tightening zero-emission vehicle standards to encourage manufacturers to supply the Quebec market with more vehicles and a greater diversity of models.
- Renewing rebates for acquiring or leasing electric vehicles and charging stations for individuals, as well as aid programs for businesses and the taxi industry.
- Achieving 1.5 million electric vehicles on the road by 2030, including targeting electrification of:
    - 55% of city buses and 65% of school buses by 2030; and,
    - 100% of governmental cars, SUVs, vans and minivans, and 25% of pickup trucks by 2030. In 2020 the province almost achieved its goal of 100,000 EVs by 2020, at 92,000 EVs on road.[150]

As a final consideration, much of the discussion and policy support for EV development to date has focused on the opportunity for these vehicles to positively impact tailpipe emissions over their operating lifetime. While it is the case that the operation of EVs offer an environmental benefit compared to ICE vehicles (in regions with clean electricity grids such as Quebec), a systemic discussion and accounting of the mining, manufacturing, and supply chain needs required to produce EVs has not yet been central to policy and planning in this area. The upstream impacts of material sourcing (particularly for rare earth minerals, which can also have major environmental implications as well as labour violations, i.e., Congo cobalt), vehicle production and infrastructure development, as well as the downstream impact of end-of-life vehicle and battery management, are a critical part of a true long-term shift to green recovery principles. Electric motors will require new infrastructure, metals, and materials, as well as related technology and especially efficient and renewable energy sources along all steps of the production cycle. Thoughtful deployment in this regard will create significant potential for new employment across many sectors, which may be timely given increased international pressure for Canada to move away from its traditional fossil-based production.[151]

[149] *Luke Sarabia. "Hydro-Québec's Electric Circuit to add up to 4,500 EV charging stations to urban centres by 2028," Electric Autonomy, published on June 7th, 2021. https://electricautonomy.ca/2021/06/07/hydro-quebec-electric-circuit-curbside/*
[150] *"Quebec narrowly misses goal of putting 100,000 electric vehicles on the road," CBC News, published on December 29th, 2020. https://www.cbc.ca/news/canada/montreal/Québec-narrowly-misses-goal-of-100000-electric-vehicles-on-the-road-1.5856007*
[151] *As signalled by the cancellation of the Keystone XL pipeline in January 2021.*

Accounting for existing workforce skills and the nature of new skill demand will be critical to generating a successful transition, which in this instance is used to define a transition that is as equitable as possible. As per the Government of Canada, a just transition is an *"approach to economic, environmental and social policy that aims to create an equitable and prosperous future for workers and communities as the world builds a low-carbon economy. No worker or community can be left behind, so government climate action must be focused on those workers."*[152]

Examples that meet these goals can be drawn from other sectors, countries, and even companies that have thoughtfully considered and prepared for workforce transition, whether this includes past transition from coal-powered generation projects in regions like Alberta or Ontario, and/or forward-looking plans such as those authored by the United Kingdom. The Just Transition Discussion Paper sets out comprehensive recommendations for how stakeholders can work together to enact a green industrial revolution toward net zero and meet the challenges of supporting high carbon sectors and their workforce in this transition, with the objective to upskill workers for green jobs and to fill gaps.[153]



[152] *"Just Transition," Government of Canada. https://www.rncanengagenrcan.ca/en/collections/just-transition*
[153] *Green Jobs Taskforce. "Report to Government, Industry and the Skills Sector," United Kingdom Government, published in 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003569/gjtf-annex.pdf*

CONCLUSION

As transportation is the second largest emitter in the Canadian economy, decarbonizing vehicles must play a key role in Canada's green future. Indeed, a shift from combustion engines to battery electric vehicles has the potential to more than halve current emissions.[154] At the same time, because the auto industry currently represents Canada's second largest export, expanding Canada's role in the global EV industry represents a significant economic opportunity. For Canada to take full advantage of this opportunity and continue to establish itself as a force in the global EV landscape, it is important to develop a nuanced analysis of provincial EV ecosystems. This report examined the current state of Quebec's EV ecosystem, potential workforce impacts, and the role of public policy in facilitating the transition from internal combustion-powered vehicles to EV.

Several factors will help Quebec respond to anticipated growth in EV demand. The province's access to low-cost clean energy as well as critical minerals will help manufacturers involved in the energy-intensive battery manufacturing process, for example, keep production affordable. An established research ecosystem will ensure that Quebec remains a thought-leader for innovation in battery materials and processing. Finally, when paired with direct provincial and federal support, including R&D investments, tax breaks for manufacturing, loan guarantees and start-up grants, as well as programs that streamline government procurement and foster private sector adoption, these provincial benefits will provide Quebec the foundation it needs to drive local innovation in a globally competitive industry.

The ability to respond to changing workforce demands will also be key to maintaining a competitive edge. Increasing levels of automation and digitization will transform work in the transportation industry, reshaping skill demand for Quebec's EV workforce. ICTC found that new roles will emerge in areas including manufacturing, product development, sales and marketing, and business operations. On the other hand, non-routine and cognitive roles are expected to replace more traditional manual roles, as demand grows for various technical positions including QA, firmware, and data platform engineers, as well as process and service technicians. Areas that may see higher levels of displacement include retail, repair and maintenance, and manufacturing. According to key players in Quebec's EV ecosystem, however, these workers at risk of displacement will still have an important role to play in this emerging industry. Moreover, ICTC's

[154] *Auke Hoekstra. "The Underestimated Potential of Battery Electric Vehicles to Reduce Emissions," Joule 3, no. 6, published on June 19th, 2021. https://doi.org/10.1016/j.joule.2019.06.002.*

analysis revealed high levels of transferable skills in at-risk roles, including varied general technical, software, data, and industrial skills. It is important to note that transitioning workers would benefit from government-supported public-private partnerships to update content in, facilitate access to, and enhance adoption of existing education and training resources.

All in all, as Quebec looks to develop a competitive and inclusive EV industry, it will be important to take advantage of existing provincial strengths and develop responsive talent programs that support retraining and retaining existing workers, as well as creating robust talent pipelines that supply new in-demand roles.

RESEARCH METHODOLOGY

Secondary Sources

Company-Level Data

Using data from Pitchbook, Traxcn, and Propulsion Quebec, ICTC compiled a dataset of 133 companies that operate in Quebec's EV industry.[155] Industry size estimates varied by the data source. For example, Propulsion Quebec's developed in 2019 included 147 companies, whereas Pitchbook's list included only 39 companies. ICTC included companies if they have an office or headquarters located in Quebec and fit into defined core product and service line definitions: Design and Engineering Services; OEMs; Tier 1,2,3 Suppliers; Charging Infrastructure; and Smart Tech. Companies working in other parts of the EV value chain, including metal fabrication, retail, repair, and recycling services were excluded due to lack of high-quality data. To determine core products and service lines, ICTC analyzed company descriptions.

Existing Literature

The qualitative and quantitative portions of this project were supported by a thorough review of available literature. The literature review helped shape research methods and questions, and provided information to help further validate findings in the report. The initial literature review helped identify interviewees, advisory committee participations, and form a methodology for the quantitative portion of the research.

Primary Research Methodology

Survey

The survey was prepared in collaboration with Propulsion Quebec. A French and English survey was released, garnering 53 responses. The survey had three focus categories: Recent Technology Investment and Labour Market Impact, Future Technology Investments and Labour Market Impact, and Future Labour Market

[155] *Companies were included if they have an office or headquarters located in Quebec and are operating in design and engineering services; OEM; electrical component manufacturing (e.g. batteries, charging infrastructure); or the development of final product EVs and software. Companies working in other parts of the EV value-chain including metal fabrication, retail, repair, and recycling services were excluded due to lack of quality data.*

Shifts and Training. These categories were intended to determine the current and future impact of technology on labour markets, as well as assess current training initiatives taking place. The survey kept the study exclusive to companies within the Quebec region and attempted to capture all sizes of businesses so long as they had a major component of their operations participating along the EV value chain. The following are additional descriptive statistics related to participating businesses.

Survey Respondents by Region in Quebec

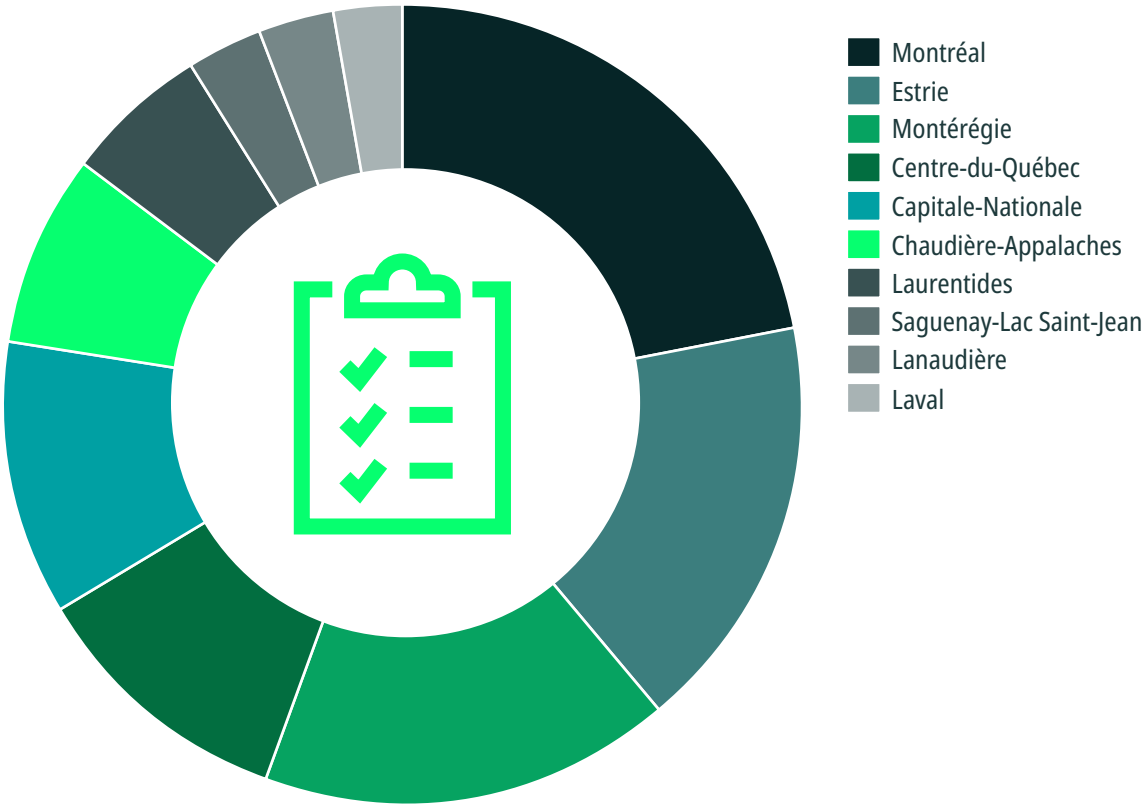


Figure 9. *Regional distribution of survey respondents (%). Source: ICTC Survey, 2021.*

Survey Respondents by Company Type in Quebec

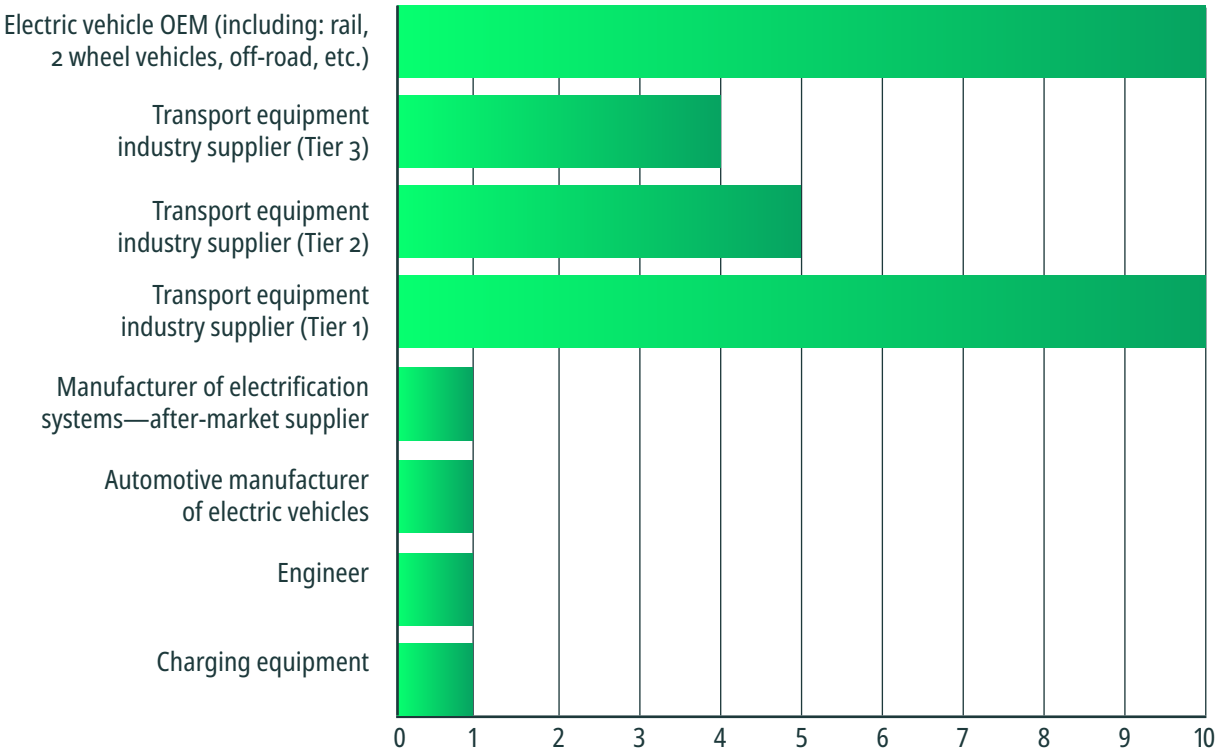


Figure 10. *Survey respondents by company type. Source: ICTC Survey, 2021.*

Key Informant Interviews

The key informant interviews where opportunities to detailed questions to business leaders involved in Quebec's EV value chain. ICTC completed 11 interviews, each lasting 30 to 45 minutes. Participants were all senior-level staff with an awareness of all aspects of the business. Questions focused on determining the current and future impact of technology investments on labour markets, via lived experience and a more detailed accounting of specific skill needs and business expansion. Questions included types of investments planned, impacts of investments on labour, existing and anticipated hiring challenges, current and future training, and upskilling plans.

Limitations of Research

As with all research on emerging industries, some limitations exist. The fast-moving nature of the EV industry, the limited number of industry players (compared to larger markets), and a lack of available secondary information relating to the skill needed to support Quebec's growing EV value chain are a few examples. The fast-moving nature of the industry means that skills are quickly changing; skills assessing today may not be as important in a few years, and warrant updated skill assessments, especially as the market matures and grows. Additionally, to define Quebec's EV industry in this report, ICTC utilized a combination of secondary and primary research to estimate size. While ICTC will continue to track this data over time, it is possible that the overall size of this industry may be smaller or larger than the initial estimate.