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OVIN INSIGHTS
Specialized Series

Annual Comprehensive Sector Report

Ontario in the Driver's Seat: Shaping the Future of Smart Mobility and the Automotive Industry

2022 – 2023

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Where Next Happens

Foreword

Ontario is at the forefront of the electric vehicle (EV) revolution. Over the last three years, Ontario has attracted over $25 billion in transformational auto and EV battery related investments. Our province has everything companies both international and domestic need to invest and grow.

We're proud to work with the Ontario Vehicle Innovation Network to grow Ontario's auto sector. Their efforts last year and in the years to come will help drive innovation in Ontario and make our province even more competitive globally. Together, we're building an end-to-end EV supply chain that will ensure the vehicles of the future are built in Ontario by Ontario workers.

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

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1. Introduction

Ontarians are moving in new ways. The advent of connected, autonomous, and electric mobility has revolutionized our transportation sector while introducing new business models, creating a need for new policies and regulations, and demanding new skillsets from Ontario's automotive workforce.

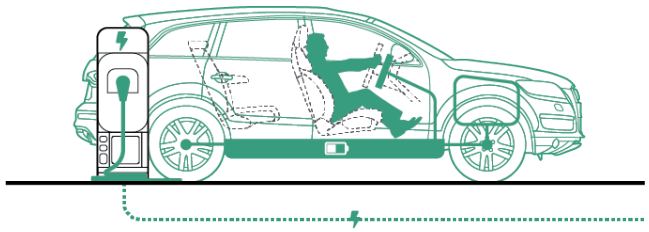
As the driving force of Canada's automotive sector, Ontario has been pioneering technology breakthroughs in connected, autonomous, and electric mobility. Home to world-class research institutions, manufacturing facilities, mining companies, technology development sites, and financial services, Ontario fosters a culture of innovation that encourages and enables the commercialization of new technologies and services. The province, which ranks as the second largest information technology (IT) cluster in North America, is home to over 300 companies developing connected and autonomous mobility technologies.[1]

The province's booming automotive technology sector is supported by a well-established ecosystem of automotive original equipment manufacturers (OEMs); parts suppliers; and tool, die, and mold makers.[2] Ontario is the second-largest vehicle producing region in North America and the only subnational jurisdiction on the continent with five OEMs.[3] Ontario's strong automotive manufacturing industry is upheld by a workforce of approximately 100,000 people.[4]

Infrastructure investments and progressive policies are paving the way for the adoption of connected, autonomous, and electric mobility throughout Ontario. Billions of dollars in funding are being injected into the province's roads, intelligent transportation systems, electric vehicle charging network, electricity grid, and telecommunications infrastructure. Meanwhile, the Ontario Vehicle Innovation Network (OVIN) is harnessing Ontario's regional strengths and capabilities by driving collaboration among the province's growing network of stakeholders; supporting training and retraining for Ontario's automotive workforce; strengthening cross-border exchange of knowledge and technology; and showcasing Ontario as a leader in the development, testing, piloting, and adoption of the latest smart mobility technologies.

This report presents a comprehensive review of Ontario's automotive ecosystem, including enabling policies, talent development initiatives, research and development advances, manufacturing upgrades, infrastructure investments, pilot programs, and technology adoption. This information is contextualized by an overview of national and international trends in connected, autonomous, and electric mobility. The report concludes by examining emerging opportunities to continue the evolution of Ontario's automotive ecosystem.

The future of the automotive sector is becoming increasingly electric, connected, and autonomous. As such, large portions of this report focus on trends, initiatives, and opportunities related to electric, connected, and/or autonomous vehicles.



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The vast majority of **electric vehicles (EVs)** on the road today are comprised of two main types. Battery EVs run only on electricity and produce zero tailpipe emissions. Plug-in hybrid EVs primarily operate on electricity but can run on gasoline and produce low tailpipe emissions.[5]

Connected vehicles (CVs) are vehicles that can share information with other devices or systems (i.e., infrastructure). Connected technologies (such as emergency call functionality) have been integrated in vehicles to improve safety, efficiency, and convenience. While connected technologies have the potential to assist in autonomous driving, they do not control a vehicle's operation.[6]

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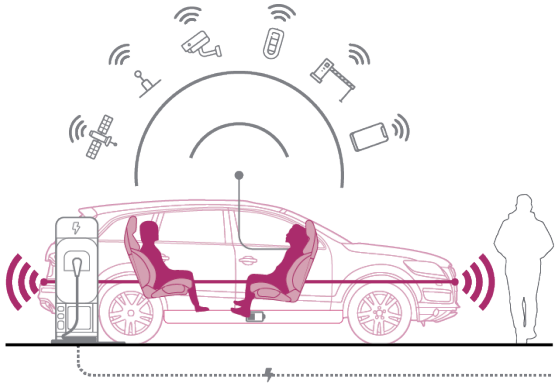

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Autonomous vehicles (AVs) use computers and sensors to operate with little or no human input. The Society of Automotive Engineers has created six levels of automation to define different types of AV technology. Level 0 to 2 vehicles provide driving assistance technologies, such as automatic emergency braking, lane control, and adaptive speed control, but the human driver must always be in control of the vehicle. Only Level 3 and up vehicles are referred to as AVs. Level 3 vehicles perform all aspects of driving under specific conditions and require the human driver to be ready to intervene. Level 4 AVs do not require an alert human driver and can perform all aspects of driving under specific conditions, such as good visibility. Level 5 AVs perform all aspects of driving in all conditions.[7]

Connected and autonomous vehicles (CAVs) are equipped with both connected and autonomous technologies.

This report examines the automotive ecosystem through seven distinct but interconnected dimensions.These dimensions are presented below.

Policies and regulations

Policies and regulations implemented to support and facilitate the development, testing, and adoption of connected, autonomous, and electric vehicles.

Skills, talent, and workforce development

Programs, processes, and initiatives used to upskill the existing and next generation workforce to support an advanced automotive industry.

Research and development

Innovation and developments that enable advances in connected, autonomous, and electric vehicle technologies.

Manufacturing

Production of auto parts, hardware, software, and services used for vehicle assembly in the automotive sector.

Supportive infrastructure

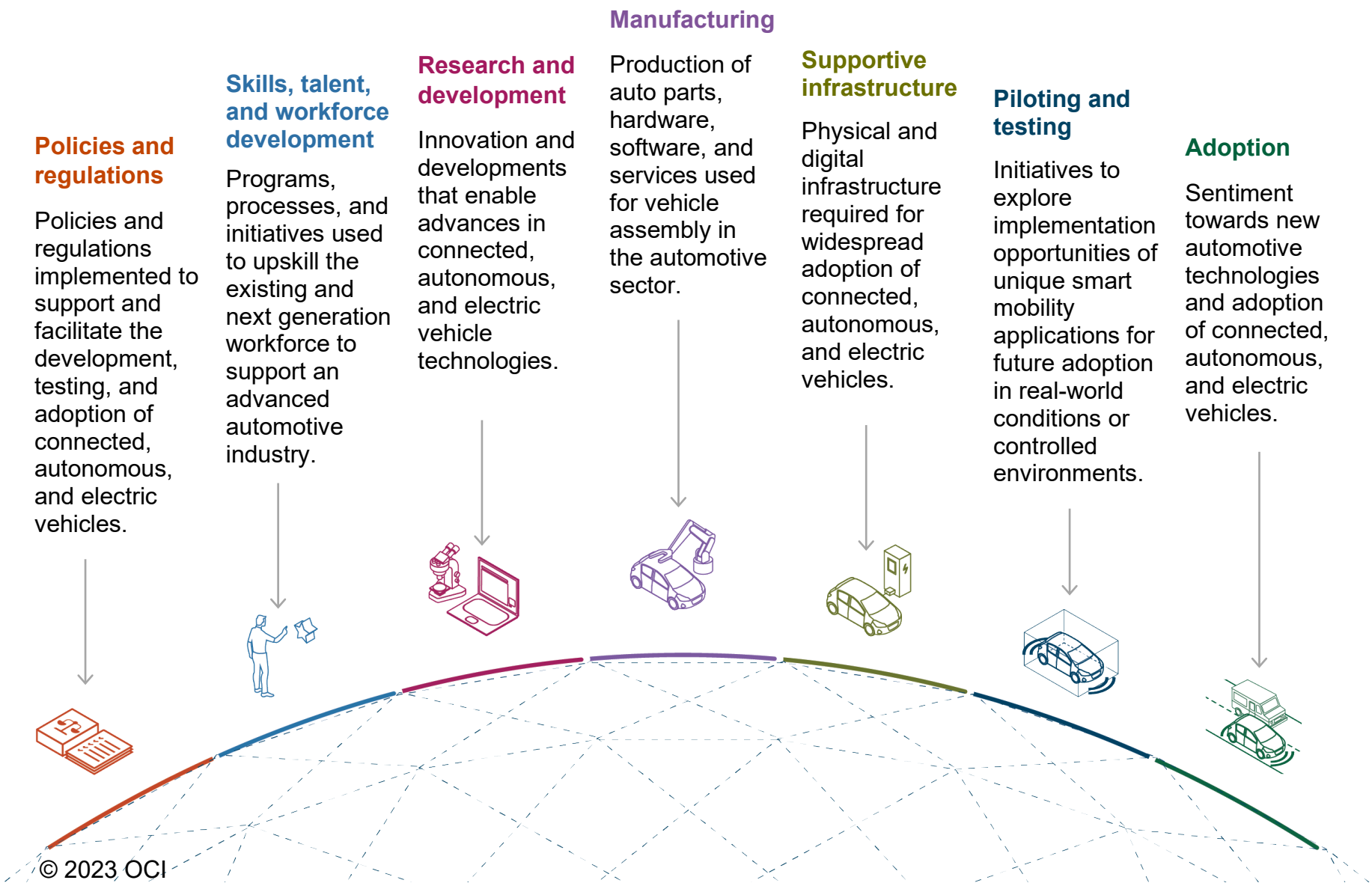
Physical and digital infrastructure required for widespread adoption of connected, autonomous, and electric vehicles.

Piloting and testing

Initiatives to explore implementation opportunities of unique smart mobility applications for future adoption in real-world conditions or controlled environments.

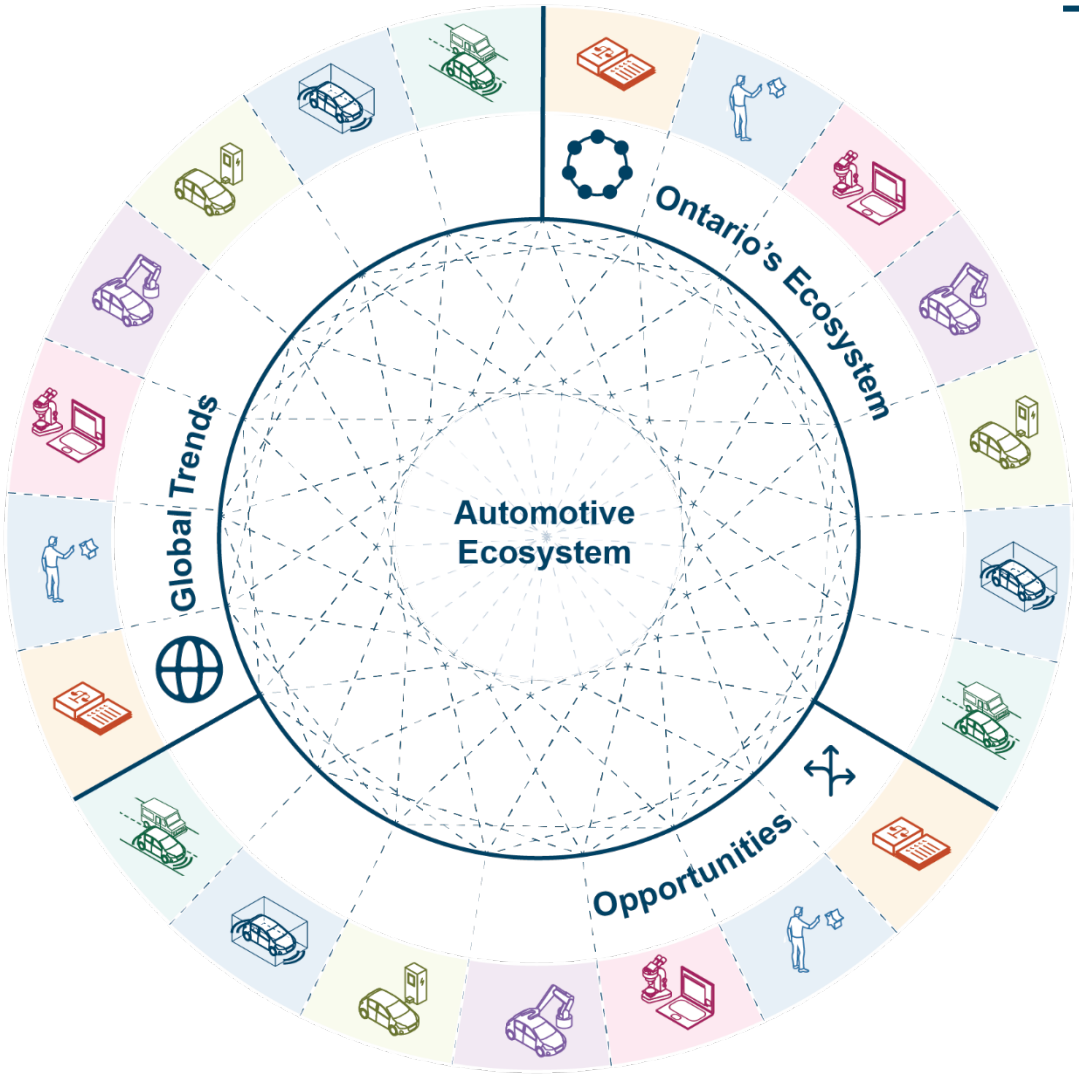
Adoption

Sentiment towards new automotive technologies and adoption of connected, autonomous, and electric vehicles.



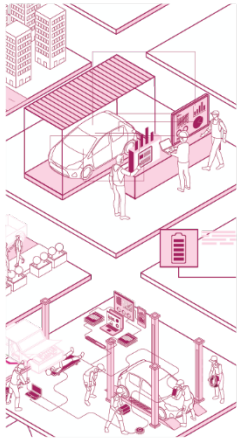
Ontarians are increasingly adopting connected, autonomous, and electric mobility—a shift which has major implications for the province's automotive ecosystem.

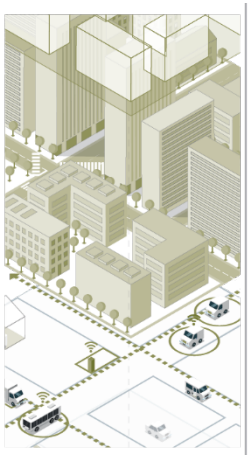
The remainder of this report uses the aforementioned seven dimensions of the automotive ecosystem as a framework to organize ongoing trends (Global Trends in Automotive and Smart Mobility Technology), current initiatives (Ontario's Automotive and Smart Mobility Ecosystem), and future opportunities (Opportunities in a Growing Industry).

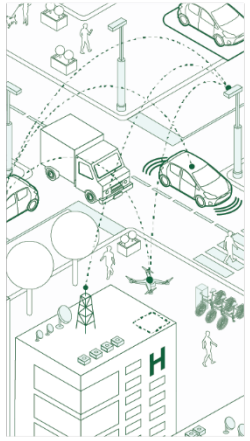


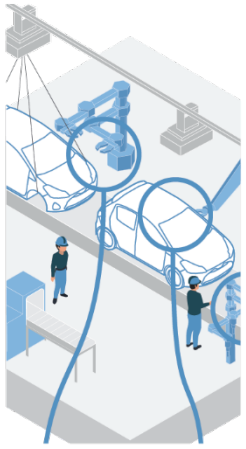
2. Global Trends in Automotive and Smart Mobility Technology

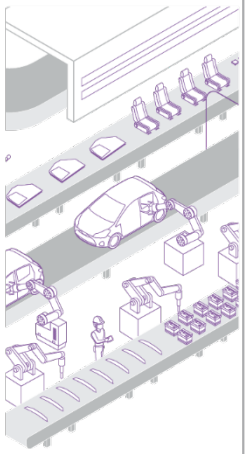
The world's automotive ecosystem is increasingly moving towards integration; stakeholders are working across borders to leverage global talent, access distant markets, and share innovative practices. As such, a general understanding of developments across the broader ecosystem is crucial to contextualize Ontario's unique position within the automotive sector. This section presents an overview of international and national trends in the automotive sector, organized in line with the seven dimensions of the automotive ecosystem described in the preceding section.

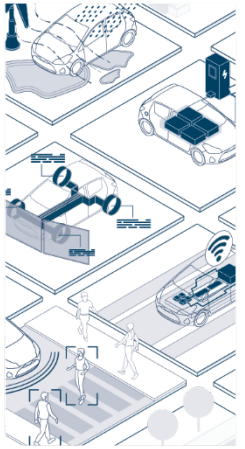












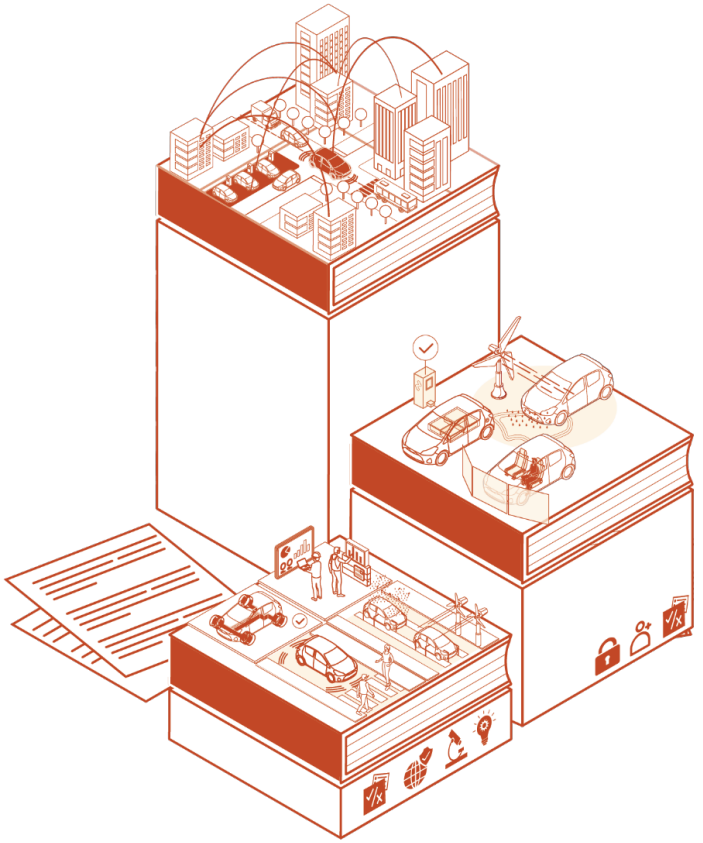
2.1 Policies and Regulations

Policies supporting connected, autonomous, and electric vehicles are becoming increasingly common as demand grows

An unambiguous regulatory environment is paramount to unlock all the benefits of connected, autonomous, and electric vehicles. However, in many jurisdictions, the policy landscape supporting the automotive industry is currently inconsistent or underdeveloped.[8]

Increasingly, governments at all levels are releasing guidelines and instating policies to better regulate connected, autonomous, and electric mobility. For instance, China updated their guidelines for driverless vehicle testing in 2021, permitting qualified companies to proceed with AV testing on public roads, thereby accelerating the commercialization process.[9] Here in Canada, Transport Canada has led and supported the development of several documents that provide guidance on a range of autonomous vehicle topics including safety,[10] testing,[11] and cybersecurity.[12] At the provincial level, Ontario became the first jurisdiction to authorize on-road testing of automated vehicles in 2016.[13] Subsequent updates to the province's Automated Vehicle Pilot Program were made in 2019 in response to developments in AV technology.[14]

Government targets for EV adoption are becoming increasingly common as well. During the 26th United Nations Climate Change Conference of the Parties (COP26) held in Glasgow in 2021, representatives of governments, businesses, and other organizations committed to making EVs comprise 100% of new car and van sales by 2040 globally, and by 2035 in leading markets.[15] The Canadian federal government has set a target for 20% zero-emission vehicle sales of new light-duty vehicles by 2026, 60% by 2030, and 100% by 2035.[16]



A global effort is underway to harmonize the connected, autonomous, and electric vehicle policy landscape

Countries are working together to harmonize the policy environment that enables CAVs and EVs to be safely used on-street. Representatives from China, the European Union, Japan, and the United States collaborated on the development of a report entitled "Framework Document on Automated/Autonomous Vehicles" with the goal of standardizing AV regulations and enabling an environment conducive to innovation. The Framework was adopted by the World Forum for Harmonization of Vehicle Regulations in June 2019 and endorsed by the United Nations Economic Commission for Europe's Inland Transportation Committee in February 2020.[17] In 2021, the World Forum for Harmonization of Vehicle Regulations also endorsed a battery durability requirement for electric vehicles[18] and adopted a regulation outlining the requirements for using Automated Lane Keeping Systems (Level 3 automation) in heavy vehicles.[19]

In some cases, non-profit or industry organizations are advancing harmonization efforts. For example, the National Fire Protection Association, a global organization based in the US, is an accredited codes and standards developer who provides critical resources for dealing with EV batteries and infrastructure.[20]

Insurers and policymakers are just beginning to grapple with a changing liability landscape

Autonomous vehicles will fundamentally alter the way we conceive of automotive liability and the insurance products that cover it. While most auto insurance policies today consider human error as the primary cause of collisions, collisions involving AVs are expected to be increasingly caused by product malfunction. This paradigm shift demands a thorough review of auto insurance laws.[21]

New technologies are emerging to address the liability questions that AVs introduce. The US-based start-up Koop Technologies is developing a new insurance platform for AVs that uses data from vehicles for insurance underwriting.[22] In some cases, insurance models are encouraging the adoption of AVs. Insurance companies such as the United States' Root have begun offering discounts to owners who use vehicles' autonomous features.[23]

Each province and territory in Canada can develop its own insurance regime, which could lead to confusing, unharmonized, and fragmented regulations across the country.[24] The Insurance Bureau of Canada has recommended a single insurance policy approach for AVs, which would cover both driver negligence and the automated technology. This approach enables compensation for the injured party and allows insurers to try and recover liability payments from the responsible party (e.g., the vehicle manufacturer or technology provider) afterwards. Such an approach will require robust data-sharing agreements to help determine the cause of collisions.[25]

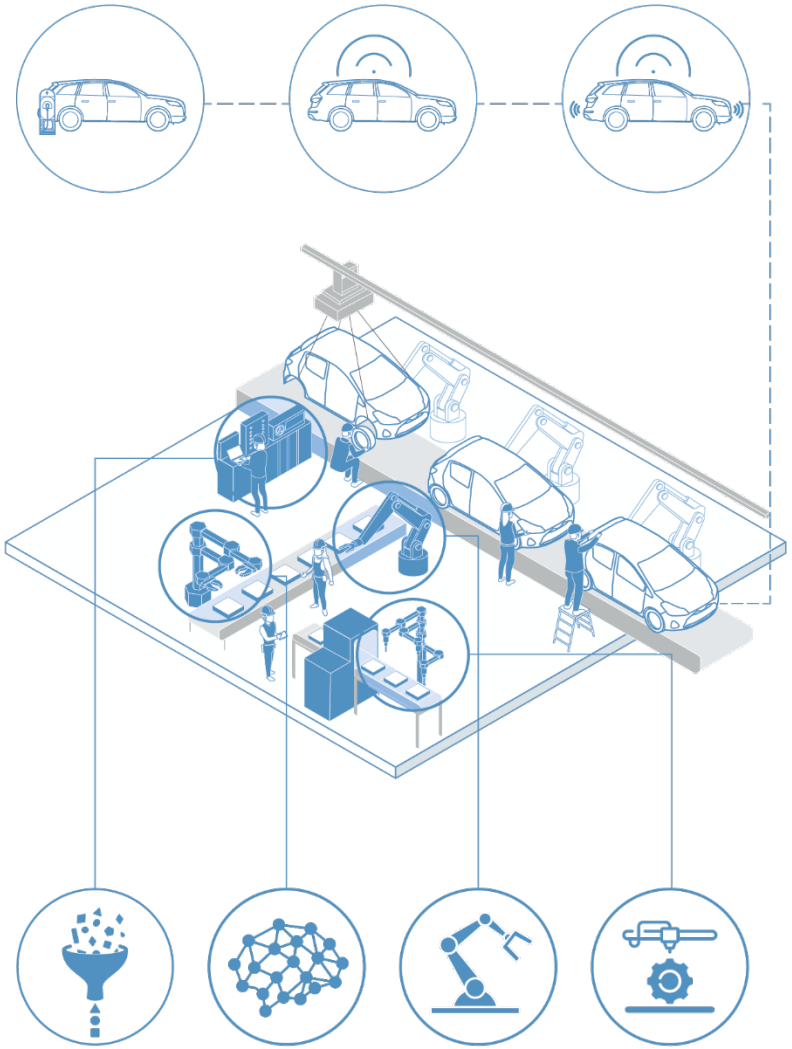
Zero-emission Zones | The Netherlands | 2025

The Netherlands has granted municipalities the ability to create zero-emission zones that prohibit the use of vans or trucks that produce exhaust emissions. The zones, which must be announced at least four years prior to their implementation to ensure that businesses have enough time to comply, will come into effect in 2025. To help businesses electrify their vehicles before the bans are imposed, the Dutch government is providing subsidies of up to €5,000.[26]

Roulez vert | Quebec, Canada | 2020

Quebec dedicated $1.4B of funding to its "Roulez vert" program, which comprises several incentives, including a variety of rebates encouraging Quebec drivers to switch to electric vehicles. This funding constitutes a major component of the $6.7B committed to combating the climate crisis announced in Quebec's 2020-21 provincial budget. This commitment has been dubbed the "largest environmental project in the history of Quebec" by Quebec Finance Minister Eric Girard.[27]

2.2 Skills, Talent, & Workforce Development



Emerging technologies and new skills requirements are driving a workforce transformation

The adoption of new mobility services and advanced automotive technologies has spurred a workforce transformation, both globally and in Canada. Workers in the automotive and mobility sector increasingly require specialized skillsets, such as advanced manufacturing, electronic design, and 3D printing.[28] At the same time, new technologies are making traditional skillsets obsolete.

Additionally, there is an increasing awareness that unforeseen disruptions, such as the COVID-19 pandemic, can have large and unanticipated impacts on entire sectors. To meet the industry's future skill needs and to stimulate the automotive industry following the supply chain disruption and factory closures caused by COVID-19, the International Labour Organization has highlighted a need to invest in education, training, and lifelong learning.[29]

Skills Training for Automotive Industry Employees | European Union | 2020

The Automotive Skills Alliance is a European partnership that facilitates cooperation on the skills agenda in the automotive ecosystem and supports the reskilling and upskilling of workers in the automotive industry. Launched in 2020, the Alliance—which has a range of members, including industry organizations, education and training organizations, regions, and municipalities—aims to upskill 5% of the workforce each year, with key performance indicators around the number of retrained and upskilled workers, the number of successful training certifications, and the number of involved stakeholders.[30]

Reskilling and Upskilling the Workforce | Saskatoon, Canada | 2022

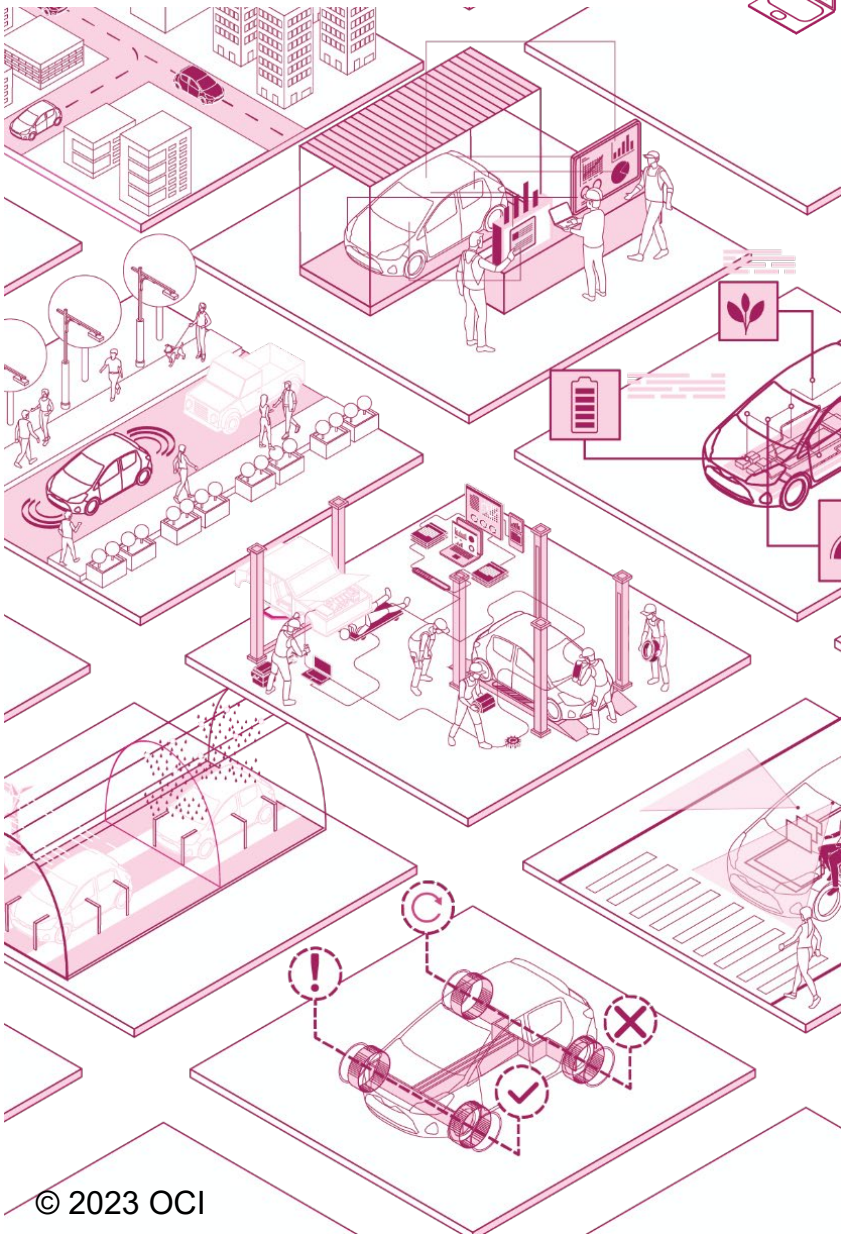
The City of Saskatoon received funding from Transport Canada's Program to Advance Connectivity and Automation in the Transportation System (ACATS) to help city staff learn about and improve skills related to connected and autonomous vehicles. This project—which concluded in March 2022—allowed city staff to attend conferences on services, infrastructure, privacy, policy, and training on traffic controls.[31] ACATS was launched by Transport Canada to prepare various Canadian jurisdictions for an eventual transition to an autonomous future through research, development of standards and guidelines, and capacity-building.[32]

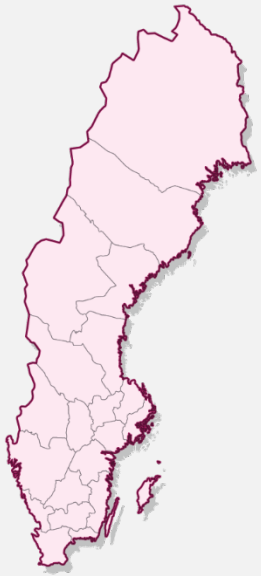
2.3 Research and Development

Emerging questions about CAV and EV integration and acceptance are opening new R&D avenues

The integration of CAVs and EVs into global transportation systems presents several challenges that require extensive research. The Connected, Cooperative and Automated Mobility Association, an organization leading a collaborative approach to CAV research and innovation in Europe, identifies seven key clusters for targeted research and innovation efforts from 2021 to 2027: large-scale demonstration, vehicle technologies, validation, integrating the vehicle in the transport system, key enabling technologies, societal aspects and user needs, and coordination.[33]

Researchers are also dedicated to developing improved CAV and EV technology. Transport Canada is actively researching the interaction between human factors and advanced driver assistance systems (ADAS)—a key safety technology in Level 2 and Level 3 AVs—with the help of domestic and international collaborators, an in-house driving simulator equipped with ADAS, and eye tracking software.[34] In Ontario, OVIN's R&D Partnership Fund supports the advancement of connected, autonomous, electric, and winterized mobility technologies.[35]





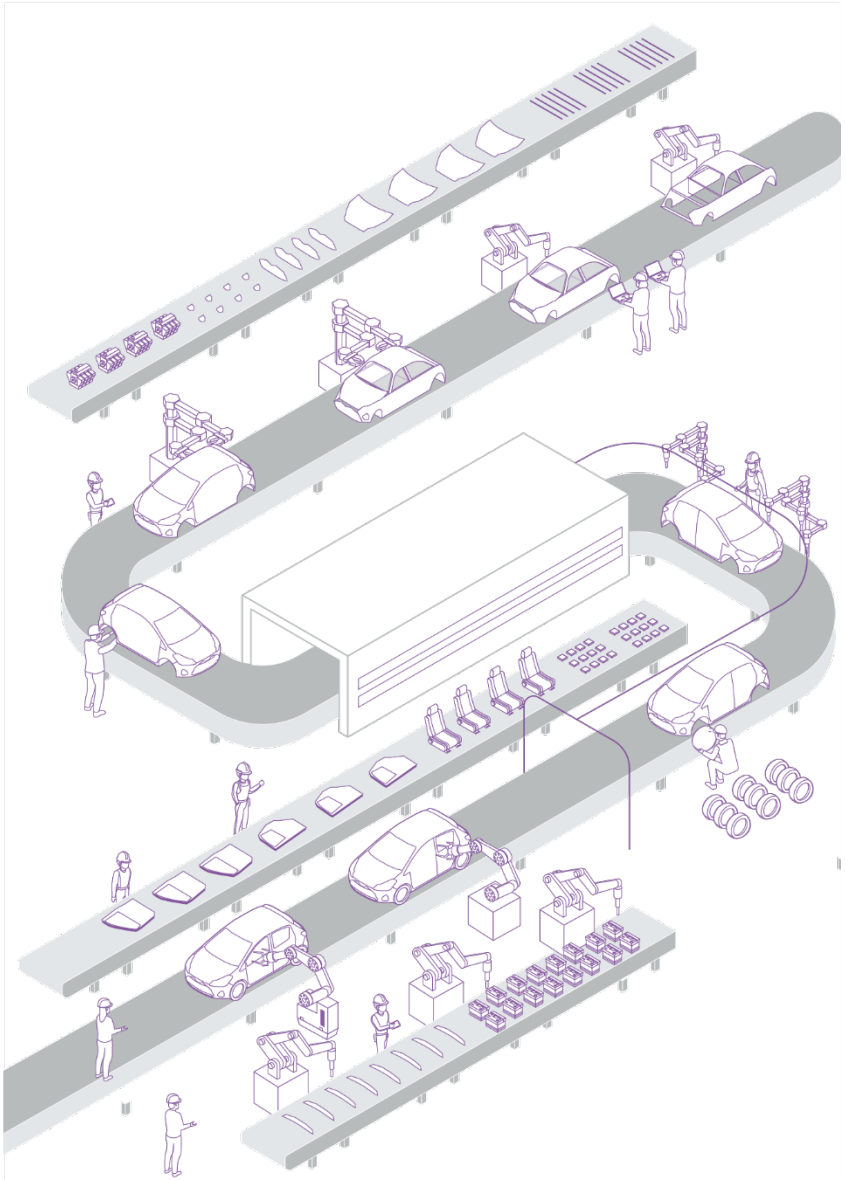
AI Freight and Passenger Transport Interactions | Sweden | 2022

A consortium of 18 companies—including academic institutions like Chalmers and University of Gothenburg, telecommunications giant Ericsson, and public transport company Keolis—is researching the interaction of autonomous freight and passenger transportation within an urban setting in Johanneberg, Sweden. The research, which commenced in January 2022 and is expected to continue for a year and a half, focuses on topics such as vehicle technology, transport efficiency, and user perspective.[36]

Secure CV Communication | Edmonton, Canada | 2021

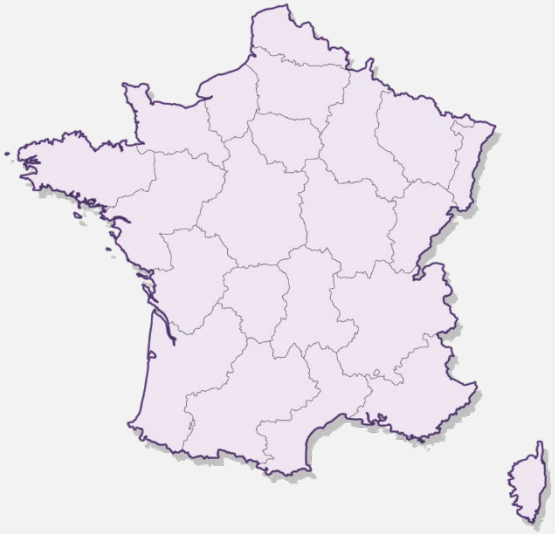
A research project funded by ACATS and completed by the University of Alberta in March 2021 successfully tested the Security Credential Management System, a technology framework keeping connected vehicle communications secure. As part of the project, researchers also developed and tested connected vehicle applications, including a road weather information system and an eco-application.[37]

2.4 Manufacturing



Governments around the world are promoting domestic automotive manufacturing

Many jurisdictions are capitalizing on the opportunity presented by EVs and CAVs to reinvigorate domestic vehicle production in their respective countries or regions. As part of the Inflation Reduction Act of 2022, the United States is promoting local manufacturing through tax credits for EVs manufactured in North America.[38] In Ontario, the government is revitalizing the province's automotive sector through its Driving Prosperity Plan, which includes a goal of building at least 400,000 electric vehicles and hybrids in Ontario by 2030.[39] The province has already attracted $25B in new automotive investments, including investments in electric vehicle and EV battery production.[40]



Digital Twins of AV Parts | France | 2022

The Renault Group has reduced the time needed to design a new vehicle by 25% (~1 year) by using digital twins, virtual representations of real-world items. The digital twins—which encompass everything from a vehicle's bodywork and chassis to its circuitry and engines—enable faster and greater quantities of testing than would be permitted with physical tests. Digital twins are also used to inform the creation of a virtual design of future assembly lines.[41]

Extreme Weather Electric Tour Buses | Manitoba, Canada | 2021

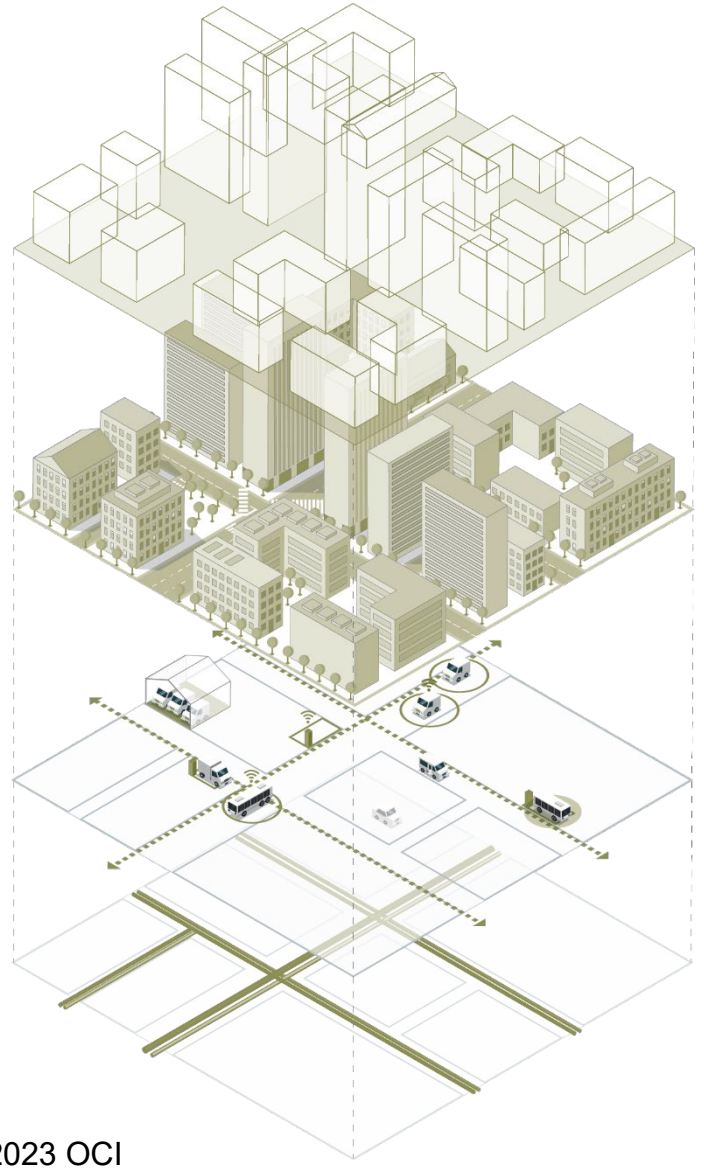
Red River College, in collaboration with tourism company Frontiers North Adventure, successfully converted a diesel-powered tour vehicle to battery electric power. Viewed as a starting point for their fleet conversion, Frontiers North Adventures is hoping to play an active role in reducing environmental impact and preserving Manitoba's sub-artic landscape.[42]

2.5 Supportive Infrastructure

New physical infrastructure is being rolled out to facilitate the adoption of electric vehicles

Additional supportive infrastructure is required to pave the way for the future of emission-free transport. Globally, the EV-charging industry saw investments totalling over $6B in the first eight months of 2022, including over $1B invested by BP and Iberdola for 11,000 chargers in Europe, and approximately $600M from Volkswagen and Siemens for Electrify America's public charging network.[43]

A 2021 study conducted by Leger for the Canadian Vehicle Manufacturers' Association and Global Automakers of Canada highlighted Canada's lack of public charging infrastructure as a major deterrent for consumers considering purchasing an electric vehicle.[44] Natural Resources Canada estimates that as of July 2023, approximately 18,400 EV chargers had been installed across the country at around 7,300 public sites, with Quebec, Ontario and British Columbia leading the way.[45] In a bid to meet Canada's ambitious target of achieving 100% sales of zero-emission vehicles by 2035, the federal government announced a target in 2021 to add 50,000 new EV chargers and hydrogen stations to the country's existing network.[46]



Investment in digital infrastructure is laying the groundwork for connected and autonomous vehicles

Scalable, replicable, resilient, and interoperable digital infrastructure is critical for the future of autonomous transport. In light of the large quantities of data on which the CAV ecosystem will rely, infrastructure that ensures effective data storage and enables ease of access is of great importance. Cloud storage and computing are poised to play an essential role in facilitating widespread access by vehicles to central databases and computer systems.[47] An increased reliance on digital infrastructure will also increase demands on cybersecurity infrastructure, which is crucial to ensure the safe and secure operation of CAVs.[48]

In recognition of the need for high-quality data storage and high-speed data exchange, National Instruments (NI) and Seagate Technology collaborated to create a unique offering to re-envision the way OEMs and suppliers store data, effectively switching from self-managed databases to a storage-as-a-service concept. Such a switch has the potential to not only make data storage more efficient, but also generate significant cost savings.[49]

Several OEMs are now aligning with tech giants to equip their CAVs with the systems, storage, and software they need to become safer while remaining cost effective – a development essential to accelerating the commercialization of CAVs. A host of partnerships between leading OEMs and cloud computing services—including General Motors with Microsoft; and Amazon Web Services with Toyota and Ford—signal the intent of industry leaders to increase vehicle reliance on cloud computing technology to optimize efficiency and economies of scale in CAV production and operation.[50]

Cybersecurity has been emerging as a key priority for governments as supportive digital infrastructure advances. In June 2020, two new UN Regulations on cybersecurity and software updates were released.[51] In 2021, the Canadian government released the Vehicle Cyber Security Strategy, which identifies a series of goals and priorities related to strengthening the cybersecurity resilience of Canadian vehicles.[52] In early 2022, the federal government appointed the National Cybersecurity Consortium to lead its $160M Cyber Security Innovation Network over the next four years. The Consortium, comprised of five founding members (University of New Brunswick, University of Calgary, Concordia University, Toronto Metropolitan University and University of Waterloo), is tasked with leading innovation and talent development in the industry.[53]

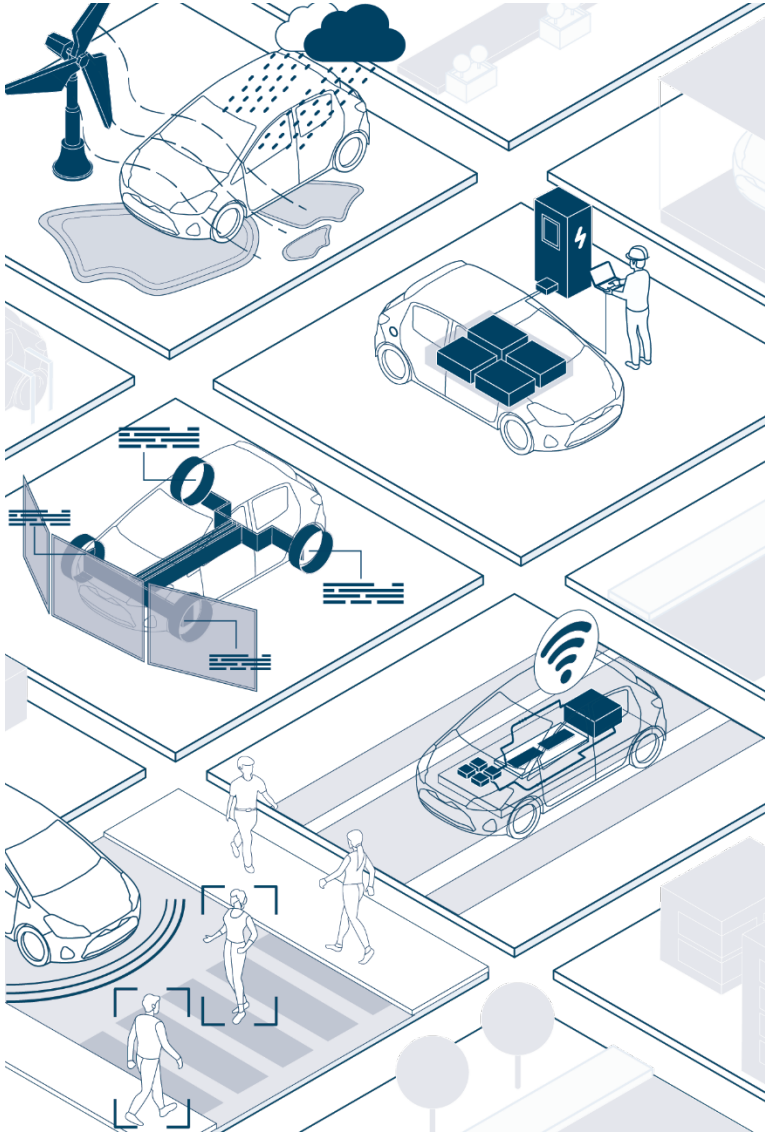
An Alternative to EV Charging | China | 2018

Drivers of NIO's smart electric vehicles can avoid long wait times at EV chargers by leveraging the company's Power Swap stations, which replace a car's partially drained battery with a fully charged battery in an automated process that takes only 3 minutes.[54] The Power Swap stations are a key part of NIO's Battery-as-a-Service model, which allows customers to purchase their car while paying a monthly subscription to use the battery and Power Station network.[55]

Electric School Bus Fleet | Quebec, Canada | 2021

Canada Infrastructure Bank provided Quebec's Bus Carriers Federation with a $400M loan to purchase 4,000 electric school buses over the next five years. The long-term loan will help the federation cover the high up-front costs and charging infrastructure expenses. This investment follows the recent announcement made by Francois Legault, Quebec's premier, pledging $250M over three years to electrify 65% of the province's school bus fleet.[56]

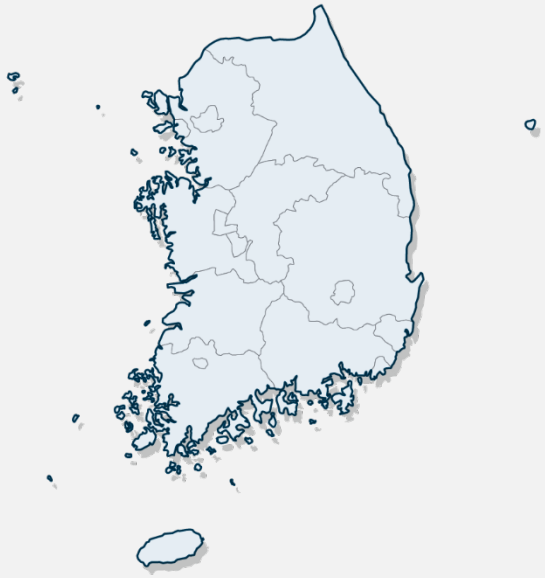
2.6 Piloting and Testing



Countries are increasingly piloting CAV and EV technology

Many countries and subnational jurisdictions have trialled EVs, CAVs, and related technologies in recent years.[57] In Michigan, a project led by the University of Michigan will install cameras, radars, and infrared sensors at more than 20 intersections, in order to provide danger warnings to CVs.[58] In Germany, Bosch is using new camera-based infrastructure to pilot a fully automated parking garage in Stuttgart.[59] In Canada, AV pilots include Ottawa's Electric Low Speed Automated Shuttle pilot;[60] Candiac's Navya shuttle pilot;[61] and ELA's electric autonomous shuttle pilots in Calgary, Edmonton, and Vancouver.[62]

Many EV pilots are searching for ways to incentivize increased adoption of electric mobility. In the United States, Santa Monica launched the country's first Zero Emission Delivery Zone Pilot. The pilot—which ended in December 2022—incentivized the use of electric trucks, bikes, and delivery robots through the provision of priority curb space and charging infrastructure.[63] In British Columbia, Uber and Shell Recharge Solutions launched a six-month pilot to provide six charging ports for exclusive use by Uber drivers.[64] Uber aims to leverage the findings of this pilot to increase EV adoption amongst ridesharing vehicles in other North American cities.[65]



Autonomous Taxis | South Korea | 2022

Hyundai's RoboRide pilot offers car-hailers the chance to ride in a Level 4 autonomous vehicle. Operating in Gangnam, one of the most congested areas of Seoul, the pilot offers a valuable opportunity to gather data about autonomous driving in urban environments that will inform Hyundai's future AV technology. The pilot leverages new traffic signals that can connect with the AVs as well as a car-hailing mobility platform developed by Korean start-up Jin Mobility.[66]

5G-Enabled Autonomous Drones | British Columbia, Canada | 2021

The University of British Columbia oversaw the successful operation of a drone flight on a 5G network, which highlighted the enormous potential of 5G-enabled autonomous flight. The drone performed a series of tasks—including picking up and dropping off medical supplies—while flying smoothly and communicating with ground operators. This research is expected to open the possibility for several new applications including inspecting critical infrastructure and monitoring the spread of wildfires. This trial is part of a larger 5G project, which includes new 5G applications for autonomous vehicles and traffic monitoring. [67]

2.7 Adoption

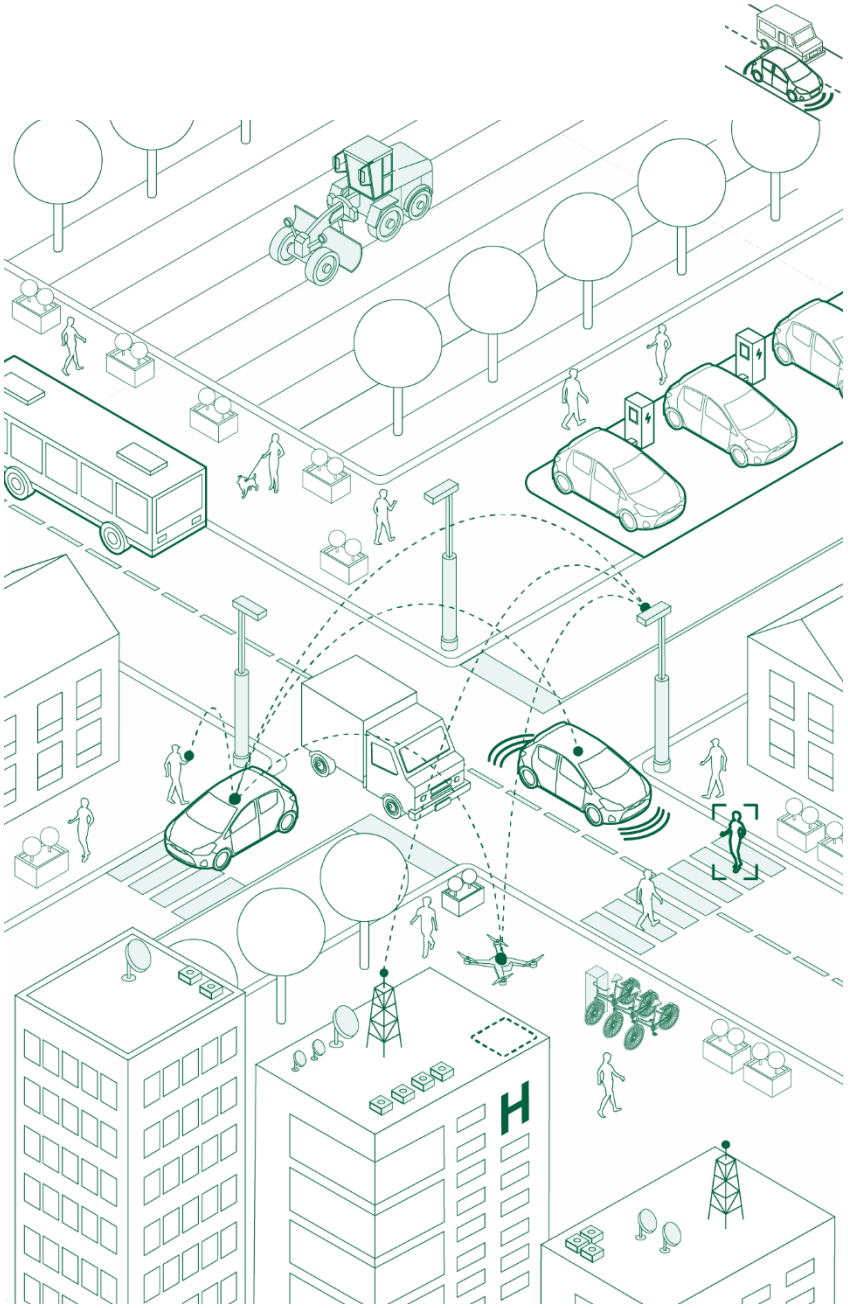
Initial CAVs are being used for shared mobility

Some level of CAV adoption is generally expected by 2040.[68] However, consumer readiness for fully automated vehicles is low in Canada, where autonomous vehicles are still novel for the majority of the public.[69]

Today, most CAVs are used for shared mobility purposes. In California, Cruise—a subsidiary of General Motors—received approval in June 2022 to start charging passengers for driverless rides.[70] A range of autonomous shuttle projects have been deployed in cities throughout Canada, laying the groundwork for the adoption of autonomous taxis or ridesharing vehicles.[71]

Other applications of CAVs, such as truck platooning, are also being tested for commercial adoption throughout Europe. The use of truck platooning has the potential to increase traffic safety, improve fuel efficiency, and support efficient goods movement.[72]

Autonomous technology is also being deployed for other forms of shared mobility, like trains. In Toronto, the use of an automatic train control signalling system on certain subway lines promises to improve reliability by decreasing headway separation between the trains.[73]



EV adoption is advancing quickly

Globally, the number of EVs on the road increased fivefold between 2018 and 2022, reaching over 26M. A total of 10M EVs were sold in 2022 alone, with China, Europe, and the United States accounting for most sales. Adoption is supported by an increasing number of EV models; 500 EV models were available worldwide in 2022.[74]

In Canada, battery-electric, hybrid-electric, and plug-in-hybrid-electric vehicle registrations reached their highest yet in the fourth quarter of 2022, accounting for 14.7% of all motor vehicle registrations.[75] Consumer adoption in Canada lags in rural and suburban populations where only one-third of rural Canadians would consider buying an EV for their next new vehicle.[76] To further advance EV adoption, the government of Canada has invested over $1B in zero-emission vehicle adoption programs and measures.[77]

> **"As the world quickens its transition towards the adoption of electric and autonomous vehicles, Ontario stands ready to lead."** [78]
>
> **– The Honourable Greg Rickford, Ontario Minister of Northern Development & Ontario Minister of Indigenous Affairs**

New business models are making EV ownership increasingly attainable

A major deterrent to the adoption of EVs is the high initial costs associated with the purchase of the vehicle and the supporting infrastructure required for its operation.

To make EV ownership more accessible, EV companies are introducing new business models that minimize upfront costs. Spring Free EV, a US-based company, announced the launch of EVInstaFleet in early 2022. Incorporating a pay-per-mile model with no personal credit requirements or guarantees, this new model helps businesses quickly electrify their fleets.[79] Mack Trucks also addressed customer hesitation with regards to EV adoption by launching a Vehicle-as-a-Service program for their model Mack LR Electric BEV, a fully electric truck.[80]

Battery subscription programs are also becoming increasingly popular. In Canada, VinFast's battery subscription program allows customers to pay a monthly fee in exchange for a battery and repair, replacement, and maintenance services.[81] Chinese EV giant NIO kick-started a similar program in 2020; customers can purchase the vehicle upfront but pay a monthly fee for the battery.[82]

Consumer Acceptance Research | Saudi Arabia | 2021

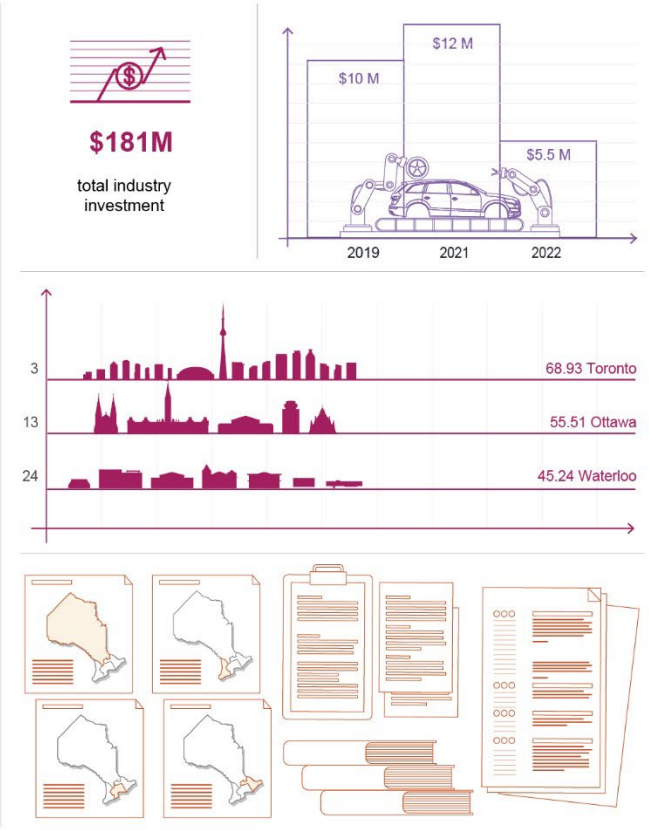
Independent research was conducted in December 2021 in Riyadh, Saudi Arabia to understand the various factors that contribute towards consumer acceptance of autonomous vehicles. The results of a survey of 500 participants led researchers to conclude that young, female, or tech-savvy people had more favourable opinions of AVs. The research recommended increasing trust of the new AV technology among older drivers to shift perceptions.[83]

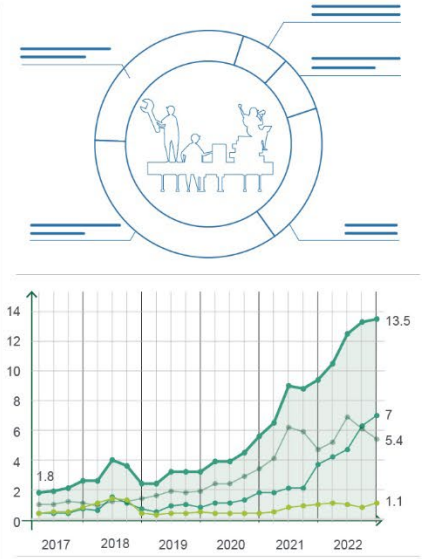
ZEVs for Rent by Lyft Drivers | Vancouver, Canada | 2021

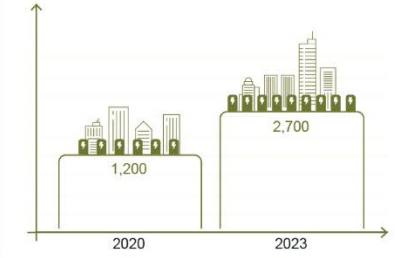
Lyft Canada and Toyota Canada partnered to provide Lyft drivers an opportunity to rent hydrogen-powered zero-emission vehicles using Toyota's KINTO Share program in Metro Vancouver. This collaboration is expected to contribute towards the federal and provincial goals of using clean energy and reducing petroleum dependency, while also reducing carbon emissions and creating awareness about ZEV technology.[84]

3. Ontario's Automotive and Smart Mobility Ecosystem

Ontario has long been a powerhouse in the global automotive sector. Continuous advancements spanning new policies, infrastructure, and pilots collectively ensure that Ontario remains at the forefront of automotive innovation. This section summarizes the current state of Ontario's automotive ecosystem, highlighting recent growth in each of the seven dimensions mentioned in this analysis.







3.1 Policies and Regulations

Driving Prosperity Phase 2 is ushering in the future of the automotive sector

The second phase of Ontario's Driving Prosperity Plan presents a strategy to achieve Ontario's ambition to be a North American leader in delivering the cars of the future. The plan, which builds off the successes realized during Driving Prosperity Phase 1, outlines four goals: reposition vehicle and parts production for the car of the future; establish and support a battery supply chain ecosystem; innovate in every stage of development; and invest in Ontario's auto workers. The four goals work in concert to achieve the plan's anchor objective of building at least 400,000 electric vehicles and hybrids in Ontario by 2030.[85]

An open-for-business approach is attracting major automotive investments

Ontario has prioritized the development of a business-friendly climate that encourages new investments in the province's automotive sector. Since the release of Phase 1 of the Driving Prosperity Plan, Ontario has introduced more than 15 regulatory and policy amendments that are streamlining requirements for the automotive and manufacturing sectors.[86] By reducing regulatory compliance costs, the province has generated $576M in annualized savings for Ontario businesses since June 2018.[87] Ontario's site readiness program, a funding initiative to help make industrial sites investment-ready, is creating new opportunities for manufacturing investments.[88]

Faster write-offs of the cost of capital investments—including manufacturing machinery, clean energy equipment, and eligible zero-emission vehicles—encourage new business investment.[89]

These efforts to foster a competitive business climate have paid off in the form of large investments in Ontario's automotive sector. The province has attracted $25B in new automotive investments.[90] Examples include a joint $5B investment from Stellantis and LG Energy Solution to open Canada's first major electric vehicle battery plant in Windsor;[91] a $1.5B investment from Umicore to develop an EV battery parts facility in Loyalist;[92] and a $1.8B investment from Ford to upgrade their Oakville plant.[93]

> **"Through our Driving Prosperity auto plan, strategic investments across our integrated supply chains, and by reducing the cost of doing business in Ontario by nearly $7 billion annually, our government is staking Ontario's claim as a leader in the emerging North American EV battery industry."[94]**
>
> **– The Honourable Victor Fedeli, Ontario Minister of Economic Development, Job Creation and Trade**

Ontario is a global leader in on-road vehicle testing regulations

Ontario was the first jurisdiction in Canada to allow on-road testing of autonomous vehicles[95] when it introduced a 10-year Automated Vehicle Pilot Program (Ontario Regulation 306/15) in 2016.[96] In 2019, the program was updated to allow the testing of driverless automated vehicles and cooperative truck platoons.[97] As of September 2021, 14 groups were approved to participate in the pilot, two of which were approved for driverless testing.[98]

$25B

in new automotive investments

400,000

EVs and hybrids to be built in Ontario by 2030

$576M

in annualized savings for Ontario businesses achieved since June 2018

Municipal policies are helping to propel electric vehicle adoption

Several Ontario cities have enacted or are investigating policies that require EV charging to be included as part of new residential construction. In Toronto, zoning by-laws[99] and the Toronto Green Standard Version 4[100] mandate that residential parking spaces be equipped with an outlet that can support EV charging.[101] Mississauga, Hamilton, and Sarnia are all investigating EV-ready parking requirements.[102]

More broadly, various strategies across the province propose a series of actions to expand EV ownership, including EV charger installation, support for electric car sharing, and adoption of EVs into municipal fleets. Examples include the City of Toronto's Electric Vehicle Strategy[103] and Net Zero Strategy[104] and the City of Burlington's Climate Action Plan.[105]

Ontario's regional transportation plans will help build a better transportation system

Ontario has released four regional transportation plans that outline actions to achieve improved transportation throughout the province. Each plan will play an important role in guiding planning and investments within their respective regions.

Connecting the North – December 2020

Key actions[106]

1. Support the development of CAVs designed for winter weather conditions
2. Consider approaches that support low carbon vehicles
3. Prepare Ontario's northern transportation system and infrastructure for the introduction of CAVs

Connecting the Southwest – February 2022

Key actions[107]

1. Explore the creation of an innovation corridor for pilots
2. Work with key partners to ensure the clean electricity system is ready for electric and innovative transportation
3. Undertake an airport activity and infrastructure survey to assess the role of airports in the region

Connecting the Greater Golden Horseshoe – January 2020

Key actions[108]

1. Explore the creation of an innovation corridor for pilots
2. Explore opportunities to get to and from rapid transit stations using AVs
3. Prepare for the use of commercial CAV platooning
4. Explore the potential of other emerging technologies like drones

Connecting the East – April 2022

Key actions[109]

1. Invest in broadband internet and cellular infrastructure
2. Develop a Transportation Electrification Policy to support EV uptake
3. Prepare for the safe deployment of CAVs by updating legislative frameworks and considering cross-border initiatives

3.2 Skills, Talent, and Workforce Development

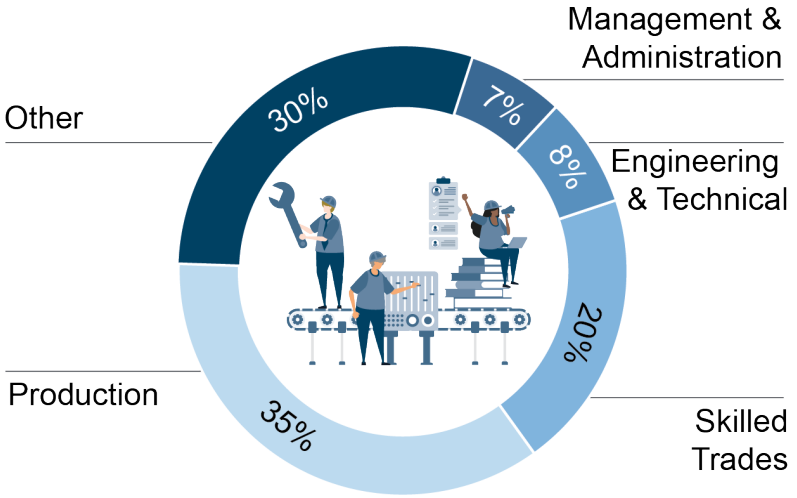
Ontario's automotive sector will need 40,000 new workers by 2030

Ontario has a large, highly skilled workforce spanning the automotive sector. Approximately 100,000 workers are directly employed in Ontario's automotive sector, including vehicle assembly and parts production.[110] The sector also supports thousands of jobs indirectly throughout the province.

By 2030, it is estimated that Ontario's automotive sector will need approximately 40,000 new workers. Most of these new workers (approximately 35,000) will be required to meet replacement demand driven by death or retirement. Approximately 5,000 new workers will be needed due to growth of the automotive industry. The industry is expected to expand through 2025 (requiring an additional 7,500 workers) and then contract and begin plateauing between 2026 and 2030 (losing 2,500 workers).[111]

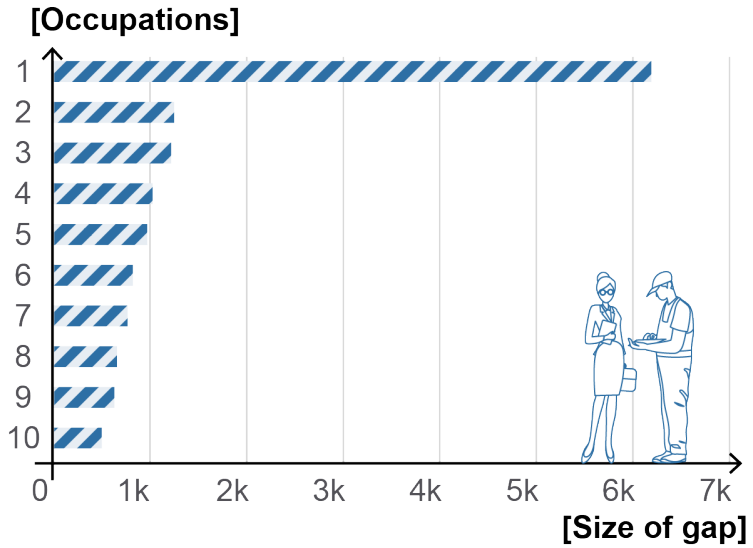
After accounting for 10,000 new entrants who are expected to enter the automotive industry over the next decade, Ontario's automotive sector is forecasted to face a recruitment gap of 30,000 workers between 2021 and 2030.[112] A series of compounding factors—including an ageing automotive workforce[113] and limited youth interest in the automotive sector[114]—have been identified as contributing to the workforce gap.

Ontario's automotive industry gap outlook (2021 – 2030) shows the largest gaps in production and skilled trades positions[115]



*Reproduction of graph from Future of Canadian Automotive Labourforce Initiative

Ontario's automotive industry recruitment gap size rankings by occupation from 2021-2030[116]



Occupations

1. Motor vehicle assemblers, inspectors and testers
2. Material handlers
3. Manufacturing managers
4. Construction millwrights and industrial mechanics
5. Supervisors, motor vehicle assembling
6. Tool and die makers
7. Machinists and machining and tooling inspectors
8. Industrial electricians
9. Welders and related machine operators
10. Shippers and receivers

A multi-faceted approach to talent development and attraction is combatting the workforce gap

Ontario is simultaneously recruiting new workers into the automotive sector while upskilling its existing workforce to fill the forecasted recruitment gap and adapt to the ongoing workforce transformation. A range of college and university programs, apprenticeship opportunities, immigration programs, digital platforms, and talent development strategies work in concert to ensure that Ontario and its workforce are aptly prepared for the jobs of tomorrow.

Currently, 12 of Ontario's universities and 24 of its colleges offer automotive research and training programs.[117] Ontario's post-secondary schools also offer a suite of science, technology, engineering, and mathematics (STEM) programs, graduating over 65,000 students in these fields annually.[118]

100,000

workers are directly employed in Ontario's auto sector

65,000+

annual graduates in STEM fields in Ontario

In addition to traditional post-secondary programs, the province supports several automotive training programs. For example, in May 2023, the Province of Ontario, in partnership with the Automotive Industries Association of Canada, St. Lawrence College, Conestoga College, Fanshawe College and Plug 'N Drive, announced two new programs: an EV, hybrid, and Advanced Driver Assistance

Systems Technologies upskilling program and a training program for jobseekers looking to join the automotive industry.[119] Similarly, in August 2022, the Province of Ontario partnered with the Automotive Parts Manufacturers' Association to deliver free training and paid job placements in the automotive sector for up to 500 people from underrepresented groups.[120] Both initiatives were funded through Ontario's Skills Development Fund, created to encourage solutions to industry problems with an emphasis on training and upskilling. OVIN's TalentEdge Fellowship[121] and Internship[122] Programs also provide funding for mentorships and applied student experiences.

To further bolster the automotive and mobility sector's talent pipeline, OVIN released a Talent Strategy & Roadmap (TS&R) in January 2022. The TS&R outlines four objectives and nine initiatives related to cross-provincial collaboration and coordination; talent sourcing and attraction; workforce development and retention; and equity, diversity, and inclusion.[123]

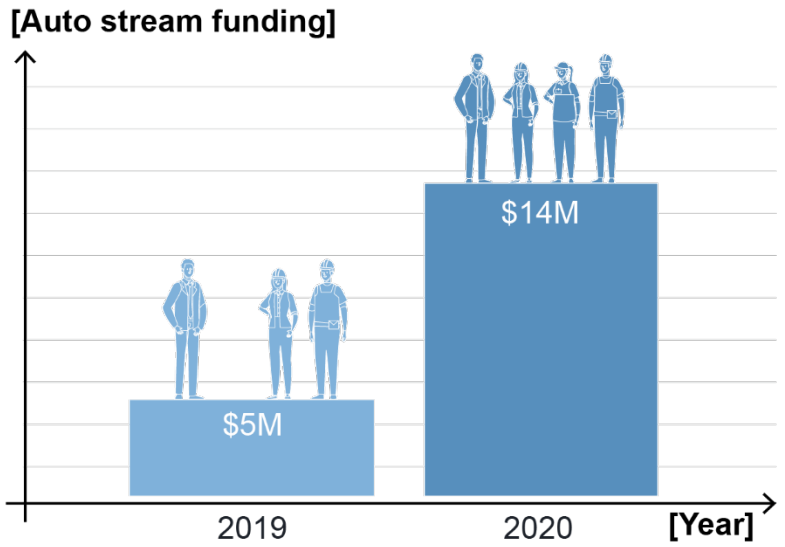
> **"We're redrawing the system to address Ontario's labour shortage and make the trades a career of choice for more people. The skilled trades provide well-paying and rewarding careers that are vital for our economy. By creating [Skilled Trades Ontario], we are working for workers and delivering the generational change that labour leaders and employers have been calling for." [124]**
>
> **– The Honourable Monte McNaughton, Ontario Minister of Labour, Immigration, Training and Skills Development**

In response to the TS&R's workforce development and retention objective, OVIN is developing a Made-in-Ontario Upskilling Platform for the automotive and mobility sector. The platform will help Ontario-based companies and employees access online educational programs in order to upskill their employees and workforce to meet future skills-needs.[125] This platform will complement OVIN's existing Skills & Career Navigator tool, which supports individuals at various stages in their career learn about various sub-areas within the automotive and mobility industry, including relevant technical and non-technical skills, course-based and experiential learning opportunities, and potential jobs and career resources.[126]

More generally, Ontario is supporting skilled trades through its Skilled Trades Strategy, which aims to break the stigma around these types of careers, make it easier to enter the domain, and encourage employer participation in apprenticeships.[127] In November 2021, the provincial government announced $90M of funding to promote the skilled trades to young people entering the workforce, bringing Ontario's total investment in the Skilled Trades Strategy to approximately $1.5B between 2020 and 2024.[128] In January 2022, Skilled Trades Ontario, the province's new training authority, became operational, making it easier for people to find careers in the skilled trades and complete training or apprenticeships.[129]

Ontario is also working to attract skilled newcomers through investments in immigration programs. In April 2022, the provincial government announced an additional $15.1M in funding for the Ontario Immigrant Nominee Program (OINP). By expanding the OINP, Ontario will be able to fill labour market gaps and spur economic growth.[130]

Ontario's investments in the Career Ready Fund's Auto Stream are connecting students to automotive job placements[131]



Ontario has its eyes set on becoming a top place to work

Ontario is becoming a top place to work by responding to the shifting needs of workers in light of disruptions caused by the COVID-19 pandemic and recent technological innovations. Investments in the province's transportation, virtual care, and broadband infrastructure are providing support for employees as novel future-of-work practices become increasingly common. Over the next ten years, the province is investing $84B in transportation—including $2.6B for highway and bridge repairs and $28.5B for the GTA's subway system—to help enable easier commutes. An additional $4B will ensure that all communities in Ontario are equipped with high-speed internet by the end of 2025, reducing barriers for remote work. The province has also expanded access to virtual care to ensure safe and equitable healthcare access regardless of location.[132]

In addition to these investments, the provincial government is considering a series of 21 recommendations made by the Ontario Workforce Recovery Advisory Committee regarding the future of work. The recommendations, released in November 2021, focus on economic recovery, strengthening Ontario's competitive position, and supporting workers, and were informed by significant engagement with workers, labour groups, businesses, and academics.[133] Initiatives such as OVIN's TalentEdge Internship[134] and Fellowship[135] funding address the Committee's recommendations for new lifelong learning opportunities and investing in new channels of career development.

$1.5B

investment in Skilled Trade Strategy from 2020 to 2024

$15.1M

investment in the Ontario Immigrant Nominee Program

$84B

investment in transportation over the next 10 years

4,640

jobs created & retained in Ontario since 2017 as a result of OVIN's contributions

OVIN Spotlight Series

PITSTOP

Pitstop | Toronto, Ontario

Pitstop, a company headquartered in Toronto that builds AI for the future of mobility, developed a platform that performs predictive analytics and maintenance on top of datasets collected from vehicles. The platform, which was first pitched in 2015, has grown to include over half a million vehicles and three billion data points as of January 2022. As a result of support from OVIN, the platform is growing at a rate of 800% per quarter.

Pitstop has recently expanded and matured its platforms and algorithms so that they can predict brake failures, electrical systems issues, and engine issues with greater than 90% accuracy. During a partnership with OVIN, Pitstop deployed these solutions on top of a massive global network created by Fleet Complete, a fleet management company. This enabled fleets across the world to get access to predictive analytics so that they can increase uptime and run more efficiently.

3.3 Research and Development

Ontario is home to a growing automotive technology cluster

Ontario is a North American leader in automotive technology. The province, which ranks as the second largest vehicle producer in North America,[136] the second largest IT cluster in North America,[137] and the number one largest cleantech sector in Canada,[138] is home to over 300 companies pioneering connected, autonomous, and mobility technologies.[139]

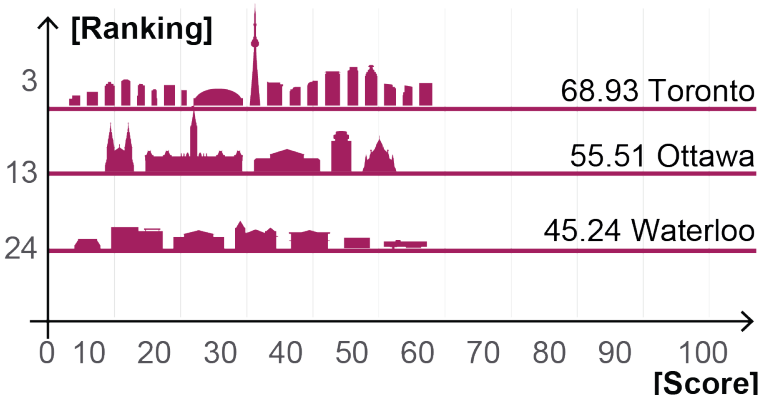
Ontario also has a highly skilled workforce. 71% of Ontario's working-age adults have completed a post-secondary program, a higher percentage than any other OECD country.[140]

In 2022, Coldwell Banker Richard Ellis (CBRE) ranked several Ontario cities in its top 50 North American tech markets, including Toronto (#3), Ottawa (#13), and Waterloo (#24). Between 2016 and 2021, Toronto had the most tech talent growth (+88,900) in North America, followed by Seattle (+45,560).[141] At current growth rates, the Toronto-Waterloo corridor—home to 16 universities and colleges, 15,000 tech companies, and 5,200 start-ups—will soon overtake New York in terms of number of tech workers.[142] Meanwhile, Ottawa has the highest concentration of tech talent out of North American cities.[143]

"Ontario has emerged as a global leader in the automotive and mobility sector as it transforms towards electric, connected, and autonomous vehicles." [144]

– Raed Kadri, Vice President of Strategic Initiatives, Business Development (OCI) & Head of OVIN

Several Ontario cities are included in CBRE's list of the top 50 North American tech markets[145]



New R&D efforts are enabling the commercialization of made-in-Ontario CAV technology

Industry- and academia-driven research efforts have led to the development of several new CAV technologies.

Goods delivery is emerging as a key topic of focus for R&D efforts. In March 2021, the Province of Ontario, NuPort Robotics, and Canadian Tire launched a two-year pilot to develop autonomous driving systems. The project—which targets middle-mile trips made between distribution centres and terminals—involves outfitting two trucks with high-tech sensors and other advanced features.[146] In October 2022, Gatik, another company working to advance autonomous middle-mile delivery, started trialling fully driverless trips in Ontario in partnership with Loblaws.[147]

Artificial intelligence (AI) is also emerging as an area of focus for AV researchers. A start-up called Waabi is using AI to help self-driving systems make informed decisions in new scenarios.[148] Untether AI, General Motors, and OVIN are also pioneering AI research as part of a new partnership that seeks to develop perception systems for autonomous vehicles.[149]

Ontario's post-secondary education institutions are leading CAV research as well. At the University of Waterloo, the AVRIL facility serves as a 10-bay R&D workspace for mobility applications like autonomous driving, vehicle connectivity, and advanced driver assistance systems (ADAS).[150] McMaster University's Centre for Mechatronics and Hybrid Technologies has developed in-house car detection and tracking technology and aims to use sensor information to continue project development.[151]

OVIN is also helping to spur automotive technology innovation. OVIN's R&D Partnership Fund, which supports industry-led projects focusing on connected, autonomous, electric, and winterized mobility technologies,[152] has enabled 91 commercialization partnerships since the program's inception.[153]

$111.8M

total OVIN program funding since 2017

$181M

total funding committed by industry partners involved in OVIN's programs since 2017

2nd

largest vehicle producer in North America

300+

Ontario companies pioneering connected, autonomous, and mobility technologies[154]

New R&D efforts are enabling the commercialization of made-in-Ontario EV technology

In February 2022, auto parts producer Flex-N-Gate announced $18.5M in funding to open the Flex-Ion Battery Innovation Centre. The centre will be outfitted with a pilot production line and will employ 18 battery engineers and scientists collaborating with college and university researchers to develop new battery technologies suited for EVs.[155]

Researchers at the University of Toronto Electric Vehicle Research Centre are studying the transition of EV batteries to second-life applications, including as backup energy sources in microgrids or support services for the power grid.[156]

At the University of Windsor, researchers in the Centre for Hybrid Automotive Research and Green Energy Lab are conducting battery-to-powertrain-to-wheel research and simulating and testing EVs to gain practical insights that can inform EV development.[157]

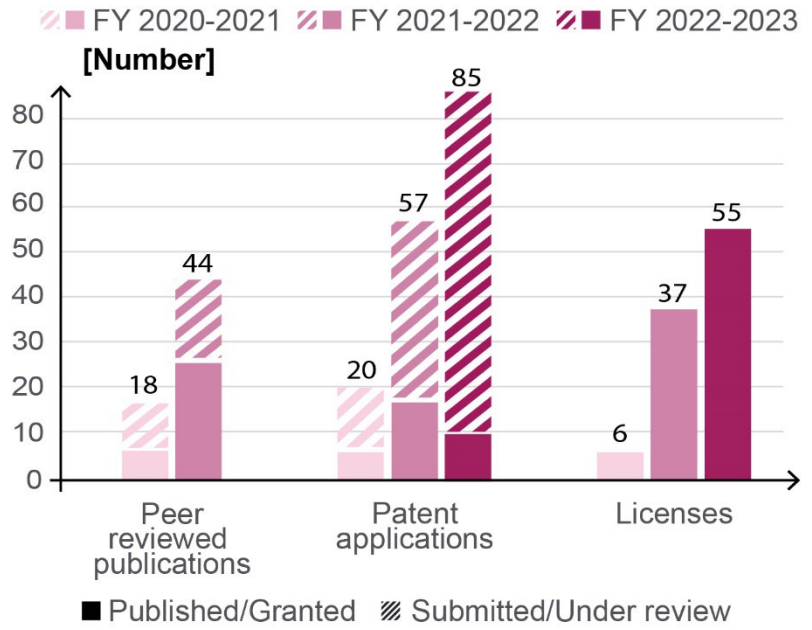
In 2021, researchers at the University of Waterloo were awarded $2M from the federal government's Canada Foundation for Innovation to create the Ontario Centre for Battery and Electrochemical Research, which is expected to become a new hub of electrochemical energy storage research and collaboration among academics, government agencies, and industry partners.[158]

$537.1M

in follow-on investment generated since 2017 as a result of OVIN's support

> **"Among Ontario's most opportunity-rich industries for sustainable career growth is Ontario's automotive and mobility sector."[159]**
>
> **– The Honourable Monte McNaughton, Ontario Minister of Labour, Immigration, Training and Skills Development**

OVIN funding has led to new publications, patent applications, and licenses



OVIN Spotlight Series

Lumibird Canada | Ottawa, Ontario

Lumibird Canada (LBC) is a global company that produces LASER-based technology solutions. Their Canada office is a leader in LiDAR technology, which uses LASERs to measure the distance to an object and create a 3D representation of an environment for obstacle detection.

Autonomous rail vehicles rely on constant knowledge of their position – the loss of this information (due to unforeseen factors such as weather and obstacles) can cause service disruptions. With OVIN's support, LBC teamed up with York University and Thales Canada to develop a solution to this problem that would reduce downtime and facilitate recovery of automated rail vehicles. The resulting OnTrAC (Ontario Train Autonomy Collaboration) project relied on a custom LiDAR system from LBC, which was designed for rail vehicles in harsh environments and included real-time analysis of data by the Lassonde School at York University. The solution was successful due to integrated decision-making algorithms for autonomous rail vehicles developed by Thales Canada.

With the project complete, the benefits of OVIN support and the made-in-Ontario partnerships it facilitated continue to pay dividends. Considering the abundance of novel LiDAR products, the many patent applications filed, the creation of new STEM jobs, and potential follow-on investment in the field, LBC and its partners are poised to implement their technology throughout North America.

3.4 Manufacturing

Automotive manufacturing is a key driver of Ontario's economy

Ontario's automotive sector is a large driver of economic activity. In 2021, motor vehicle and parts manufacturing accounted for 1.4% of Ontario's Gross Domestic Product (GDP).[160] In 2019, auto products were Ontario's top export, comprising 21.6% of all exported products.[161] Today, the province's automotive manufacturing ecosystem includes over 700 part firms and over 500 tool, die, and mold makers.[162] Additionally, Ontario is the only subnational jurisdiction in North America with five OEMs,[163] including Stellantis headquartered in Windsor, Ford Motor Company headquartered in Oakville, General Motors headquartered in Oshawa, Honda headquartered in Markham, and Toyota headquartered in Toronto.

Recent initiatives from the provincial government are reenergizing Ontario's automotive sector. While auto manufacturing declined by 25% between 2000 and 2019,[164] initiatives such as the Driving Prosperity Plan are generating new investments targeting the creation of beginning-to-end domestic automotive supply chains. Through the plan, the province aims to build at least 400,000 EVs and hybrids in Ontario by 2030.[165] The government is committed to advancing the development of a comprehensive EV battery supply in Ontario. The province has already attracted $25B in new automotive investments, including investments in electric vehicle and EV battery production.[166]

Ontario is partnering to develop the first Canadian-made zero-emissions vehicle

OVIN is a partner in Project Arrow, an initiative launched by the Automotive Parts Manufacturers' Association to develop and build the first all-Canadian, zero-emission vehicle. The project brings together a collective of experts and over 500 alternative-fuel, electric-drive, connected, autonomous, and light-weight technology companies.[167] In 2023, the concept car was released and started a global tour.[168] In addition to accelerating EV technology domestically, Project Arrow aims to highlight Ontario's role as an advanced manufacturing hub, support collaboration, increase R&D, and encourage talent development.[169]

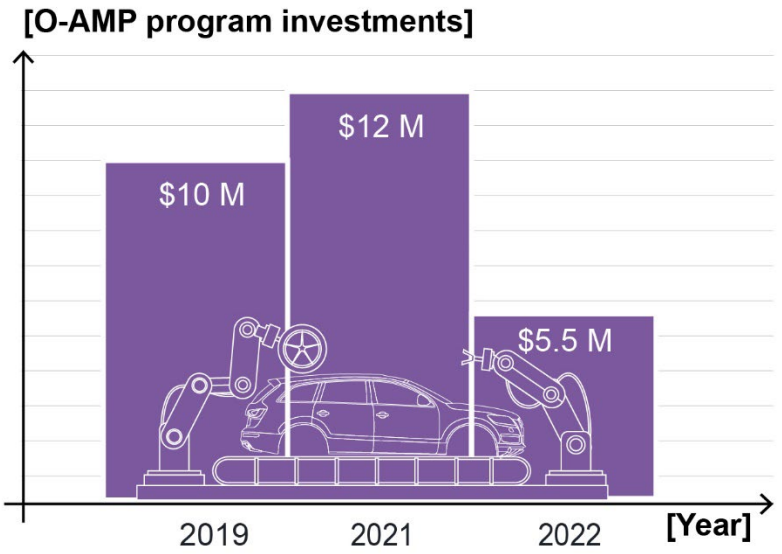
> **"The cars of the future will be built in Ontario from start to finish because we made a promise to support our auto sector."** [170]
>
> **– The Honourable Doug Ford, Premier of Ontario**

Billions in funding are going towards upgrades for Ontario's manufacturing facilities

Ontario launched the Ontario Automotive Modernization Program (O-AMP) in 2019 as a centrepiece of Driving Prosperity Phase 1. The program aims to help small and medium-sized enterprises remain competitive and responsive to customer needs by providing funding to support the implementation of advanced manufacturing hardware or software, the adoption of technologies to facilitate the design of new products, and the use of lean manufacturing techniques. As of April 2022, the $27.5M O-AMP program has completed three funding rounds, leveraging more than $36.5M in industry investment. Some 150 projects are either completed or underway and are creating over 820 jobs.[171]

Automotive OEMs are investing in their Ontario facilities as well. In March 2022, Honda announced a $1.38B investment to facilitate production of hybrid EVs at its Alliston manufacturing plant. The federal and provincial governments are supporting Honda's upgrades through equal contributions of $131.6M each.[172] In October 2020, the Ontario government matched a federal investment of $295M to support a $1.8B investment into the modernization of Ford Canada's Oakville Assembly Complex. The investment aims to upgrade the plant with a flexible manufacturing system which will be able to produce multiple battery EV models. EV production is scheduled to begin by 2025.[173] The provincial government also recently provided support for General Motor's efforts to transform their Oshawa and Ingersoll plants, contributing $259M in April 2022. At Ingersoll, this investment will facilitate the production of commercial EV delivery vehicles.[174] In May 2022, Stellantis announced a $3.6B investment to retool their Windsor and Brampton plants for EV production.[175]

Ontario has dedicated $27.5M to small and medium-sized enterprises (SMEs) to implement new technologies through the Ontario Automotive Modernization Program[176]



558

Ontario companies supported by OVIN's contributions since 2017

New investments are closing the gaps in Ontario's automotive supply chains

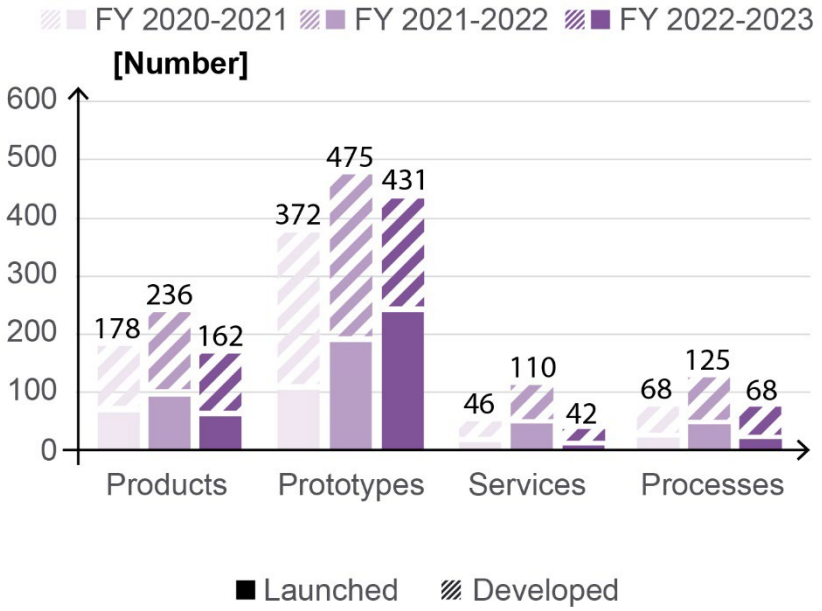
Auto manufacturing involves more than just auto assembly plants. Recent investments are bringing Ontario closer to having an end-to-end domestic vehicle supply chain.

Auto parts suppliers are upgrading their facilities to support enhanced production for vehicle supply chains. In February 2022, ArcelorMittal Dofasco, Canada's largest flat-rolled steel producer, confirmed a $1.8B investment to modernize its Hamilton facility with new sustainable manufacturing technologies.[177] This project—which is supported by a $400M investment from the federal government and a $500M investment from the Province of Ontario—aims to reduce carbon emissions from steel production. This project will enhance ArcelorMittal Dofasco's capability to produce automotive exposed, advanced high strength steels.[178] Similarly, in November 2021, auto parts supplier THK Rhythm Automotive Canada announced a $27M investment that will enable a facility expansion, the creation of 100 new jobs, and the purchase of advanced manufacturing equipment to produce steering and linkage components.[179]

Ontario's capacity for battery manufacturing is expanding as well. In March 2022, LG Energy Solution, a leading battery manufacturing company, and Stellantis, a large automaker, announced a joint investment of $5B to create Canada's first large-scale EV battery manufacturing plant in Windsor, Ontario. Once operational, the factory is expected to provide 2,500 jobs.[180]

Following the announcement of the new plant, DongShin Motech, a parts supplier, announced its intention to open a $90M plant in Windsor to supply the new plant with aluminum battery casings.[181] In July 2022, Umicore, a multinational enterprise focused on circular materials technology, announced a $1.5B investment that will fund a large-scale battery active materials manufacturing facility in Loyalist. The facility is expected to start operation towards the end of 2025. [182] The manufacturing of these materials will create a valuable link in Canada's battery value chain for electric mobility.

OVIN's contributions are increasingly enabling the development of new Ontario-made products and services



Buy local incentives and strong trade agreements are strengthening Ontario's position as a leader in auto manufacturing

Several initiatives are increasing the attractiveness of Ontario-made vehicles.

On August 16, the United States passed the Inflation Reduction Act of 2022, allowing EVs manufactured in Canada to be eligible for US tax credits. The bill provides a $4,000 tax credit on the purchase of used EVs and a $7,500 tax credit on the purchase of new EVs. Moreover, the bill includes provisions for manufacturing EV batteries. Beginning in 2024, 50% of mineral content in EV batteries must be extracted or processed in a country with which the United States has a free trade agreement to qualify for the full incentive, and 60% of the battery's components (by value) must be made or assembled in North America – with both requirements increasing by 10% each year until 2027 and 2029, respectively.[183] Ontario's abundance of critical minerals and Canada's favourable trade relations with the US will help position the province at the forefront of EV manufacturing in North America.

Additionally, as part of the Canada-United States-Mexico Agreement, the North-American-made auto content requirements for passenger vehicles and light trucks shipped duty-free within North America is set to increase to 75%. Consequently, auto manufacturers are likely to search for key auto parts domestically to comply with the updated content requirements, thereby further solidifying Ontario's position as a leader in the automotive sector.[184]

Ontario is becoming a hub for producing critical minerals essential to EVs

Ontario has an abundance of the critical minerals required for EV batteries—including graphite, lithium, nickel, and cobalt—and is home to several active mines and refineries. The town of Cobalt, Ontario has the only permitted cobalt refinery in North America while Greater Sudbury has the world's second-largest nickel sulphide deposit.[185] Ontario's Ring of Fire is a major mineral development region in Northern Ontario, with long-term potential to produce chromite, cobalt, nickel, copper, and platinum.[186]

As the world shifts towards EVs, Ontario's direct access to these critical minerals coupled with its automotive manufacturing capabilities make it uniquely positioned to develop a thriving end-to-end EV supply chain.

Recent investments demonstrate the private sector's confidence in Ontario's mining sector. BHP Group Ltd., an Australian mining company, recently moved their nickel and copper exploration headquarters to Toronto, paving the way for future international investments.[187] Frontier Lithium, an owner of lithium deposits in northwest Ontario, is in the process of developing a mine, mill, and lithium chemical processing plant to supply lithium hydroxide and lithium salts for battery production in North America.[188]

OVIN Spotlight Series

eLeapPower | Toronto, Ontario

eLeapPower is a tech company that delivers a range of power conversion solutions to the mobility industry. eLeapPower's Smart Inverter System enables vehicles to charge directly from the grid to the Smart Inverter which handles the AC/DC conversion without the need for external fast chargers or internal on-board chargers. The system facilitates faster charging and results in substantial cost savings for vehicle manufacturers. eLeapPower's smart inverter-enabled powertrain solution has won several awards, including Natural Resource Canada's breakthrough energy solution competition.

eLeapPower also created a wireless charging system that allows vehicles to charge without human intervention. With the help of OVIN, eLeapPower held a successful project demonstration in 2021 that showed that their wireless charging technology has over 90% efficiency even with normal parking misalignment.

OVIN also provided support through its TalentEdge program, allowing eLeapPower to bring talented new graduates into the industry to support their work. In total, project partners invested $2M in Ontario, including a $1M OVIN grant and $1M in funding from all industry partners, and have created 24 jobs with five additional jobs retained in Ontario.

3.5 Supportive Infrastructure

New initiatives are preparing roads for CAVs

The province is currently testing a range of ITS technologies such as real-time traffic movement sensors, vehicle-to-infrastructure communication, and highway sensors and signs that provide safety warnings and updates about weather-related dangers.[189] On Highway 401, the Ministry of Transportation ran a pilot project testing communication and data collection of roadside units.[190] Highway 407's operator and manager has tested high contrast pavement marking tape to improve AV system visibility in dry and wet weather conditions.[191] The Municipal Alliance for Connected and Autonomous Vehicles in Ontario (MACAVO) portal helps municipalities located in the Windsor-Ottawa corridor identify preferred roads for testing of CAV technology.[192]

> **"Our government understands that when the automotive sector succeeds, our province succeeds. Along with the historic investments our government is making in building the vehicles of the future, we are proud to support the development of next-generation transportation technology that will transform the way we travel while furthering our position as a leader in the automotive technology space."**
>
> **– The Honourable Caroline Mulroney, Ontario Minister of Transportation & Ontario Minister of Francophone Affairs**

Ontario is exploring CAV-supportive digital infrastructure

CAVs require a range of digital infrastructure to ensure safe deployment.

The provincial government is pushing for greater high-speed connectivity to meet the ever-increasing demand across the province and serve as critical supportive infrastructure for smart mobility. Over $109M was invested by Ontario in Telesat's next-generation Low Earth Orbit (LEO) satellite network, Telesat Lightspeed, which is the largest space program ever to be undertaken in the country. Ontario's investment will allow local internet service providers to purchase high-speed satellite bandwidth at reduced rates, enabling them to provide affordable high-speed connectivity services across the province, including LTE and 5G. Expected to go into service in the first half of 2024, the network investment is aimed at futureproofing and diversifying Ontario's broadband infrastructure.[193]

Safety and cybersecurity will require extensive focus to facilitate the adoption of CAVs in the coming years. SHIELD, an automotive cybersecurity research centre, is a leader in the development of security solutions for the automotive industry. Located in the Windsor-Essex region, the centre's objectives include facilitating Canadian-made solutions in innovation, training, and public awareness for automotive cybersecurity. Additionally, SHIELD aims to help create standards for securing manufacturing integrity and build a library of information and engagements to promote the importance of mobility cybersecurity.[194]

In early 2022, Rogers and OVIN collaborated to launch the 5G Transportation Challenge, which encourages SMEs to use Roger's world-class 5G testbed at the University of Waterloo campus to create innovative transportation solutions. This partnership intends to leverage the benefits derived from applying the latest 5G technology in the AV domain by providing a platform for participants to envision potential use-cases and technological crossovers.[195]

Accurate and detailed maps are also critical for autonomous vehicles. To this end, the City of Toronto partnered with Ecopia AI to collect critical road network data to develop maps that are compatible with AVs. Ecopia AI's maps—which use proprietary artificial intelligence technology and imagery from several aerial and street view imagery providers—contain information such as land cover features like buildings, curbs, driveways, parking, bike signs, and other features needed for accurate foundational data for safe deployment of AVs on Ontario's roads.[196]

Cross-provincial charging networks will encourage EV adoption

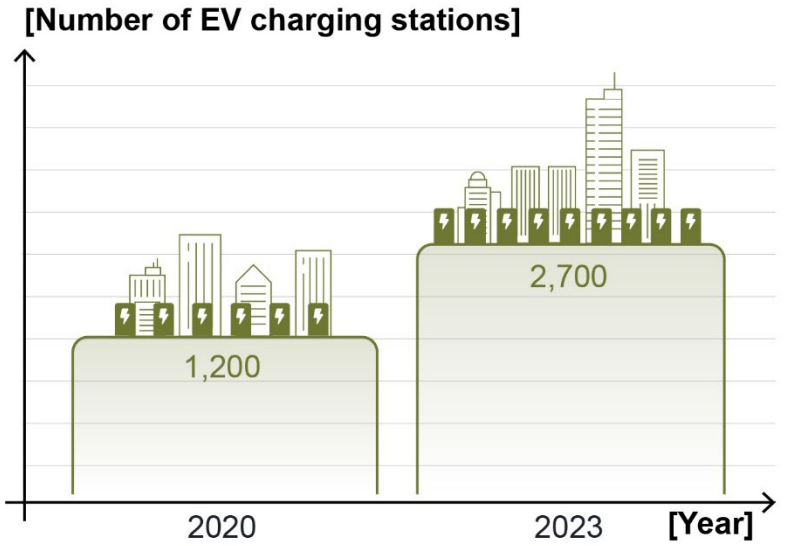
Ontario is investing heavily to improve its EV charging infrastructure. In 2021, the federal government announced a target of installing 50,000 new electric-vehicle chargers and hydrogen stations throughout Canada.[197] Today, there are nearly 7,500 public charging ports available at over 2,700 charging stations in Ontario.[198]

Ontario is expanding its EV-charger network by investing up to $91M to increase the number of EV chargers at various locations such as carpool parking lots, highway rest stops, community hubs, and Ontario Parks.[199] In the spring of 2022, the province announced that they will introduce the Rural Connectivity Fund to support EV charger installations in rural communities.[200]

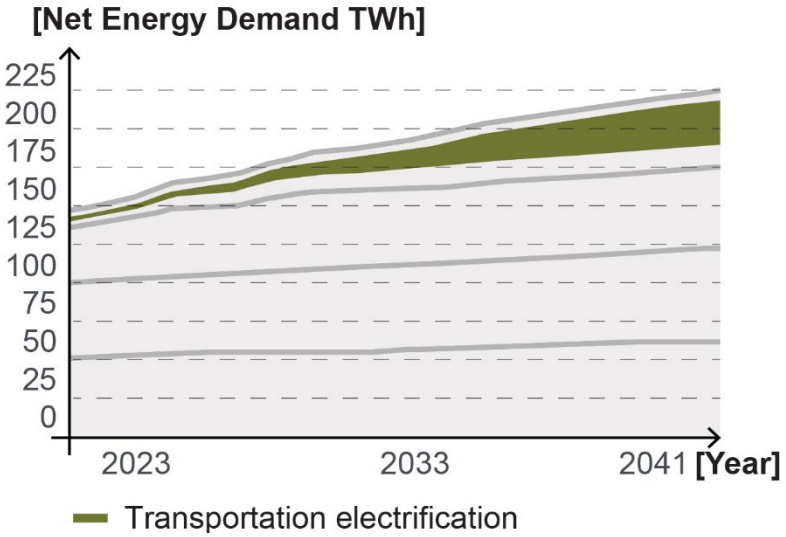
Over $300,000 in funding was also announced by Indigenous Clean Energy through their Charge Up program to help Canadian Indigenous communities and businesses install EV charging stations – covering up to 50% of installation costs. This investment will provide more charging stations to power light-duty vehicles in a variety of spaces such as multi-unit residential buildings, on-street, and workplaces.[201]

The City of Toronto's TransformTO Net Zero Strategy, released in 2021, set an objective to provide over 3,200 charging ports at important locations across the city by 2025. The plan also contains provisions for creating incentives for charger station installation within existing buildings.[202]

Ontario's EV charging network grew by approximately 1,500 charging stations from 2020[203] to 2023[204]



Ontario's electricity demand due to transportation electrification is expected to grow over the coming decades[205]



*Reproduction of graph from IESO

Large investments in the energy sector are supporting transportation electrification goals

The electrification of transportation systems is bound to increase demand for electricity. Latest estimates suggest that Ontario could be home to over 1M EVs by 2030.[206]

Electricity companies are taking note of these developments and are collaborating with the government and industry partners to stay ahead of the curve. The Independent Electricity System Operator (IESO) and the Ontario Energy Board are supporting a project by BluWave-ai and Hydro Ottawa to prolong the life of electricity infrastructure. The project aims to use artificial intelligence to manage and optimize EV charging during peak demand periods in the Ottawa area, resulting in cost savings for the customers and, consequently, an increased life span for the charging infrastructure.[207]

In March 2022, the East-West Tie, a new 450km transmission line running from Wawa to Thunder Bay, entered service. The line, which cost an estimated $777M, will play a critical role in supporting Northern economic development initiatives, and will help connect mines in the north with the growing EV manufacturing sector in Southern Ontario. The line increases availability to Ontario's clean electricity system, helping businesses throughout the province produce greener products.[208]

In April 2022, the Ontario government announced that they were advancing work on a new, ultra-low overnight time-of-use (TOU) electricity rate. By using electricity during the night when demand is low, customers could save up to $90 annually while helping to increase grid efficiency. TOU plans support EV adoption and manufacturing by providing an option for reduced electricity costs.[209]

Ontario is also seeking to expand its clean energy advantage through its Low-Carbon Hydrogen Strategy. Released in April 2022, the strategy explores how the province can accelerate the development of a low-carbon economy that will create jobs and reduce emissions. Modelling completed by Natural Resources Canada suggests that the use of hydrogen could reduce 50 megatonnes of greenhouse gas emissions and create over 100,000 jobs in Ontario by 2050. As part of the strategy, the government is supporting a proposal put forth by Atura Power, a subsidiary of Ontario Power Generation, to build, own, and operate the province's largest low-carbon hydrogen production facility in Niagara Falls. The facility would expand the province's low-carbon hydrogen

production capacity eight-fold and help position the province as a low-carbon hydrogen hub.[210]

In July 2022, the Independent Electricity System Operator (IESO) announced $4.8M in funding for 47 recipients through its Indigenous Energy Support Programs. Projects eligible for funding include those that will help develop renewable energy generation, EV charging, community energy planning, and skills development. As part of this program, Bingwi Neyaashi Anishinaabek (Sand Point First Nation) was awarded funds to pilot two solar-powered EV charging stations.[211]

1M

EVs expected in Ontario by 2030

$777M

investment to build the East-West Tie transmission line

"Our agreement with Ivy, ONroute and Canadian Tire to construct EV chargers at all of the province's 23 ONroute stations is an important step forward, allowing EV owners to travel our great province with more freedom and confidence. This deployment will reduce barriers to EV ownership, supporting Ontario's growing EV manufacturing market and critical minerals sector, and help achieve Ontario's goal of building at least 400,000 electric and hybrid vehicles by 2030." [212]

- The Honourable Todd Smith, Ontario Minister of Energy

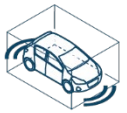
OVIN Spotlight Series

Visual Defence | Richmond Hill, Ontario

Visual Defence is a company that helps organizations around the world use cameras to operate more efficiently. Visual Defence developed a new product called Rover, which automatically identifies road inefficiencies by using artificial intelligence. Once equipped on fleets, Rover is expected to automatically report incidents so that municipal staff do not have to identify and report these issues manually.

Funding from OVIN helped Visual Defence hire new personnel and encourage collaboration with municipal partners. Visual Defence has explored this technology with over 40 governmental and private organizations, the majority of which are located in Ontario due to the province's positive reception and desire to innovate and collaborate.

3.6 Piloting and Testing



Partnerships between Ontario and Michigan are promoting cross-border testing and piloting

OVIN and the Michigan Department of Transportation signed a Memorandum of Understanding in 2021 to collaborate on the implementation of a cross-border testing environment to spur technology innovations and strengthen the long-standing relationship between the two regions. Specifically, the partners hope to leverage their new collaboration to identify the potential economic, social, and environmental benefits of increased collaboration on automotive and transportation technologies; identify challenges and solutions for the cross-border transportation of goods and people; explore implications for regulatory and policy considerations; and develop a roadmap for cross-border transportation pilots.[213]

Another initiative to realize cross-border autonomous driving was unveiled by Invest WindsorEssex in 2022. The organization created a digital twin of the Windsor Detroit Tunnel in its state-of-the-art simulation environment, enabling researchers to understand how connected and autonomous vehicles would operate at the international border crossing.[214]

Ontarians are riding autonomous shuttles for the first time

Starting in late 2021, residents of Whitby, Ontario were able to ride the first autonomous shuttle integrated into an existing Canadian transit service as part of a pilot program led by SmartCone. The pilot served over 250 passengers and facilitated learning around technology capabilities, weather, accessibility, and insurance for autonomous vehicles.[215]

Toronto-based company CUTRIC is helping optimize AV pilots. The company developed an in-house simulation tool, Rout∑.i™, to predict the performance of electric low-speed automated shuttles (e-LSAs). The tool was used to assess the performance of e-LSAs on nine different routes where regional governments were considering incorporating e-LSAs as a solution to the first/last mile problems faced by residents.[216]

Ontario's seven Regional Technology Development Sites are piloting automotive and smart mobility advancements

Ontario is home to seven Regional Technology Development Sites (RTDSs). OVIN supports the RTDSs by providing funding for innovative projects and showcasing opportunities for participants and respective partners at OVIN events. To date, OVIN has committed over $4M to create the Northern RTDS.[217]

The seven RTDSs form a support network for SMEs in various phases of automotive and smart mobility solutions and connect post-secondary institutions, incubators and accelerators, regional innovation centers, municipal and regional resources, and industry collaborators. Each RTDS carries out activities focusing on a unique aspect of the smart mobility and automotive sector.

The RTDSs reduce barriers to accessing resources and collaborative support for testing, prototyping, validation, and commercialization within the province. Through the development of the seven RTDSs, Ontario has strategically positioned itself to test and confirm the suitability of emerging technologies across the province.[218]

Ottawa RTDS

Lead partner: Invest Ottawa

Key focus areas: Research & Development, Smart Mobility, Defence & Security, Drones, Smart Agriculture

Key project: Area X.O., a private CAV testing environment which includes a 16km test track with real-world mobility infrastructure and supports real-world deployments at nine intersections in the City of Ottawa[219]

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Waterloo RTDS

Lead partner: Communitech

Key focus areas: Vision Zero, Mobility, Transportation, Autonomous, Data Science

Key project: The development of Vehicle Safety Systems through automated technology such as sensors, distributed computing, and mobility networks[220]

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Hamilton RTDS

Lead partner: Innovation Factory

Key focus areas: EV, Alternative Powertrain Technology, Hydrogen Energy, CAV, Smart Transportation Infrastructure, Transportation-as-a-service Solutions

Key project: Centre for Integrated Transportation and Mobility (CITM), an accelerator for Ontario businesses focused on smart mobility solutions[221]

Toronto RTDS

Lead partner: ventureLAB

Key focus areas: Hardware & Semiconductor, Enterprise Software & AI, MedTech, Advanced Manufacturing, Automobility

Key project: The globally competitive expansion of Canadian hardware technology and enterprise software companies through VentureLAB[222]

Durham RTDS

Lead partner: Sparks Centre, Durham College, Ontario Tech University

Key focus areas: Electric Vehicles, Smart Mobility, Smart Communications, Smart Transportation, Sandbox

Key project: The Automotive Centre of Excellence (ACE) Climactic Aerodynamic Wind Tunnel at Ontario Tech University, designed to validate prototype vehicles and capable of simulating rain, freezing rain, light snow, blizzards, and wind speeds capable of reaching 300 kilometres per hour at temperatures ranging from -40˚C to +60˚C[223]

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WindsorEssex RTDS

Lead partner: Invest Windsor Essex

Key focus areas: Advanced Simulation Testing, Virtual Reality, Digital Twinning, Digital Test Tracks, Cross-border Simulation Testing, Automobility CyberSecurity

Key project: The Invest Windsor Essex VR Cave, Canada's largest publicly accessible VR cave, which provides advanced virtual test tracks simulating various geographic areas across the world for CAV-related training, teaching, and research[224]

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Northern Ontario RTDS

Lead partner: NORCAT

Key focus areas: Critical Mineral, Mineral Exploration, Mining, BEV, EV

Key project: Skilled training and mining technology innovation, supported by access to 70,000 square feet of lab space, a rugged terrain test track, and an operating mine[225]

3.7 Adoption

New business models are encouraging car-sharing

Rising costs of car ownership have prompted some car owners to explore new ways to extract the most value from their vehicles. Car-sharing has emerged as a popular solution, inspiring several companies to develop business models for shared consumption. Car-sharing—which differs from ridesharing (e.g., Uber, Lyft, etc.)—refers to the use of a single car by multiple drivers. Car-sharing provides a viable alternative for people who want to avoid car ownership and associated costs like taxes, repair, maintenance, and parking.

Turo and Communauto are two dominant forces in the Canadian car-sharing market. The two companies fundamentally differ in terms of business models, with the former offering a peer-to-peer platform on which individuals list their cars for use by other individuals,[226] and the latter offering a business-to-consumer platform, wherein a business owns all the cars and permits their use by customers.[227]

Ontarians are increasingly open to purchasing EVs, but EV ownership in Ontario lags behind other provinces

EVs are becoming increasingly common in Ontario. In the fourth quarter of 2022, EV registrations (including battery-electric vehicles, hybrid-electric vehicles, and plug-in hybrid-electric vehicles) reached 13.5% of all new vehicle registrations, up from 9.4% a year earlier. However, EV ownership in the province lags behind the country overall, for which 14.7% of all new vehicle registrations were EVs, as well as provinces like Quebec, for which 18.2% of all new vehicle registrations were EVs.[228]

A majority of Ontarians are likely to buy an EV the next time they purchase a vehicle, with 53% of people surveyed noting that they were leaning towards electric over gas or diesel. This trend is especially prominent among Ontarians under 30, 67% of whom are likely to purchase an EV as their next vehicle. Additionally, 63% of Ontarians believe that the lifetime ownership costs of EV ownership are cheaper than the lifetime costs of gas vehicles.[229]

Fleet electrification is helping achieve emission reduction goals

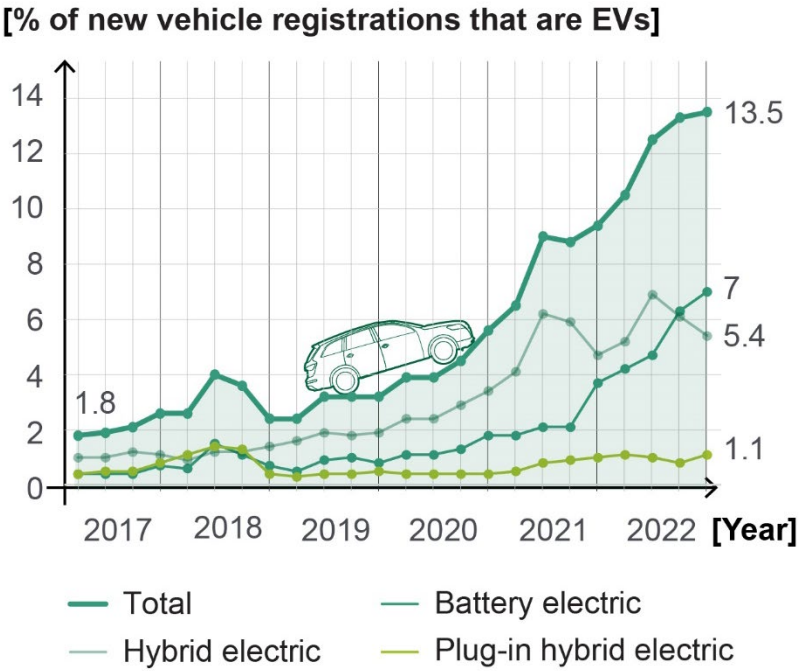
The federal government is playing a pivotal role in the switch to net-zero emission and electric transit. In 2021, a $2.75B Zero Emission Transit Fund was unveiled by Infrastructure Canada as part of a five-year national program aimed at helping communities invest in zero emission public transit and school transportation.[230]

The Toronto Transit Commission (TTC) has committed to being 100% zero emissions by 2040,[231] with Ontario Power Generation and Toronto Hydro collaborating to electrify the TTC's fleet.[232] The TTC issued its first large-scale electric buses Request for Proposals for 240 buses in April 2022 and plans to procure 1,826 electric buses by 2040.[233] Other municipalities like Greater Sudbury[234] are following suit by committing to electrify their public transit fleets as well.

The City of Brampton will be the first municipality in Ontario to make use of an electric firetruck, joining other world-class cities in using electric-powered front-line emergency response vehicles. The decision is in line with the city's dedication to sustainability and environmental innovation.[235]

Private-sector fleets are electrifying as well. In early 2022, Element Fleet Management, a Toronto-based fleet management firm, released a new electrification service that helps their clients transition to an electrified fleet. Their comprehensive service offering includes EV pilot design and support, charging solution planning, EV incentive support, and driver education.[236] In April 2021, IKEA Canada announced a partnership with last-mile delivery provider Bolt Logistics (known at the time as Second Closet) which saw the use of 15 co-branded EV trucks for home deliveries at key IKEA locations in Canada, including a location in Etobicoke.[237] In January 2022, IKEA and Bolt Logistics announced plans to deploy an additional 30 electric trucks.[238]

EVs are comprising an increasing proportion of new vehicles registered in Ontario[239]



1,826

electric buses to be procured by the TTC by 2040

Preparatory work is underway for an autonomous future

The City of Toronto released its Automated Vehicles Tactical Plan in 2019 to prepare the city for an autonomous future. Building on existing policies and regulations, the plan details the City's current understanding of autonomous technologies, potential timelines for incorporation, and different business models for AVs. The plan listed five priority AV projects to ensure AV readiness by 2022, including:[240]

- Completing an automated shuttle trial project;
- Establishing a process and identifying locations for transportation innovation zones within Toronto;
- Developing a testing response and incident preparedness system;
- Initiating collaboration to provide opportunities to better equip users for AV interaction; and
- Continuing research and development efforts to address current transportation related challenges.

In addition, OVIN has created the Ontario Smart Mobility Readiness Forum, which provides a platform for municipalities and public sector agencies to collaborate on, discuss, and prepare for the adoption and implementation of smart mobility technologies. This Forum promotes collaborations across the public sector, the private sector, and academia.[241]

Advancements in autonomous technology are benefiting sectors beyond transportation

Autonomous technologies have great potential for use in a plethora of applications outside of the transportation industry.

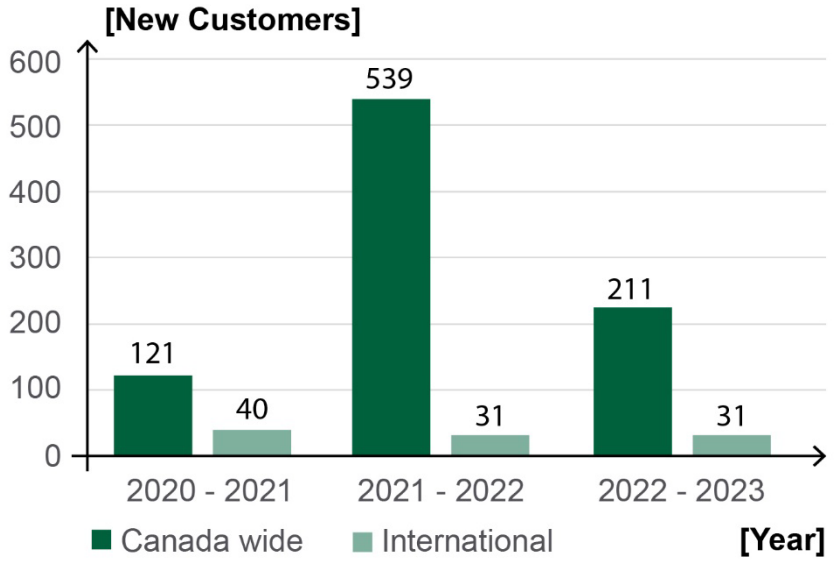
Moose Cree First Nation, an Indigenous community in Ontario, collaborated with Drone Delivery Canada in 2017 to autonomously bring food, medicine, and other supplies to their community.[242] A Kitchener-based company, Forward Robotics, developed the U7AG drone sprayer, which enables spraying at 120km per hour with a seven-metre boom. [243]

In Toronto, start-up Tiny Mile partnered with Foodora to develop sidewalk delivery robots to aid with contactless delivery.[244] Korechi Innovations Inc., an agriculture machinery company based in Oshawa, recently developed the RoamIQ, an autonomous agricultural robot consisting of an expandable platform compatible with a variety of attachments for different uses within a farm.[245] Raven Industries' DOT Power Platform is also capable of completing farm tasks autonomously. The platform, which was first used in 2020 at a farm in Chatham-Kent, is currently being tested in several farms across Ontario.[246]

Ridesharing is taking on electrification

Ridesharing companies are providing incentives for drivers to switch to electric vehicles. Uber drivers with EVs can earn one extra dollar on every trip they make up to an annual maximum of $4,000. Uber EV drivers can also earn an additional 50 cents per ride paid by customers who opt for a low-emission ride through Uber Green. Additionally, Uber offers an EV purchasing program in partnership with General Motors through which Uber drivers can access various discounts on certain EV models.[247]

OVIN support enabled companies to secure an increasing number of new customers



OVIN Spotlight Series

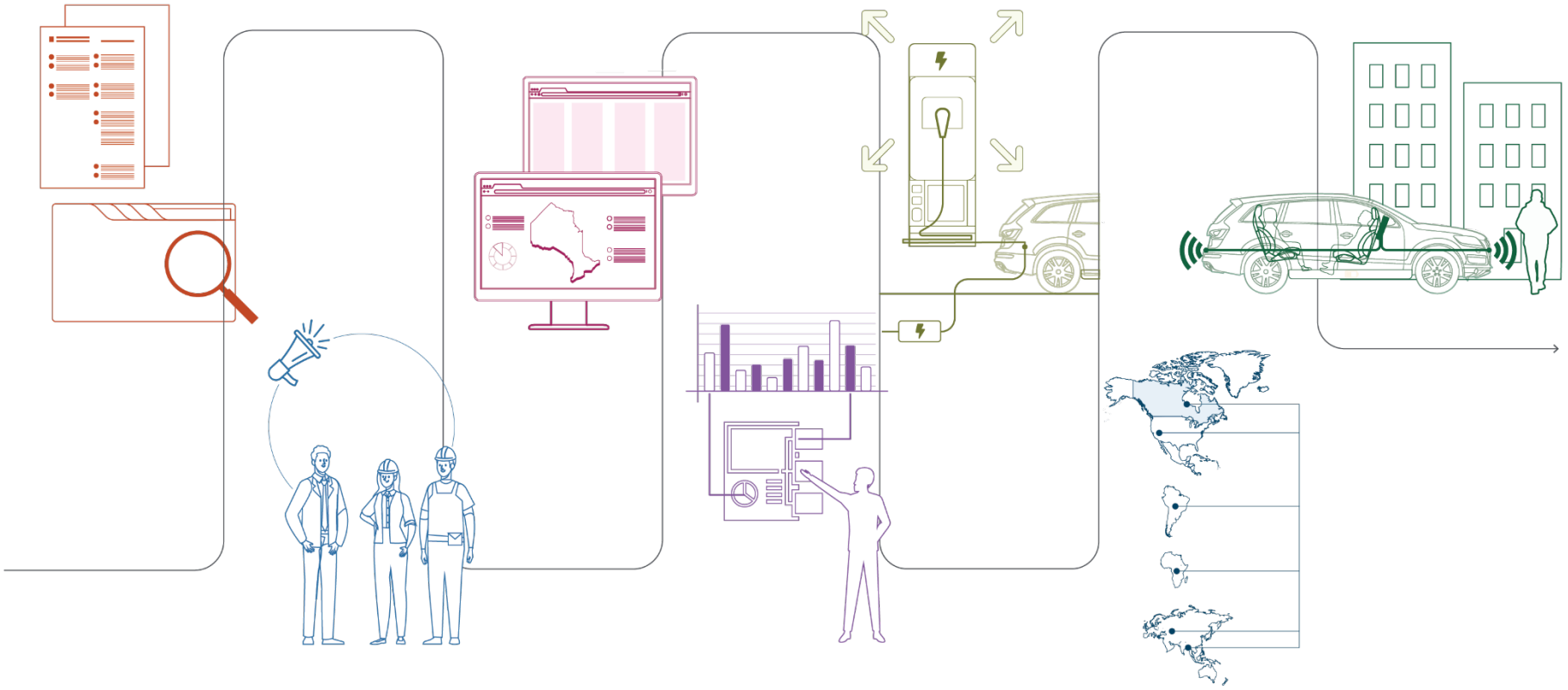
CLOUD DX

Cloud DX | Kitchener, Ontario

Cloud DX is a leading provider of telehealth and remote patient monitoring solutions with rapidly growing sales across North America. Cloud DX is working to streamline healthcare delivery by automating the gathering of accurate vital signs during patient transport by embedding their remote monitoring technology into vehicle interiors. OVIN has helped Cloud DX explore how they could leverage some of the billions of dollars that are being invested into vehicle autonomy, especially since health-tech has not been a priority for autonomy researchers so far. With the help of OVIN, Cloud DX is anticipated to add up to five new high-tech jobs in Ontario, generate new intellectual properties, and ultimately sell or license their autonomous remote monitoring technology for use worldwide.

4. Opportunities in a Growing Industry

Ontario is a leader in advanced automotive regulation, manufacturing, research and development, piloting, and testing. To secure and expand the province's unique position amid emerging national and international trends, Ontario can pursue a number of opportunities.



4.1 Policies and Regulations

Foster standardization and collaboration

The standardization and harmonization of CAV regulations across Canada and internationally is crucial for CAV implementation and is essential to facilitate the interoperability and scalability of emerging technologies across jurisdictions.[248]

Currently, regulations are largely unharmonized, with each jurisdiction having its own customized regulatory framework.[249] However, several recent initiatives are helping to standardize policy landscapes, including new provisions for the harmonization of EV battery durability requirements,[250] and requirements for using autonomous vehicle technologies in heavy vehicles.[251]

Ontario, being home to a broad range of automotive stakeholders and a pioneer in the adoption of polices that support advancements in the automotive sector, is uniquely positioned to influence the ongoing standardization of EV and CAV policies. Ensuring collaboration amongst Ontario's many automotive and mobility players will help to push the standardization agenda. For example, the province might lead standardization efforts among municipalities, with a focus on infrastructure such as signage and EV chargers. OVIN's Smart Mobility Readiness Forum will be a cornerstone in promoting cross-sectoral collaboration among the government, the private sector, and academia. The Forum offers a platform for municipalities and public sector agencies to discuss their transportation objectives and collaborate in preparation for the adoption and implementation of smart mobility technologies.[252]

Where appropriate, the province can also lead collaboration with other countries to advance standardization efforts—including cross-border initiatives with jurisdictions in the United States—that will promote adoption of made-in-Ontario technologies, products, and services.

Advance insurance and liabilities frameworks

Policy reforms aimed at curbing uncertainty, reducing ambiguity, and promoting public safety present a significant opportunity to encourage the widespread adoption of EVs and CAVs. There is a particularly notable need to modernize the CAV insurance market, where the historically unprecedented and often ambiguous question of producer or user liability in the event of an accident has been addressed differently in various jurisdictions.[253]

As the first jurisdiction in Canada to permit the testing of autonomous vehicles,[254] Ontario is well-positioned to take the lead on the policy updates necessary to facilitate next-generation vehicle technology, including updates to insurance and liability laws to extend their applicability to Level 4 CAVs. Organizations such as OVIN can foster collaboration to ensure these regulations are defined prior to 2040 – the year in which more than 30M CAVs are expected to enter the market.[255] As a result of its role as a leader in policy development, Ontario has the potential to accelerate the adoption of EVs and CAVs beyond its borders, which could in turn have positive spillover effects for manufacturing in Ontario itself.

4.2 Talent, Skills, and Workforce Development

Promote upskilling initiatives

The future of EVs and CAVs requires a paradigm shift in skills development for the automotive sector's workforce. Globally, jurisdictions are providing upskilling and tailor-made training programs for the automotive sector's workers to prepare for the production and maintenance of new automotive technologies.

Ontario has a highly skilled workforce ready to make contributions to the development, production, and maintenance of EVs and CAVs. Several Ontario cities—such as Toronto, Waterloo and Ottawa—have been propelled to the forefront of innovation in North America as a result of the province's dozens of post-secondary institutions and welcoming immigration policies. Ontario's tech talent is fuelling growth in areas such as AI, automotive and mobility, business and fintech, cybersecurity, manufacturing, industry 4.0 and quantum technology.[256]

OVIN will play a fundamental role in identifying critical opportunities for growth in Ontario's automotive and mobility workforce. OVIN's Labour Market Insights, for example, provide an overview of the supply and demand of talent and skills in Ontario's automotive sector, helping individuals understand the future of the automotive sector and how they may fit within this domain.[257]

OVIN will also play a large role in helping to train and further upskill the automotive and mobility workforce, building off past efforts such as the Talent Strategy & Roadmap, released in 2022. OVIN's digital Upskilling Platform—which will assist employers in providing remote education, training, and micro-credentials—will be crucial to ensuring that Ontario's workforce has the broad range of skills needed to build and maintain the vehicles of the future.[258]

4.3 Research and Development

Enable sectoral spillovers and geographic expansion

The development, introduction, and eventual widespread use of EVs and CAVs in the automotive space is anticipated to result in increasingly complex challenges which demand research from industry and academia.

Ontario has emerged as a leader in EV- and CAV-related R&D due to its renowned academic institutions and well-educated workforce, supportive environment for start-ups, and history as an innovation centre in the automotive industry. The province is home to numerous EV and CAV related companies pursuing research and development in the field, as well as numerous research and development initiatives in post-secondary institutions.[259]

The growth of R&D in Ontario's automotive and mobility sector has enabled positive spillover into intersecting sectors, such as agriculture[260] and health care, [261] enabling the introduction of new products such as autonomous tractors, agricultural robots, and health technology in automobiles. OVIN's RTDSs are poised to play a critical role in facilitating and expanding inter-industry R&D spillover. The newly established Northern RTDS, for example, is encouraging collaboration with the mining industry to advance innovations in mineral refining and battery design.[262]

Opportunities also exist to broaden research and development in the EV and CAV space beyond the traditional research hubs in the Toronto-Waterloo corridor. The City of London in southwestern Ontario, for instance, is home to a major research university and was ranked #10 on CBRE's list of the next 25 up-and-coming tech hubs.[263] OVIN's RTDSs will be crucial in supporting geographic diversity in Ontario's research and development initiatives by continuing to lead efforts to promote collaboration with post-secondary and private-sector partners across the province.

4.4 Manufacturing

Scale up and modernize production

Demand for EVs is to increase significantly in accordance with sales targets adopted in several countries. This, along with increased CAV uptake, will result in a significant technological shift in the automotive industry, with large ramifications for how vehicles are produced.

In recent years, Ontario has made significant progress towards preparing for large scale production of EVs and CAVs. For example, Honda invested $1.38B to increase hybrid EV production at their Alliston manufacturing plant,[264] while LG Energy Solution and Stellantis invested $5B to create Canada's first EV battery gigafactory in Windsor.[265] Ontario's government has made contributions to complement investments from OEMs[266] and to support SMEs wishing to modernize through the Ontario Automotive Modernization Program (O-AMP).[267]

In the future, the province, through programs such as O-AMP, might aim to provide an increasing level of support to businesses in their efforts to adopt more modern manufacturing practices. OVIN is well-positioned to facilitate modernization through initiatives aimed at supporting research on new production methods.

Attract new investment

As regional content requirements[268] and American tax credits applicable to Ontario-made vehicles[269] strengthen the province's position in vehicle manufacturing, the province will be an increasingly attractive target for new investment from OEMs.

Ontario can emphasize efforts to attract investment that will fill gaps in Ontario's existing manufacturing processes in pursuit of a domestic end-to-end vehicle supply chain. To this end, Ontario can advocate for and support trade agreements, attractive work environments, and advanced piloting and testing regulations while promoting its capabilities overseas to continue attracting global investment. Efforts to assist OEMs and SMEs modernize their production practices may also serve to attract increasing levels of investment.

4.5 Supportive Infrastructure

Upgrade infrastructure

Paving the way for the widespread introduction of EVs and CAVs requires extensive infrastructure investment in, among other things, road and signage upgrades to ensure CAV compatibility, charging stations and electricity grid upgrades to support EV uptake, and cybersecurity infrastructure to account for the vulnerabilities of vehicles increasingly dependent on technology.

Having made significant progress towards investments of this type, the province is continuing to prioritize infrastructure upgrades. Examples of significant investments aimed at upgrading infrastructure required for EV and CAV adoption include investments to prepare roads for CAV testing,[270] expansion of the province's EV charging network,[271] and public incentives for private investment in hydrogen production facilities such as the Atura Power facility in Niagara Falls.[272]

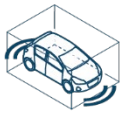
In the future, the province may look to identify opportunities to deliver these infrastructure upgrades through a variety of business models, to capitalize on the possibility of securing the participation of a broader range of players and investors. Infrastructure could, for instance, be increasingly delivered by the private sector – either alone or in partnership with the government – as well as through "as-a-service" and subscription-based business models. Promoting the unique position of Ontario nationally and globally will play a critical role in securing the public and private-sector investment in infrastructure required for the province to foster further innovation in EV and CAV technology and support increased uptake.

Collect and share data

CAVs will generate an unprecedented amount of new data. To fully embrace the value of this data, governments must develop harmonized and standardized cross-jurisdictional data management frameworks.[273]

As a hotbed for innovation and technological development, Ontario is well-positioned to be a pioneer in the development of such a framework and in the realm of data collection and management as it relates to CAVs more broadly. Ontario's future priorities may include open data platforms for use by CAVs and their manufacturers. The CAV space in Ontario might also benefit from greater participation in international data infrastructure initiatives such as Gaia-X, a federated ecosystem aiming to define uniform standards for data use and management to enable decentralized ownership of and widespread access to data.[274]

4.6 Piloting and Testing



Promote cross-border initiatives

Cross-border initiatives are inevitable in an integrated and connected world; while supporting domestic industries, it is evident that jurisdictions still need to foster cross-border collaboration to facilitate scalability and interoperability of their market-ready products and services. Cross-border initiatives are possible in a broad range of aspects from manufacturing to supportive infrastructure, where consistency in signage, regulations and road standards is vital to ensure safety.

There is a history of trade and collaboration between Canada and the United States in the automotive industry that stretches back several decades. A large portion of this collaboration has been between the Province of Ontario and the State of Michigan – both automotive hubs in their respective countries. In 2021, Ontario and Michigan signed a Memorandum of Understanding to encourage automotive innovation and promote cross-border collaboration.[275]

Multi-modal cross-border-testing facilities present an opportunity to pave the way for technology innovations and transportation solutions between Ontario, the United States, and beyond. Issues such as standardization for signage, communication protocols, data sharing, legal agreements, and safety procedures need to be addressed to ensure replicability and scalability of CAVs in the future. In this context, cross-border testing should be expanded to ensure alignment across jurisdictions for safety and scalability of connected and autonomous mobility and to facilitate user acceptance and adoption.

Leverage pilots to inform policy development

Piloting and testing are effective instruments to assess feasibility and confirm due diligence of new emerging technologies prior to widespread application. Piloting and testing help ensure that essential aspects such as safety, security, public acceptance, etc., are well-assessed and that lessons learned are shared with policymakers to inform the development of policies and regulatory frameworks.

For example, the City of Toronto trialled micro-utility devices (also known as sidewalk robots) in its Transportation Innovation Zone to understand their impacts on accessibility, economic development, and security. These trials occurred following a decision by City Council to ban the use of micro-utility devices until the Ontario Ministry of Transportation releases details about its provincial pilot scheme. The findings of the trials can inform the development of future policies or regulations when or if the devices are permitted in the City.[276]

In this context, dedicated testing facilities provided by OVIN or other authorities enable new emerging technologies and solutions to be proven safe and effective for public use.

4.7 Adoption

Raise awareness and promote public acceptance

The success and scalability of EVs and CAVs are both highly dependent on consumer acceptance. While relatively widespread CAV adoption is expected globally by 2040,[277] surveys continue to indicate that many Canadian consumers are not yet comfortable with CAV technology.[278]

To prepare the public for a future with electric and autonomous transportation, Ontario should continue to create more educational resources, undertake public awareness campaigns, and host public demonstrations of EV and CAV technology. OVIN and various RTDSs have played a large role in bringing EVs and CAVs closer to the public, enabling increased interactions between OEMs and end users. New educational resources can increase the public's comfort with advanced automotive technologies by informing people about their impacts on urban design, regulations, and career opportunities. Ontario can also push for the adoption of EVs and CAVs by influencing consumer behaviour through financial or other incentives.

Another opportunity to encourage adoption exists in public sector fleet vehicles, which provide the province with the ability to support the EV and CAV industry and serve as a leader in adoption. Public fleets are not limited to the provincial level, and the province might look to identify opportunities to incentivize further EV adoption by municipal governments and other public agencies, in an overall effort to bring a critical mass of EVs and CAVs to Ontario's roads and kickstart private adoption.

5. About OVIN

OVIN is a key component of Phase Two of Driving Prosperity, the Government of Ontario's ambitious plan that positions Ontario as a North American leader in developing and building the car of the future through emerging technologies and advanced manufacturing processes. The Government of Ontario has committed an additional $56.4 million, for a total investment of over $141 million to date, through OVIN's innovative programming to support research and development (R&D) funding, talent development, technology acceleration, business and technical supports, and testing and demonstration.

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

The initiative comprises five distinct programs and a central hub.

The OVIN programs are:

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

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

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

To find out the latest news, visit www.ovinhub.ca or follow OVIN on social media @OVINhub

OVIN Objectives

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

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

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

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

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

6. Meet the OVIN Team

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7. Acronyms

AC	Alternating current
ACATS	Transport Canada's Program to Advance Connectivity and Automation in the Transportation System
ACE	Automotive Centre of Excellence
ADAS	Advanced driver assistance systems
AI	Artificial intelligence
ASA	Automotive Skills Alliance
AV	Autonomous vehicle
CAV	Connected autonomous vehicle
CBRE	Coldwell Banker Richard Ellis
COP26	26th United Nations Climate Change Conference of the Parties
CV	Connected vehicle
DC	Direct current
e-LSA	Electric low-speed automated shuttles
EU	European Union
EV	Electric vehicle
GDP	Gross domestic product
IESO	Independent Electricity System Operator
IT	Information technology
LASER	Light amplification by stimulated emission of radiation
LEO	Low earth orbit
LiDAR/LIDAR	Light detection and ranging/Laser imaging, detection, and ranging
LBC	Lumibird Canada
MACAVO	Municipal Alliance for Connected and Autonomous Vehicles in Ontario
MEDJCT	Government of Ontario's Ministry of Economic Development, Job Creation and Trade
MTO	Ministry of Transportation (Ontario)
NI	National Instruments
O-AMP	Ontario Automotive Modernization Program
OCI	Ontario Centre of Innovation
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer
OINP	Ontario Immigrant Nominee Program
OnTrAC	Ontario Train Autonomy Collaboration
OVIN	Ontario Vehicle Innovation Network
R&D	Research and development
RTDS	Regional Technology Development Sites
SME	Small and medium-sized enterprise
STEM	Science, technology, engineering, and mathematics

TOU	Time-of-use
TS&R	Talent Strategy & Roadmap
TTC	Toronto Transit Commission
UN	United Nations
VR	Virtual reality
ZEV	Zero-emission vehicle

8. Disclaimer

This report was commissioned by the Ontario Centre of Innovation (OCI) through a Request for Proposals titled "Ontario Vehicle Innovation Network (OVIN) – Annual Comprehensive Sector Report & Quarterly Specialized Reports," dated April 26, 2022, and has been prepared by Arup Canada Inc. It is one of five reports covering an analysis of Ontario's automotive technology, electric vehicle and smart mobility landscape while incorporating implications for the sector's skills and talent landscape.

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