OVIN
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Ontario

OVIN INSIGHTS
Specialized Series

Executive Summary

Ontario's Unique Position: Hardware Electronics and Semiconductors and Their Role in the Automotive and Mobility Sector

Quarterly Specialized Report

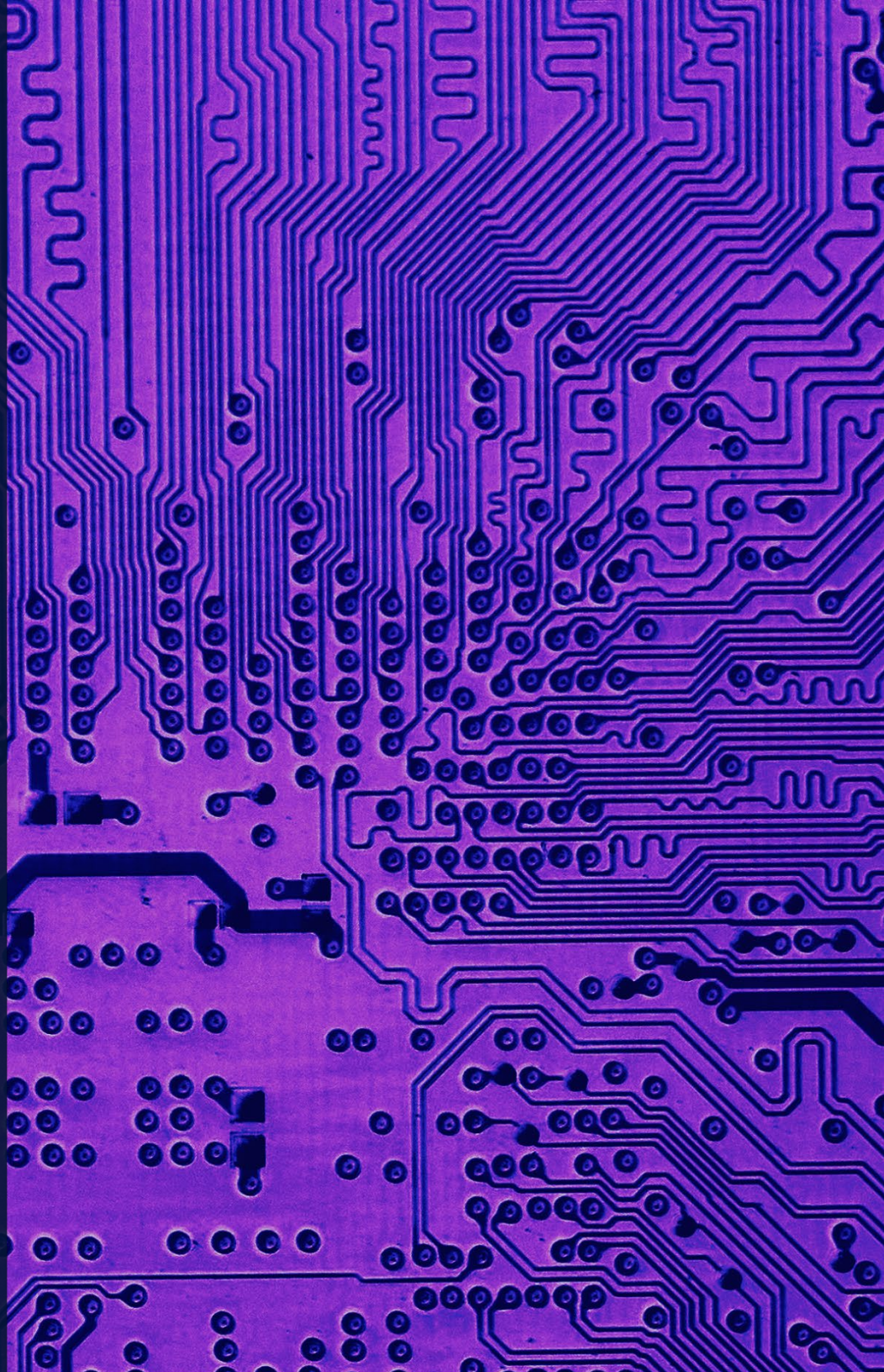
OCI
Where Next Happens

Executive Summary

Semiconductors play an essential role in modern life, enabling advances in a multitude of areas – transport, communications, computing, gaming, healthcare, military systems, and clean energy, to name but a few. They are a vital component of all electronic devices, providing the functionality to process, store, and transmit data. One sector in which they play a particularly significant role is that of automotive and mobility.

Ontario is uniquely positioned to be a central player in the semiconductor supply chain. The province is home to sought-after technical expertise and key industrial dependencies in automotive and advanced manufacturing. Ontario can play a leading role in the semiconductor space through its robust automotive sector, providing the link between chip manufacturing, EVs, and advanced automotive and mobility technologies.

This report presents an overview of semiconductors, highlights their role in the automotive industry, and examines Ontario's existing strengths in the semiconductor supply chain. This report also discusses global trends within the broader semiconductor ecosystem and identifies opportunities for Ontario to secure its role as a central player in multiple stages of the semiconductor lifecycle.



"Canada has the talent, capability, and tools to grow and expand in the hardware and semiconductor space. The benefits of growing this vital sector are numerous and include creating good jobs, boosting the economy, and standing out in the global market."

– The Honourable Mélanie Joly, Minister of Foreign Affairs

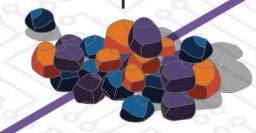
The semiconductor lifecycle

1 Research
Research in science and engineering

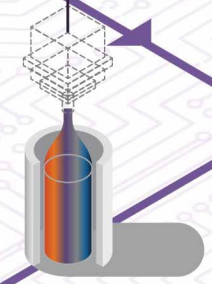
2 Design
Sophisticated equipment used to design chips

3 Manufacturing (front end)

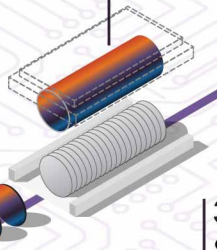
3a Raw materials
Pure material, such as sand, sourced from quarries and mines



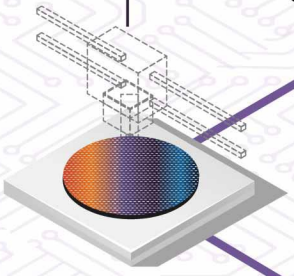
3b Ingot
Sand is purified and melted into solid cylinders called ingots



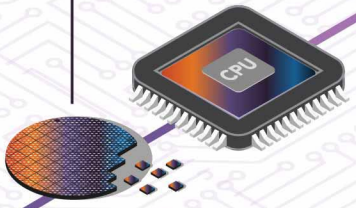
3c Blank wafer
Ingot is sliced into very thin (1mm) silicon discs and polished



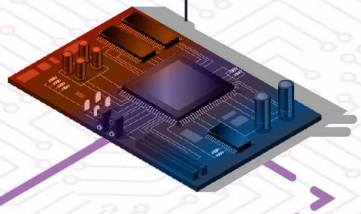
3d Finished wafer
Wafers printed with highly intricate circuit designs



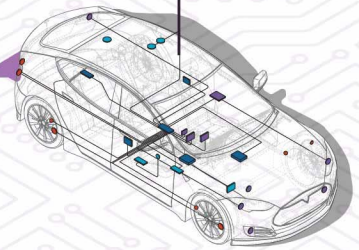
3e Cut wafer
Silicon wafer cut into tiny individual semiconductors called dies



4 Manufacturing (back end)
Chips assembled into packages to form the electronic components that can be mounted onto circuit boards



5 End product integration and consumption
Chips integrated into finished goods



Semiconductors and their application in the automotive industry

Semiconductors have a vital role for a number of functions in the automotive industry, including driver assistance, electrification, communication, and entertainment. According to estimates, the average non-electric car has over 1,000 semiconductor chips. Hybrid EVs can contain more than 3,500 semiconductors. As demand for EVs grows, so will the demand for semiconductors.

Powertrain

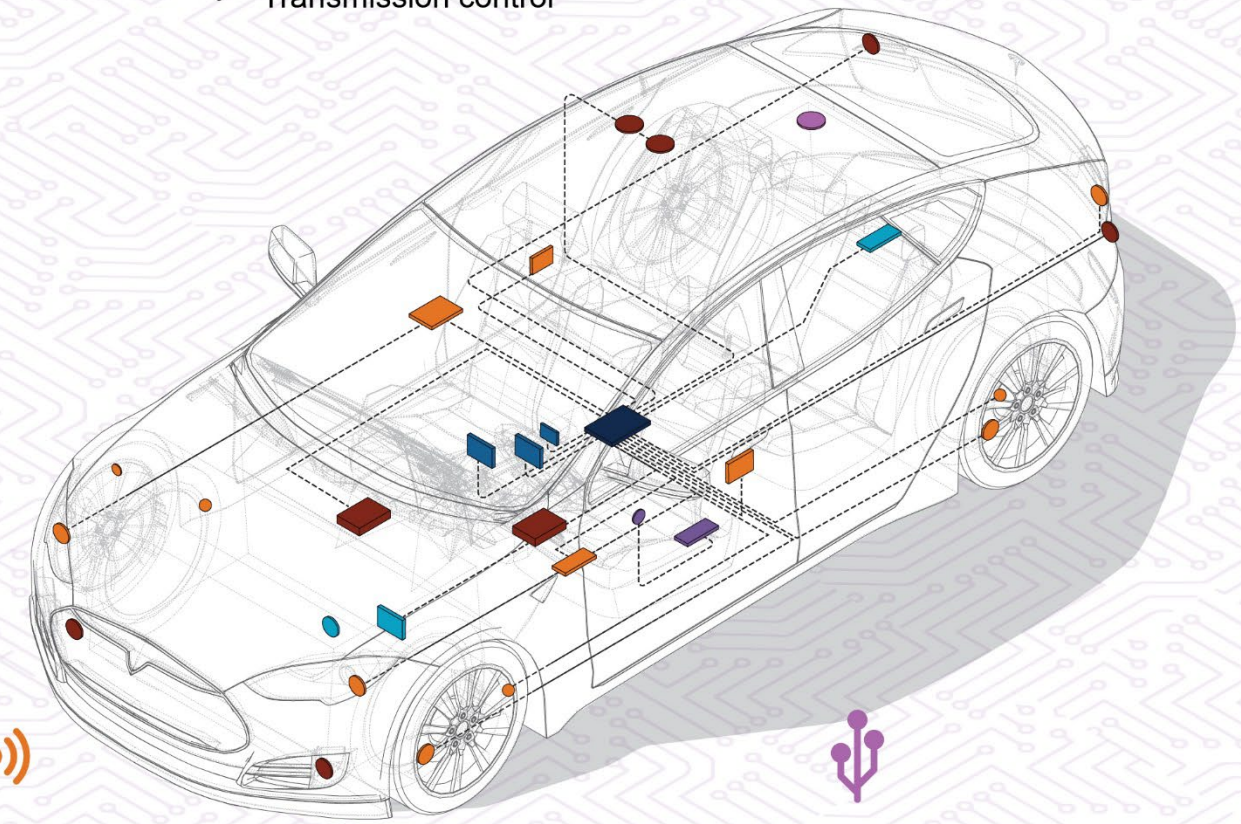
- Engine control
- Fuel injection system
- Hybrid electric control
- Transmission control

Electrical

- Starter
- Lighting system
- Vehicle diagnostics

Infotainment

- Audio/video
- Driver display
- Navigation



Comfort

- Window/mirror controls
- Seat controls
- Climate control

Safety

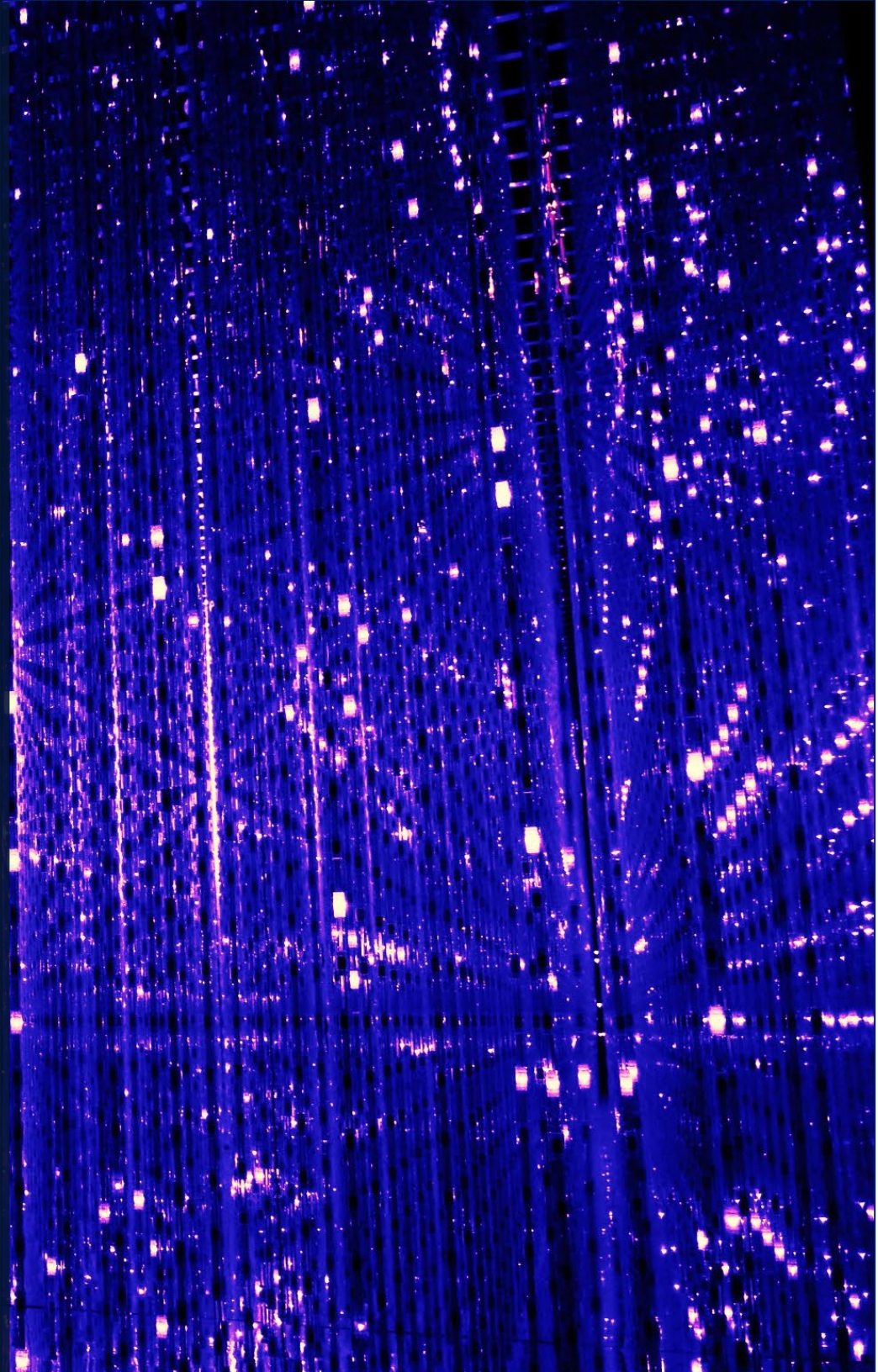
- Airbag controls
- Collision avoidance
- Parking assistance system
- Power locks
- Braking assistance system
- Tire pressure monitoring
- Traction control system

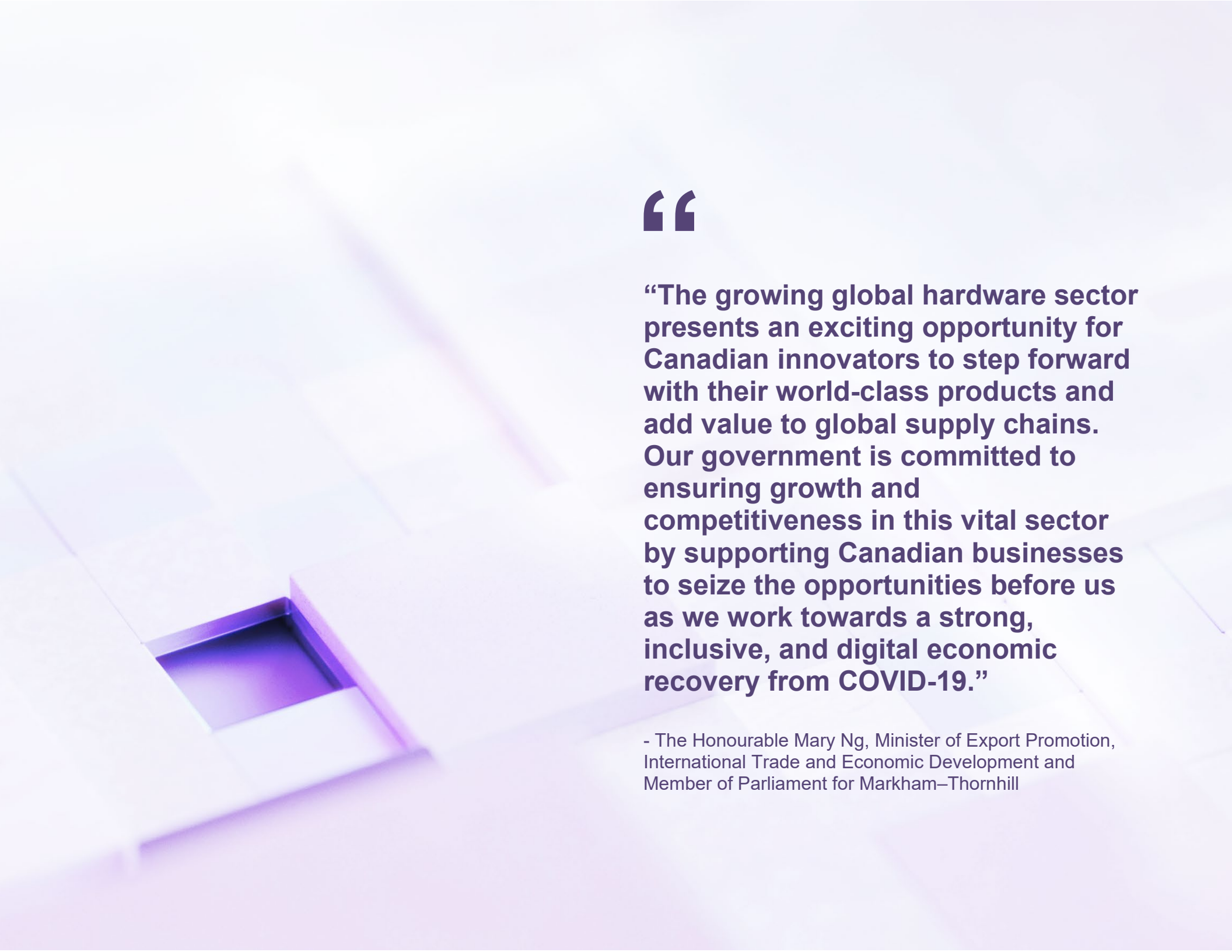
Connectivity

- Controller Area Network (CAN)
- Broadband, Wifi,
- Bluetooth
- Over-the-air software updates

Global Trends in the Semiconductor Sector

As the clean energy transition progresses, demand for semiconductors is forecasted to increase significantly due to their wide-ranging application in EVs, advanced automotive technologies, mobility solutions, and electrical components for renewable energy. In this context, several overarching trends, which are detailed below, are shaping the future of the semiconductor sector.





“The growing global hardware sector presents an exciting opportunity for Canadian innovators to step forward with their world-class products and add value to global supply chains. Our government is committed to ensuring growth and competitiveness in this vital sector by supporting Canadian businesses to seize the opportunities before us as we work towards a strong, inclusive, and digital economic recovery from COVID-19.”

- The Honourable Mary Ng, Minister of Export Promotion, International Trade and Economic Development and Member of Parliament for Markham–Thornhill

Supply chain diversification

The global semiconductor market is forecast to reach USD $1T by 2030, but semiconductor activity is currently highly concentrated in a few countries and companies. This is due to the technically complex nature of chips, and the requirement for high levels of investment in R&D and capital expenditure. This concentration constrains access and reduces resilience. Policymakers across the world are taking action to make their domestic industrial capacity more self sufficient, whilst also recognizing that there will likely always be a need to have some reliance on manufacturing in other countries.

Supply chain complexity

The semiconductor supply chain is highly complex, with a wide range of industries dependent on production running effectively. It is a global ecosystem, with the components of a chip travelling over 40,000 kilometres before it is even integrated into the final product and crossing international borders 70 times or more before reaching the end consumer. The global nature of the supply chain enables the semiconductor sector to innovate and generate advancements through having access to a diverse talent pool. It also allows for flexibility and adaptability to mitigate against risk, by enabling the sector to react to incidents and challenges in specific locations and shift operations to a different region.

Increasing demand for EVs

It is becoming ever clearer that the future of transport is electric. Semiconductors are a core component of EVs, enabling a multitude of functionalities that would not be possible without them. There is an increasing desire from consumers for more accessible and affordable EVs, as people are becoming more aware of the changes needed to curb climate change.

Transition to a low-emission economy

Semiconductors are at the heart of the transition to clean energy. They are critical for solar energy systems, wind turbines, and other electric equipment used in the renewable energy supply chain. The use of semiconductors in the global renewable energy market is expected to grow with a compound annual growth rate (CAGR) of 8-10% through to 2027.

Skills and employment trends

Semiconductor companies play a vital role in global value chains, and so they need the skills and talent required to continue to innovate and be global players. It is estimated that in excess of an additional 1M skilled workers will be needed in the semiconductor sector globally by 2030.

The journey a semiconductor makes around the world

40K km

Distance a chip travels before it is integrated in the final product.

70+ border crossings

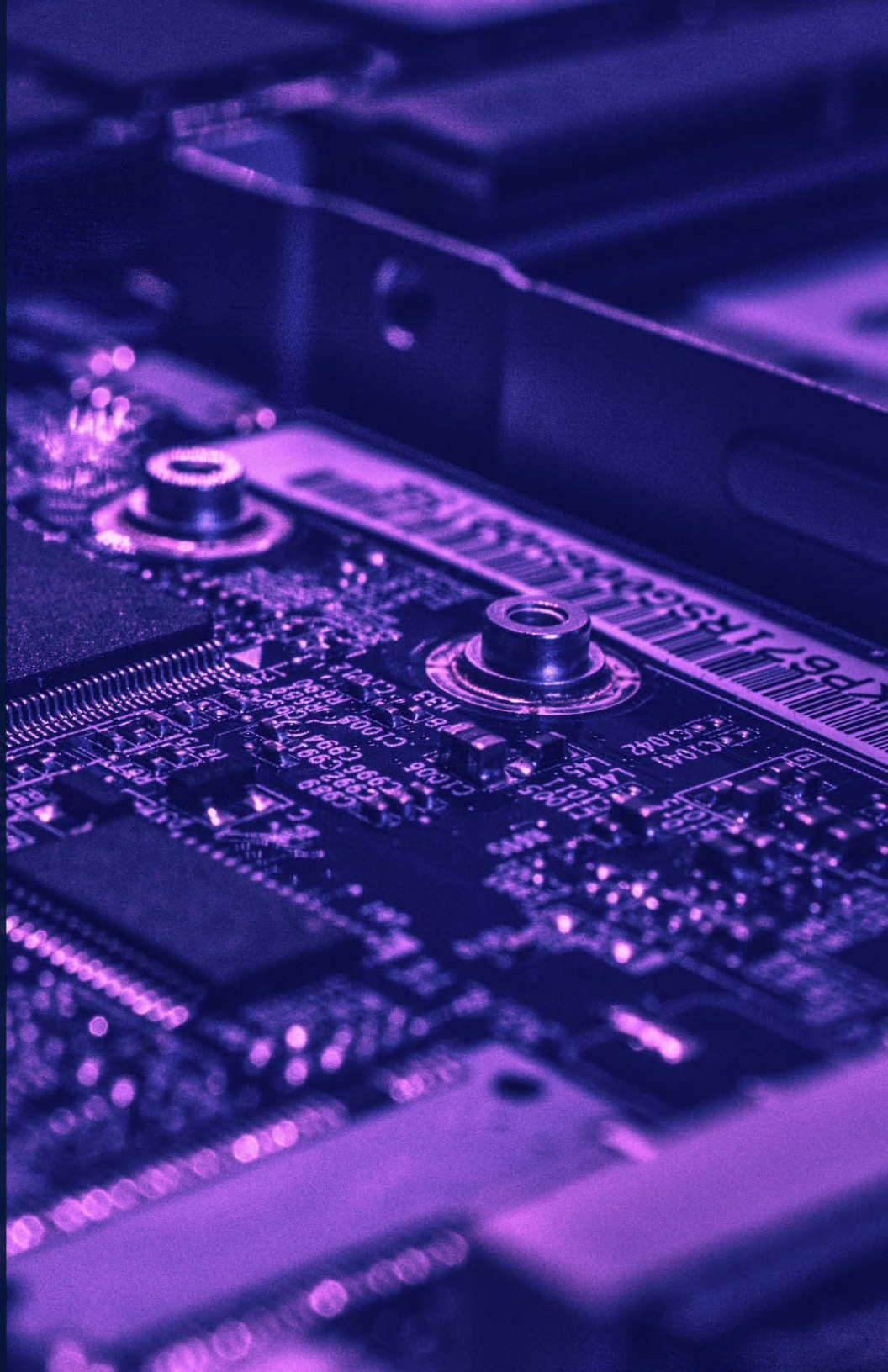
Made by semiconductor components during the manufacturing process before reaching the end consumer.

26 weeks

The lead time for receiving the final product containing a semiconductor from date of placing order.

Ontario’s Unique Position in the Semiconductor Sector

Ontario has the potential to play a key role in the global semiconductor sector. A growing level of influence suggests that Ontario could be at the forefront of semiconductor innovation.



Key facts...

$800M+

The semiconductor sector's contribution to Ontario's GDP in 2022.

$6.96B

The Canadian semiconductor market's forecasted revenue in 2023.

$8.96B

The Canadian semiconductor market's forecasted revenue in 2027.

$1.1B+

The value of Ontario's total semiconductor and other electronic component manufacturing exports in 2022.

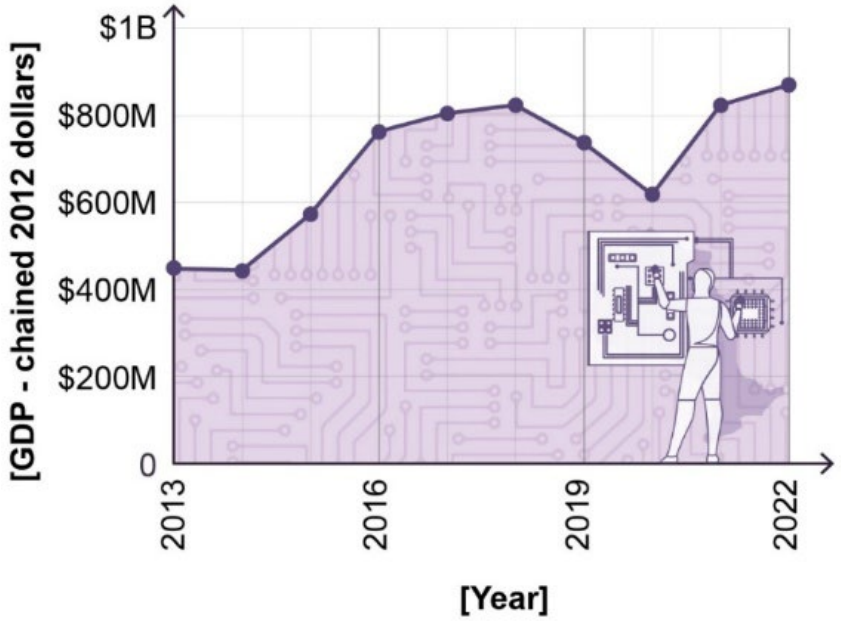
$3.3B+

The value of Ontario's total semiconductor and other electronic component manufacturing imports in 2022.

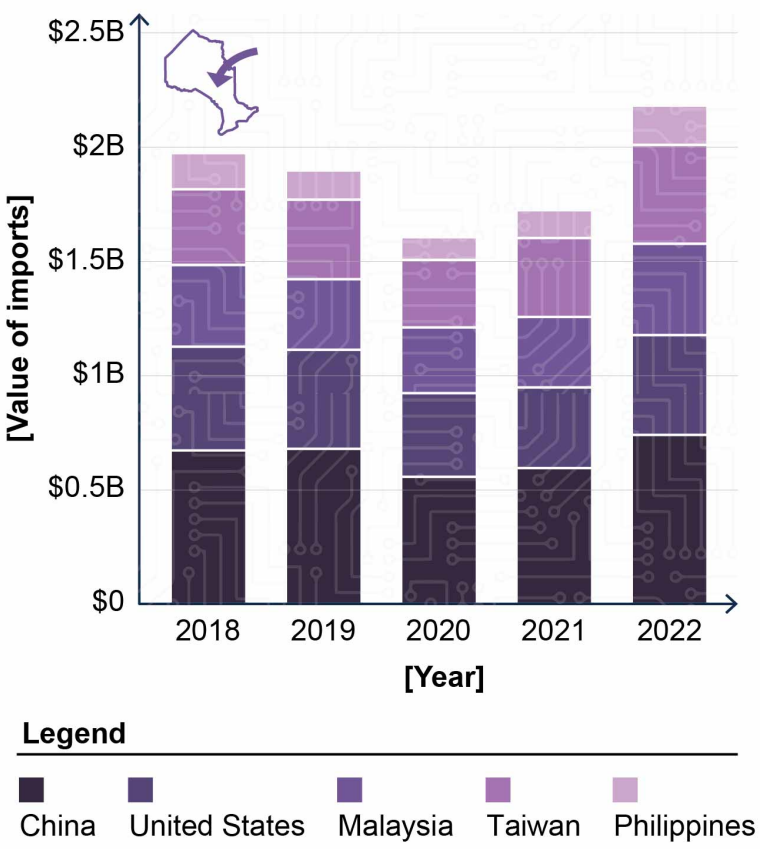
8.5K+

The number of employees working in Ontario's semiconductor and other electronic manufacturing sector in 2022.

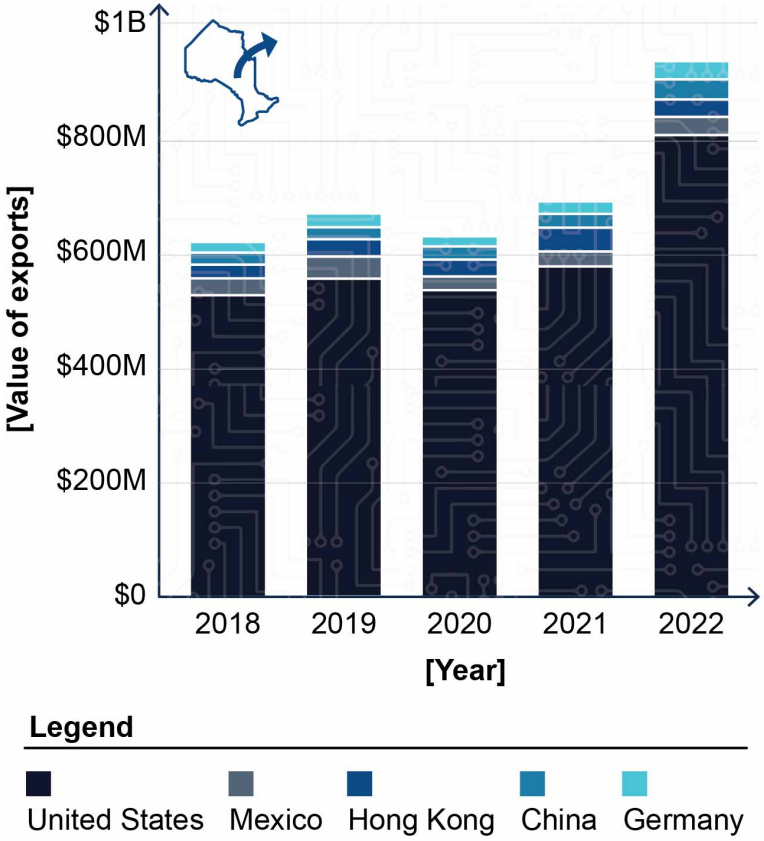
Ontario's GDP from semiconductor and other electronic component manufacturing (NAICS 3344)



Ontario’s imports from top five countries over the last five years in semiconductor and other electronic component manufacturing (NAICS 3344)



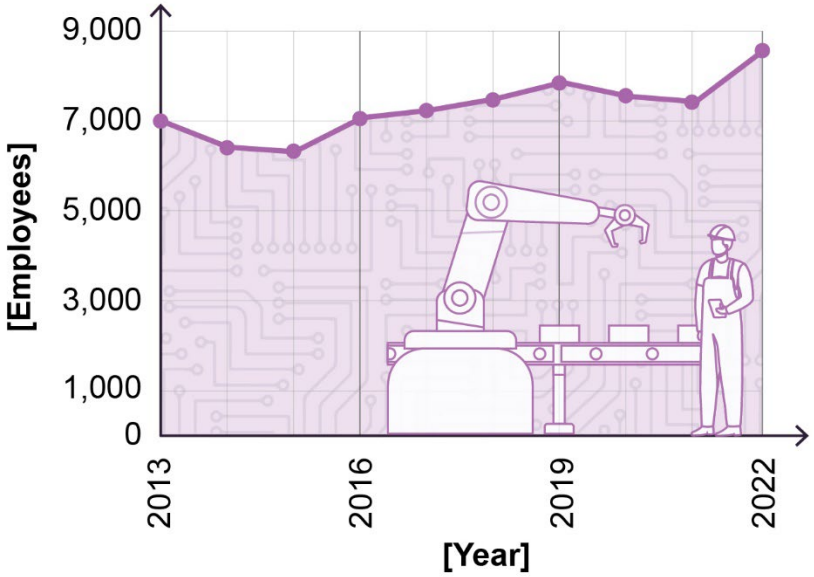
Ontario's exports to top five countries over the last five years in semiconductor and other electronic component manufacturing (NAICS 3344)



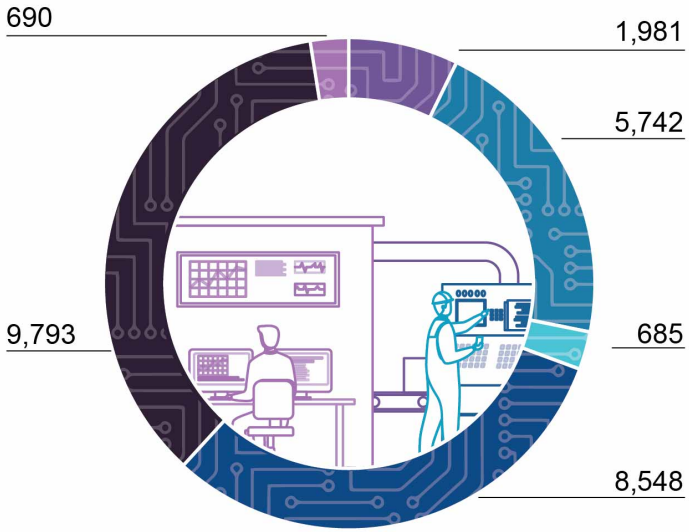
Contribution to employment

In 2022, over 8.5K people were employed in the semiconductor and other electronic component manufacturing sector in Ontario. The number of employees working in the semiconductor manufacturing sector in the province has steadily grown since 2013, with recruitment picking up pace between 2021 and 2022, and showing resilience during the COVID-19 pandemic.

Employment in semiconductor and other electronic component manufacturing (NAICS 3344) in Ontario



2022 breakdown of employment within computer and electronic product manufacturing (NAICS 334) in Ontario

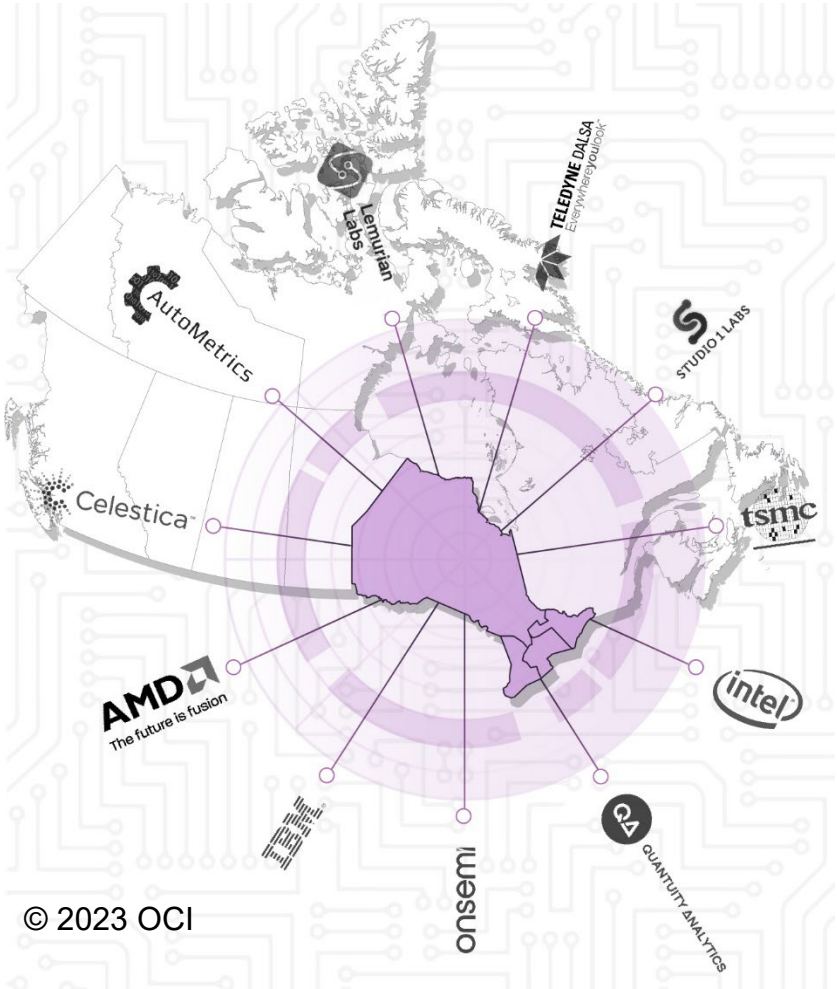


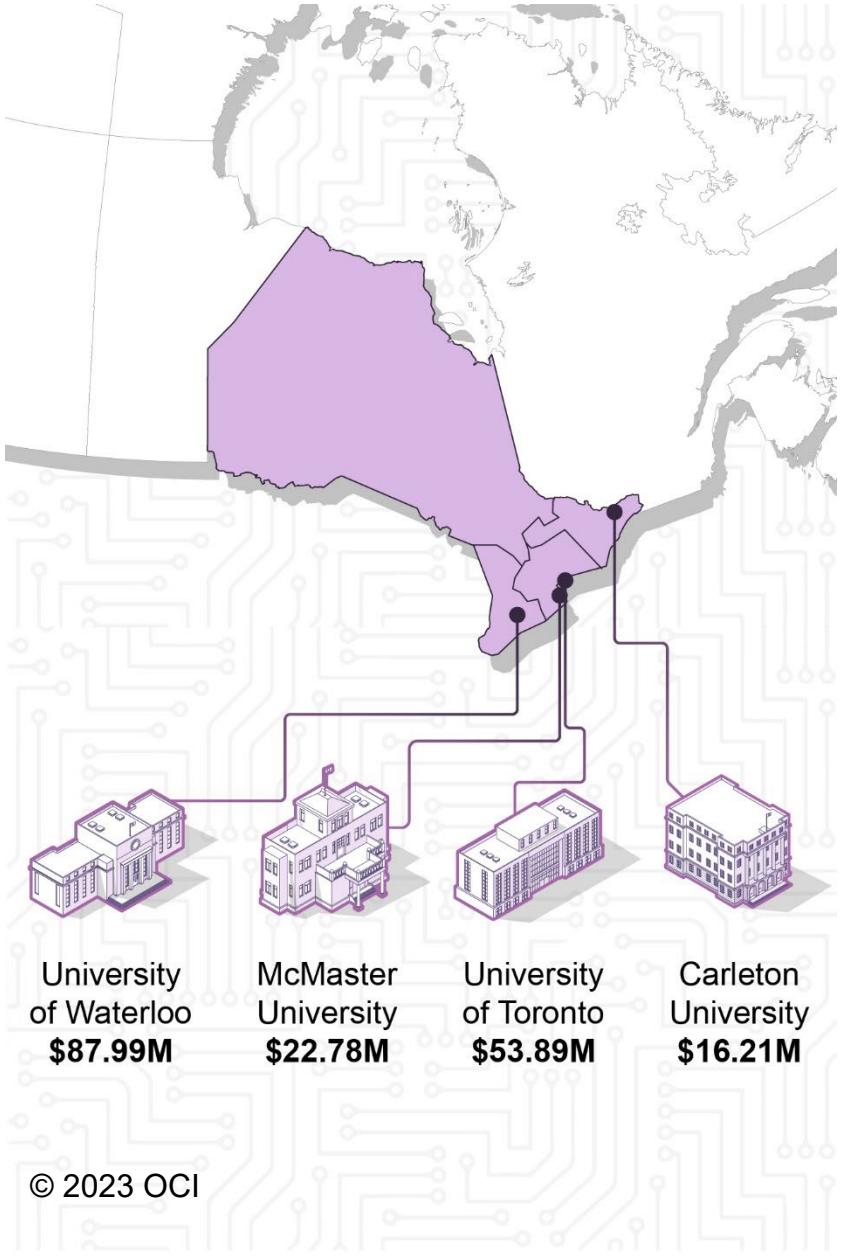
Legend

- Computer and peripheral equipment manufacturing
- Communications equipment manufacturing
- Audio and video equipment manufacturing
- Semiconductor and other electronic component manufacturing
- Navigational, measuring, medical and control instruments manufacturing
- Manufacturing and reproducing magnetic and optical media

Ecosystem players

There are several organizations and facilities based in Ontario that are playing a core role in driving Canada's semiconductor sector. These include industry organizations, design centres, research institutions, and manufacturing companies.





Regulatory and policy framework

Canada is seen as a desirable place for doing business, having been ranked among the top three countries in the G20 – the primary forum for international economic cooperation among the world's leading developed and emerging economies – in the last five years, and the easiest place to start a business in the G20. It also has strong foreign trade relationships, providing semiconductor manufacturers and designers preferential market access via 15 free trade agreements to 51 countries.

Furthermore, Canada was the first country in the G20 to become a tariff-free zone for manufacturers, with the federal government eliminating over 1,500 tariffs on manufacturing inputs, machinery, and equipment.

In addition to the nationwide trade agreements and tariff regime, Ontario has a general "open for business" attitude. It provides further support for businesses located in the province, by providing electricity to manufacturing companies at reduced costs through the Northern Energy Advantage Program (NEAP) and the Comprehensive Electricity Plan.

Key facts…

100+

The number of national and multinational companies conducting research and development on chips in Canada.

$150M

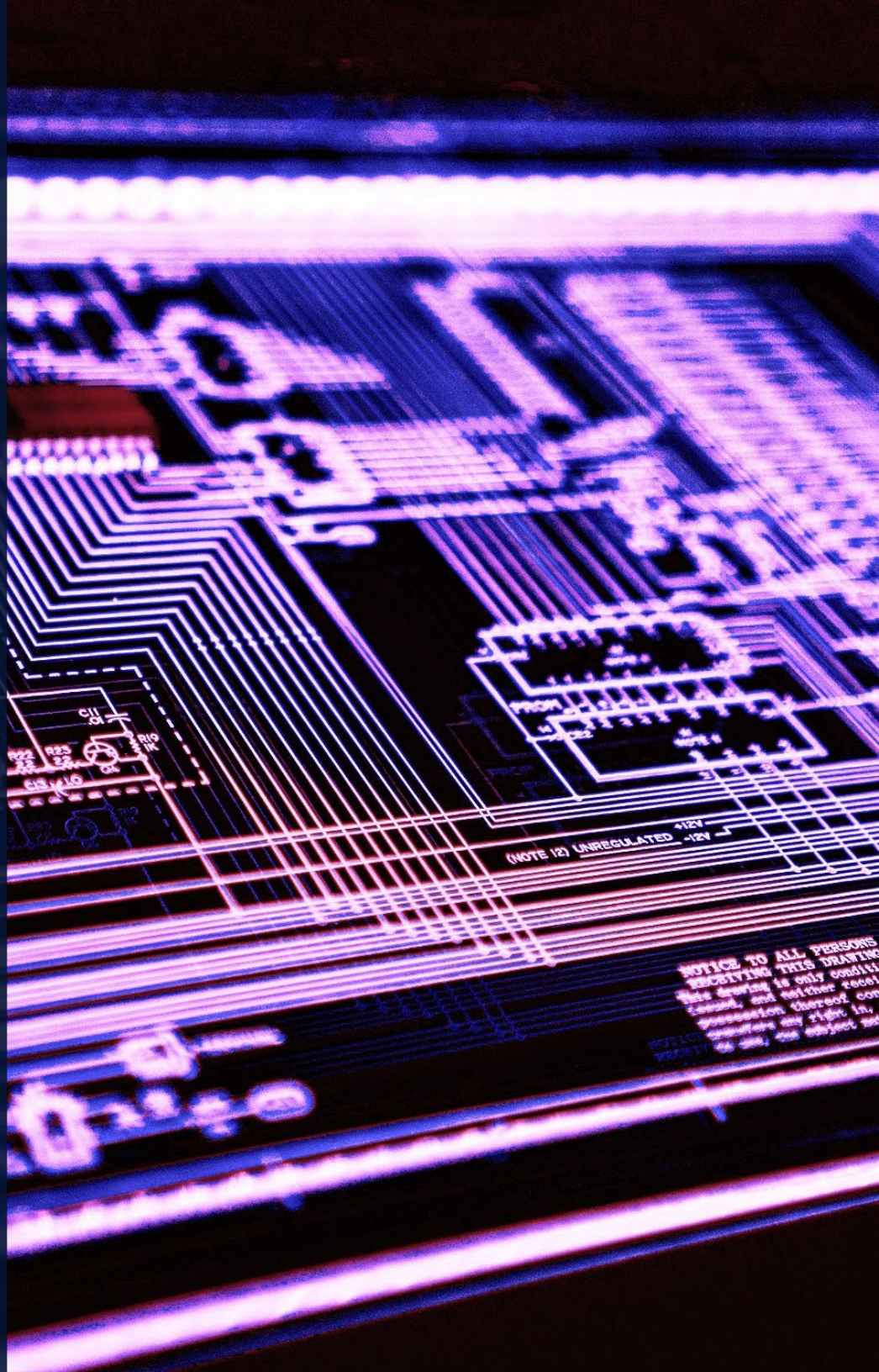
Value of funding provided by the Government of Canada through the Semiconductor Challenge Callout.

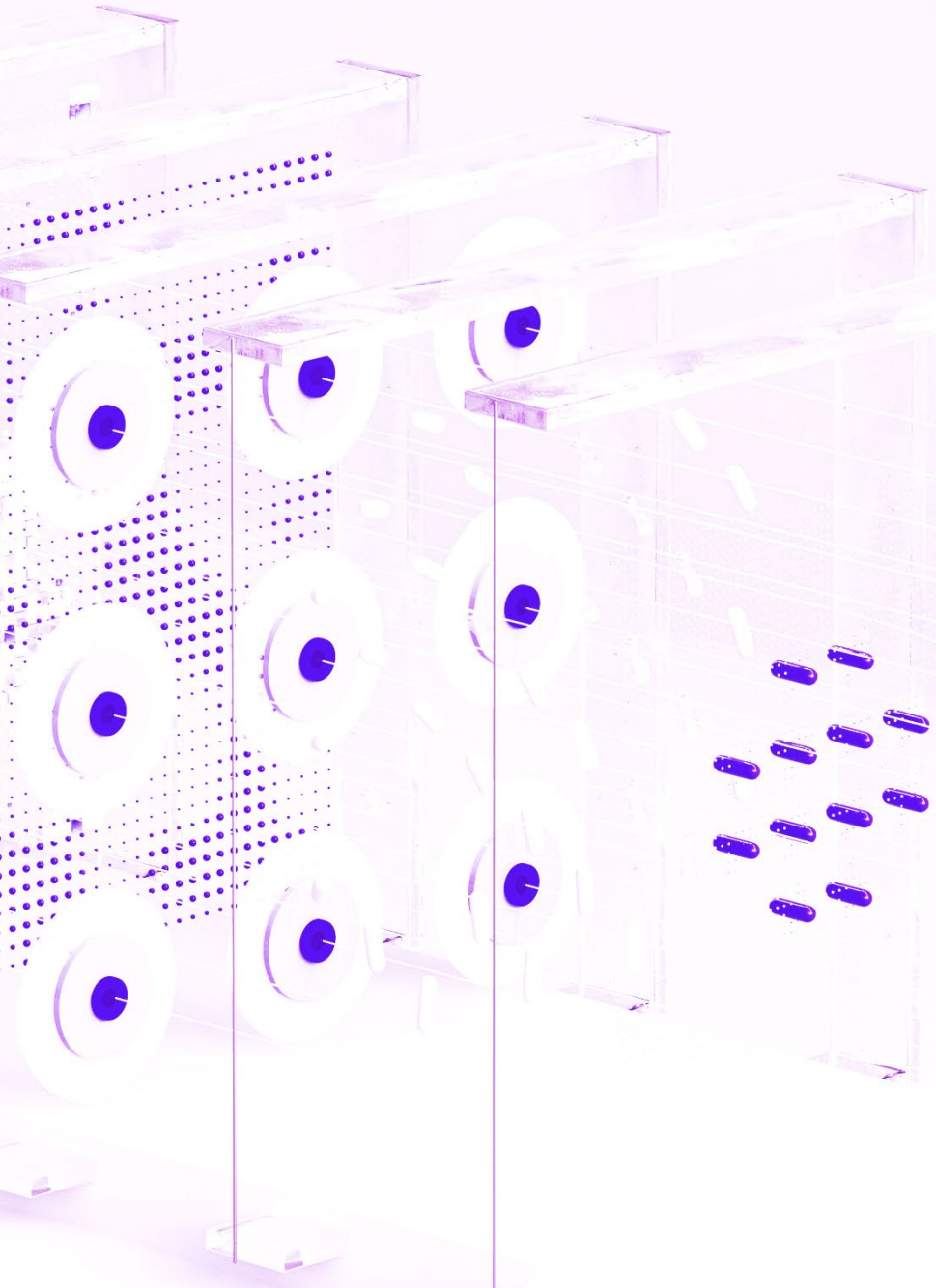
2,000+

The number of tech ventures supported by ventureLAB.

Opportunities for Ontario in the Semiconductor Ecosystem

As demand for semiconductors expands, global market resiliency is becoming increasingly important. The sector faces challenges related to climate impacts and the need to transition to a low-emission economy, along with a growing need for skilled workers, and supply chain diversity. Ontario is well-positioned to leverage its existing strengths not only to support sector stability and resiliency, but also to foster and secure its own position as a key player in the end-to-end semiconductor lifecycle.





“Semiconductors are part of our everyday life. They are in our phones, our cars and our appliances...Canada will continue to play a leading role in the rapidly growing semiconductor industry, helping to strengthen and secure the North American supply chain.”

- The Honourable François-Philippe Champagne, Minister of Innovation, Science and Industry

Expand semiconductor research and design programs

Building on Ontario's central role in taking research and early-stage design to the commercialization stage, there is a key opportunity to further expand assets such as the Hardware Catalyst Initiative. This will help promote Ontario as a nucleus for acceleration of the semiconductor sector.

Continue to invest in the talent pipeline

There is an opportunity to ensure that the specialized skills required for designing and manufacturing semiconductors are developed and retained in Ontario. The semiconductor sector should be seen as an attractive choice for students and workers. This can be done through investment in scholarships, internships, and apprenticeships right across the semiconductor lifecycle, from research and design, to fabrication plant construction and maintenance, to packaging and assembly.

Ontario as a source of raw materials

Ontario has a thriving mining industry, with 35 active mining operations producing $13.5B worth of materials in 2022. Gallium and germanium, key materials in the manufacture of semiconductors, have exploration potential in Ontario but are not currently produced here. Building on Ontario's reputation as one of the top jurisdictions in the world for mineral exploration spending, with $989M invested in 2022, there is an opportunity to concentrate research and exploration on the potential of Ontario as a source for gallium and germanium.

Beyond the raw materials needed to create the silicon wafers, there is also an opportunity for Ontario to explore its supply of high purity chemicals and the materials required for other key stages in the semiconductor manufacturing lifecycle, such as lithography, cleaning, or etching.

Invest in technological advancement

Ontario has a robust automotive industry, which has been built on a strong foundation of research and development. Multiple research centres, development sites, and innovation networks are situated in the province, supporting innovation and the commercialization of new technologies, particularly within the EV sphere.

Developing robust and resilient domestic supply chains in these areas can be supported by the province through its proven expertise in research. Increasing investment in research and development of technologies in the province will solidify Ontario's role as an advanced manufacturing hub and encourage talent development.

Facilitate the transition to a low-emission economy

Ontario is already recognised as a clean manufacturing hub, through the implementation of the province's Low Carbon Hydrogen Strategy and the Hydrogen Innovation Fund, which was announced in March 2023. It also has the largest cleantech industry in Canada, with major innovative advances taking place in the province. Ontario is therefore well-placed to lead the way in exploring options to reduce the impact of semiconductor manufacturing.

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

Meet the OVIN Team

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Disclaimers

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 August 25, 2023, 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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