

AUTOMOTIVE INDUSTRY LABOUR MARKET ANALYSIS

REGIONAL AUTOMOTIVE TECHNOLOGY CLUSTERS: MONTREAL CLUSTER



The project is a collaboration of the Canadian Skills Training and Employment Coalition, Prism Economics and Analysis, and the Automotive Policy Research Centre.

THIS PAPER was prepared for the Auto Labour Market Information (LMI) Project, now known as the Future of *Canadian Automotive Labourforce (FOCAL) Initiative*.

The goal of the project is to help stakeholders better understand the automotive labour market. The Project will create industry-validated, regional, occupational supply and demand analyses and forecasts and skill profiles for skilled trades and other key skilled occupations in the broader automotive sector including vehicle assemblers, parts manufacturers and technology companies that supply the industry. The project will also examine various labour market trends in the sector and facilitate discussions among stakeholders about how to address any forecasted skills shortages and other labour market challenges. The planned outcome of the project is enhanced regional labour market information that will support colleges, employers, policy makers and other stakeholders in taking practical steps to address skills shortages and other labour market challenges in the automotive sector.

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INTRODUCTION

In this series of reports, we observe the contributions of Canada's six automotive technology clusters located in Vancouver, the Greater Toronto and Hamilton Area (GTHA), Kitchener-Waterloo-Cambridge (KWC), Windsor, Ottawa and the Greater Montreal Area (GMA). In doing so, we shed light on each regional cluster's domains of technological expertise, its employment and skills distribution, and the factors that sustain its development. Moreover, we examine the pivotal role played by Canada's automotive technology clusters in the advancement of the country's broader automotive sector through their contributions to its manufacturing capability, development of new product technologies and enhancements to product quality.

This report focuses on the automotive technology cluster located in the GMA. It examines the distribution of automotive technology companies and organizations in the region, highlighting the cluster's domains of technology focus. Furthermore, using the APRC's¹ comprehensive automotive database and through an establishment-level approach, it maps the regional distribution of employees and individuals that are engaged in advanced automotive technology manufacturing and research & development (R&D) activities. It sheds light on the concentration of labour and skills in specific technology fields within the cluster. Finally, through a survey of occupational profiles within selected companies, this report provides details on the occupations and skill streams that are in most demand in the local labour market.

In performing the profiling and occupation analysis, we refer to FOCAL's "Canada's Automotive Technology Clusters: Labour Market Characteristics and Regional Specializations" report. That report outlines the full spectrum of current trends shaping innovation in the automotive industry and provides details on the ten main domains of technological progress in the sector. Those ten automotive technology domains include: (1) Autonomous Vehicle (AV) Technologies, (2) Connected Vehicle Technologies, (3) Artificial Intelligence & Machine Learning (AI & ML), (4) Materials & Light Weighting, (5) Battery Electric & Hybrid Vehicle Technologies, (6) Hydrogen Fuel Cell (HFC) Technologies, (7) Internal Combustion Engine (ICE) Powertrain Technologies, (8) Production Technologies, (9) Vehicle Safety & Security and (10) Other Software & Electronics.

¹ APRC: Automotive Policy Research Centre

Additionally, FOCAL's report "Canada's Automotive Technology Clusters: Labour Market Characteristics and Regional Specializations" sets out the methodology that we used to identify and profile each cluster. It also provides details on the 18 automotive highly skilled occupations which are selected to examine the occupational distribution in the clusters.

BACKGROUND ON THE MONTREAL TECHNOLOGY CLUSTER

In recent years, the GMA has emerged as an important Canadian automotive technology cluster. It is home to numerous companies and organizations with expertise in big data, artificial intelligence (AI), and clean vehicle technologies. In addition, the region has a long history of traditional automobile and heavy-duty vehicle (HDV) manufacturing. It previously hosted a General Motors (GM) plant, which assembled the company's Chevrolet and Pontiac vehicles. Although that facility closed in 2002, the GMA maintains several HDV assembly plants, including Nova Bus (Volvo Group), PACCAR and Lion Electric. Those HDV assembly facilities have served to attract numerous part suppliers and tool, die and mould making (TDMM) companies to the region.

The GMA is also home to a well-developed and growing EV industry. The sector benefits from several competitive advantages, including Hydro-Quebec's direct support for developing clean technologies, numerous provincial policies that incentivize EV purchases, the recent establishment of a Zero Emission Vehicle (ZEV) credit system in Quebec, and the development of electric HDVs in the region (Propulsion Quebec, 2020). Prominent EV companies in the GMA include Dana TM4, Blue Solutions and C-MAC Electronic Solutions. Dana TM4 designs and manufactures low- and high-voltage electric powertrain components and was formed through a joint venture between Dana Holding Corporation and Hydro-Quebec (Dana, 2019).² Blue Solutions develops and manufactures high-tech battery solutions and modules in its Sherbrooke facility. Finally, C-MAC Electronic Solutions designs and manufactures electric motor controls and power steering circuit boards.

Regional innovation support is provided by the Centre of Excellence in Transportation Electrification and Energy Storage. A part of Hydro-Quebec's "Institut de recherche d'Hydro-Québec," the centre is a leader in battery materials research in the GMA. The centre holds

² Dana also acquired Nordresa Motors in 2019, which develops and manufactures electric drivetrains for vans and trucks.

over 800 technology patents and maintains numerous research partnerships (Hydro-Quebec, 2018). The region is also home to several organizations and partnerships that promote alternative propulsion technologies, such as Propulsion Quebec.

In addition to its emerging EV industry, the GMA is home to the world's highest concentration of researchers and students studying artificial intelligence (AI) and deep learning (Invest Canada, 2019). AI and deep learning are critical for the development of connected and autonomous vehicle (CAV) technologies as well as the production process improvements associated with Industry 4.0 (see FOCAL Initiative, 2019). The GMA's AI and deep learning talent is developed by numerous public research institutions. It is home to 11 higher education institutions, including McGill University, Concordia University and the Université de Montréal. Those institutions host several automotive research labs such as McGill University's Automotive Materials Research and Additive Design and Manufacturing labs and Concordia University's Security Research Centre and Networked Autonomous Vehicles (NAV) Lab.

The region's AI cluster is supported by the Canada First Research Excellence Fund (\$93.5M) and federal funding for the Pan-Canadian Artificial Intelligence Strategy (\$40M). It is also supported by the Government of Quebec's investment of \$100M between 2018 and 2023 for the creation of a Québec AI cluster. In 2019, the GMA was selected as the headquarter location for the federal government's AI supercluster (SCALE.AI), receiving funding under the Canadian Innovation Supercluster Initiative (ISI). Those public expenditures, coupled with the presence of AI and deep learning talent in the GMA region, have attracted recent investments from several prominent global AI companies and organizations. For example, Cerence, a global supplier of automotive AI technologies, is developing accurate voice recognition technologies and conversational AI for vehicles at its Montreal R&D office. Samasource also maintains an office in the area, which develops object identification and navigational AI solutions. Additionally, DENSO joined the GMA's AI cluster with its establishment of an AI Innovation Lab.

Further to the above listed companies, the GMA has attracted significant AI investments from international companies such as Google (Google Brain), IBM (DeepMind), Samsung, Facebook, Microsoft (Maluuba) and McKinsey & Company (QuantumBlack). The vast majority of companies in the GMA's AI ecosystem are clustered in an area referred to as the 'Mile-Ex'. Mile-Ex is home to the Montreal Institute for Learning Algorithms (MILA), Borealis AI (Royal Bank of Canada's AI lab), the Institute for Data Valorization (IVADO) and Element AI.

MONTREAL'S CLUSTER PROFILING AND OCCUPATIONAL ANALYSIS

A total of 99 automotive companies and organizations were identified in the GMA. Of those 99 organizations, 59 entities were identified to be engaged in designing or developing the automotive technologies under study. Those 59 organizations included: 37 companies; eight academic labs; five government facilities; and eight partnerships or not-for-profit organizations. In addition, we identified a total of 3,269 employees and other associated individuals in the region's 59 auto-tech organizations.³ This section details the technologies, occupations and skills present in the GMA automotive technology cluster.

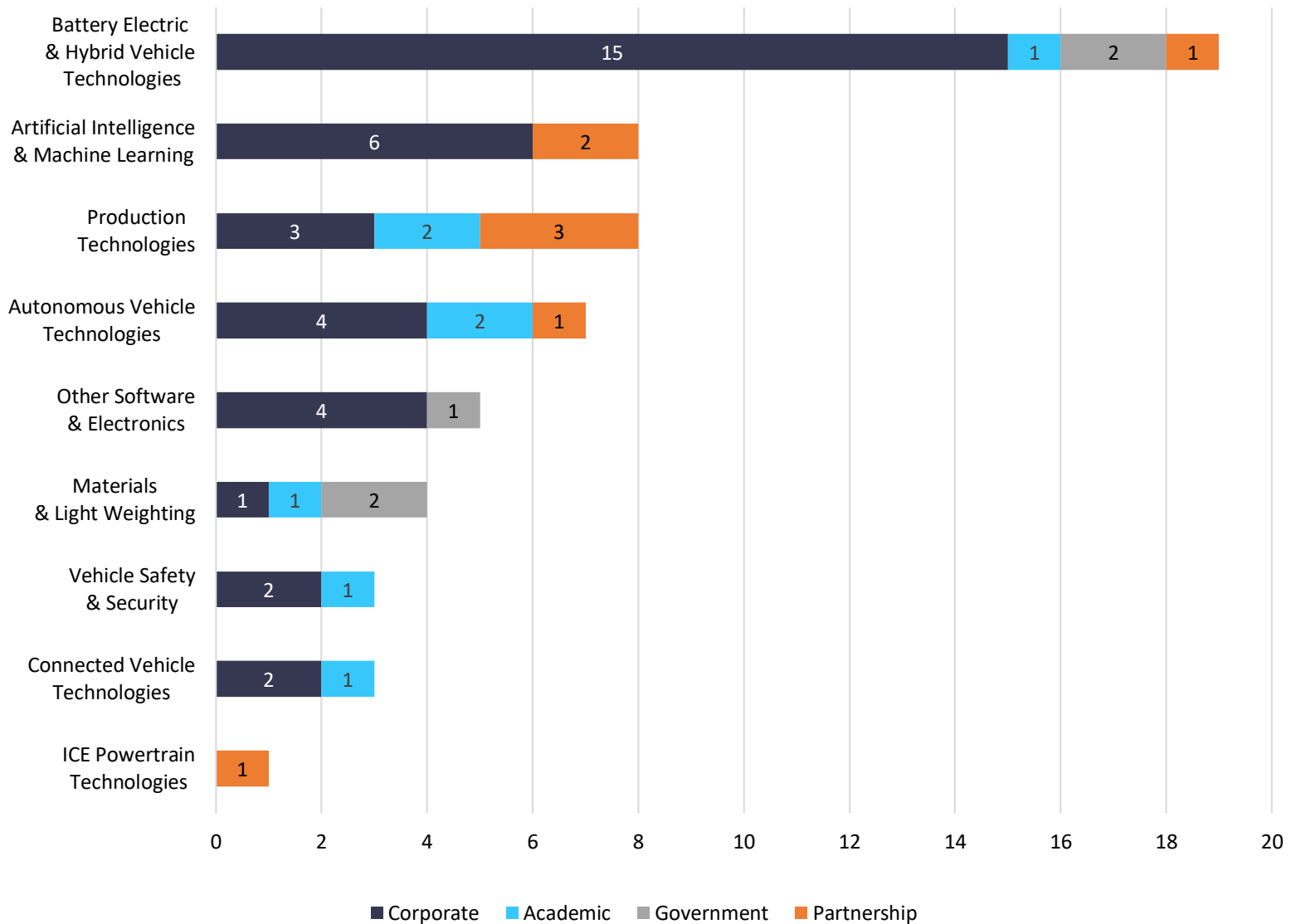
Distribution of Companies and Organizations

As presented in Figure 1, the GMA cluster is home to a wide array of organizations developing new automotive technologies. In fact, with the exception of hydrogen fuel cell technologies, each technology category was represented by at least one organization. With that being said, the cluster does portray several strengths. Of the technologies that were selected for the study, the four most represented technological categories were (1) battery-electric & hybrid vehicle technologies, (2) artificial intelligence & machine learning, (3) production technologies and (4) autonomous vehicle technologies. In numerous respects, this distribution aligns with the background description of the GMA region, in which we identified a strong focus on clean vehicle technologies and AI.

The GMA automotive technology cluster's leading technology focus by organization count was battery-electric & hybrid vehicle technologies. In total, we identified 15 companies, one academic lab, two government facilities and one partnership in the field. Besides companies like TM4, Nordresa, Blue Solutions and C-MAC, we also identified companies involved in raw battery materials (Lithium Ion and Manganese dioxide) such as Johnson Matthey Battery Materials, TORNGAT Metals and Manganese X Energy Corp. Other companies in the field include Calogy Solutions, which optimizes thermal management for vehicle batteries in extreme weather conditions, and OPAL-RT Technologies, which performs numerical simulations to test EV powertrain designs.

³ In this report, 'employees' refers to employees of private companies, as well as professors, researchers and students working in university labs and other research partnerships.

Figure 1. Distribution of automotive-related technology companies and organizations in the Montreal area by technology



The second most common technological category in the region was artificial intelligence and machine learning (8 organizations in total). In this category, we identified 6 companies, including Cerence Montreal R&D Office, Samasource and DENSO’s Montréal Innovation Lab, Stradigi AI, and Capgemini. Organizations and partnerships that we recognized in the AI and machine learning category included Mila - Quebec Artificial Intelligence Institute, a leading partnership in Montreal which recently partnered with Cerence to assist in the development of the AI-powered in-vehicle voice assistance.

We also identified 8 organizations that are developing production technologies in the region. Of those, we recognized 3 companies, including SYNERGX, which develops precision glass

inspection systems, and Blue Yonder, which provides IoT and AI solutions for manufacturing platforms. We also found several partnerships that are active in developing new production technologies, such as the Innovation 4.0 Network Reseau, a partnership between eight Quebec-based universities and colleges designed to accelerate the development of Industry 4.0 manufacturing technologies.

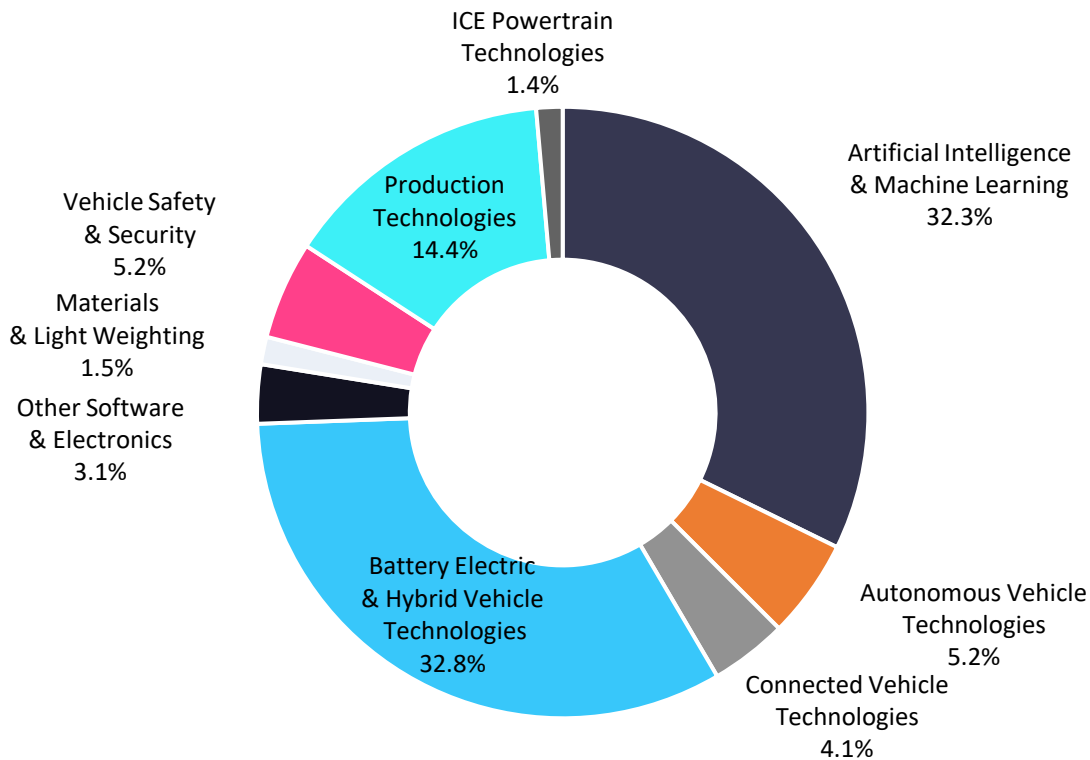
Other prominent technology categories in the region included autonomous vehicle technologies and other software & electronics. Examples of companies developing solutions related to those categories include Algolux, Immervision, Audiokinetic and IRYSTec Software.

Distribution of Employment and Skills

Of the 3,269 employees in the GMA cluster, the majority were employed in the development of battery-electric & hybrid vehicle technologies and artificial intelligence & machine learning technologies. The battery-electric and hybrid vehicle technologies category represented 32.8% of the region's total auto-tech employees, researchers, and experts. Under this group, we identified 1,063 employees engaged in manufacturing or R&D operations related to the development of electric powertrains and electric vehicles. The 15 companies that we identified collectively employ 930 individuals, many of which manufacture parts for electric powertrains or assemble vehicle battery units.

Major EV manufacturing employers include TM4 Electrodynamics Systems, which has 155 employees, Blue Solution, which has more than 125 engineers and technicians, OPAL-RT Technologies, which employs close to 160 electronics and software experts, and C-MAC MicroTechnology in Sherbrooke with close to 170 employees. Beyond those, Johnson Matthey Battery Materials, Effenco and Nordresa Motors collectively employ more than 160 engineers and experts in the EV technologies field. We also identified two government facilities in the region that provide significant employment in the electric & hybrid technology field: Hydro-Quebec's Varennes Research and Testing Laboratories, and the NRC's Pilot-scale Battery Manufacturing Line Facility. When combined, those facilities add more than 80 researchers and experts engaged in the development of electric energy storage technologies to the regional labour market.

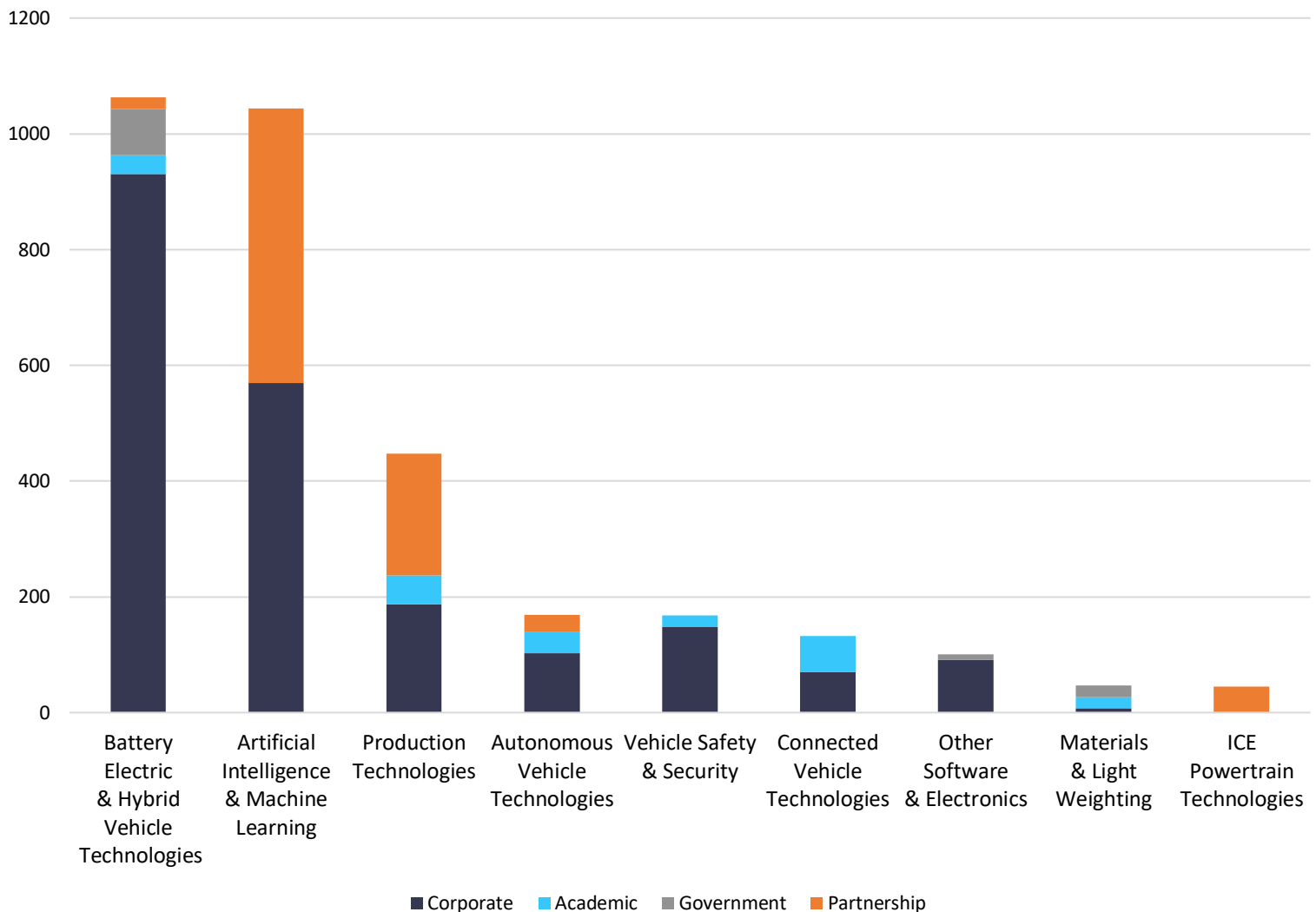
Figure 2. Distribution of employees and individuals (by percentage) associated with automotive activities by technology in the Montreal cluster



A significant number of employees in the region are engaged in developing artificial intelligence & machine learning solutions. In total, we identified 1,044 employees and experts in the field (32.3% of the total new automotive technology workers in the GMA). Those included 569 employees at six companies and 475 researchers and experts working under two partnerships. We identified Cerence to be the most prominent automotive AI employer in the region, with nearly 230 employees. Other major employers in the AI field include Capgemini and Stradigi AI, where we counted more than 120 software designers and developers. The remaining 78 individuals under this category are employed at Ingtech, Samasource and DENSO’s Montreal Innovation Lab. Among the AI partnerships in the Montreal area (such as Mila’s Quebec Artificial Intelligence Institute) we counted more than 450 researchers and experts engaged in developing AI solutions.

Finally, we found that 14.4% of workers in the region are engaged in developing new production technologies. Significant employers in that category include SYNERGX Technologies Inc., INO and Pyrogenesis, which collectively employ more than 300 personnel.

Figure 3. Distribution of employees and individuals associated with automotive activities by technology in the Montreal cluster



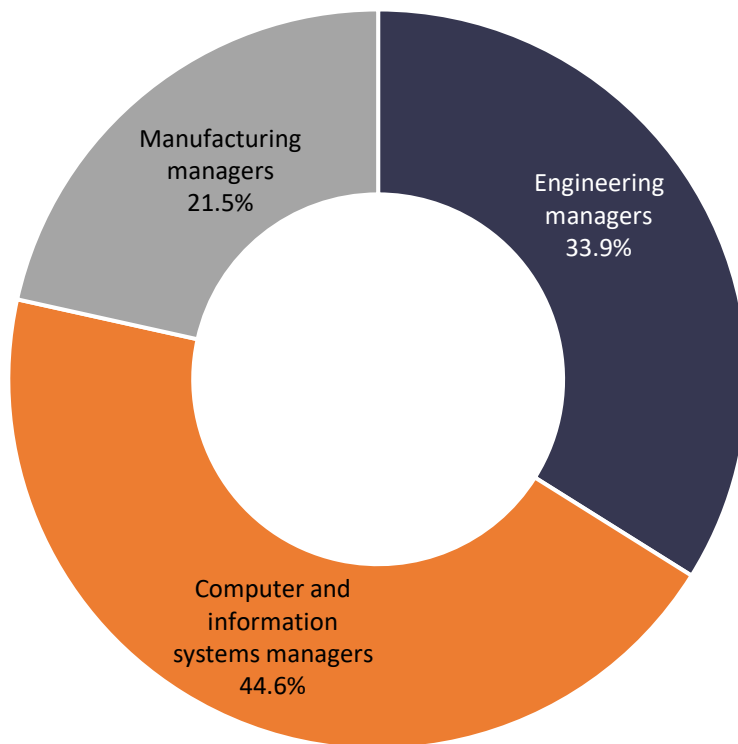
Occupational Distribution

Our occupational distribution analysis reviewed 1,023 employee profiles out of the total 2,105 employees associated with the 37 automotive technology companies in the GMA. Of those 1,023 profiles, we identified a total of 644 profiles relevant to the 18 highly skilled occupations selected for this study. The analysis highlighted a mix of talent and skills in electrical and electronics engineering, software engineering, and computer programming. This section reviews the distribution of occupations in three categories: management, engineering, and engineering technicians and technologists.

Management Occupations

Under the management occupational group, “Computer and information systems managers” represented 44.4% of the automotive-related management occupations. “Engineering managers” accounted for 34% of the sample, and “Manufacturing managers” accounted for the remaining 21.6% of the profiles that we reviewed (Figure 4). The majority of the “Computer and information systems managers” were found in companies under the artificial intelligence & machine learning technology category. Conversely, “Engineering managers” and “Manufacturing managers” were present in companies developing and manufacturing electric powertrain solutions.

Figure 4. Occupational distribution for management occupations in the automotive technology companies of Montreal

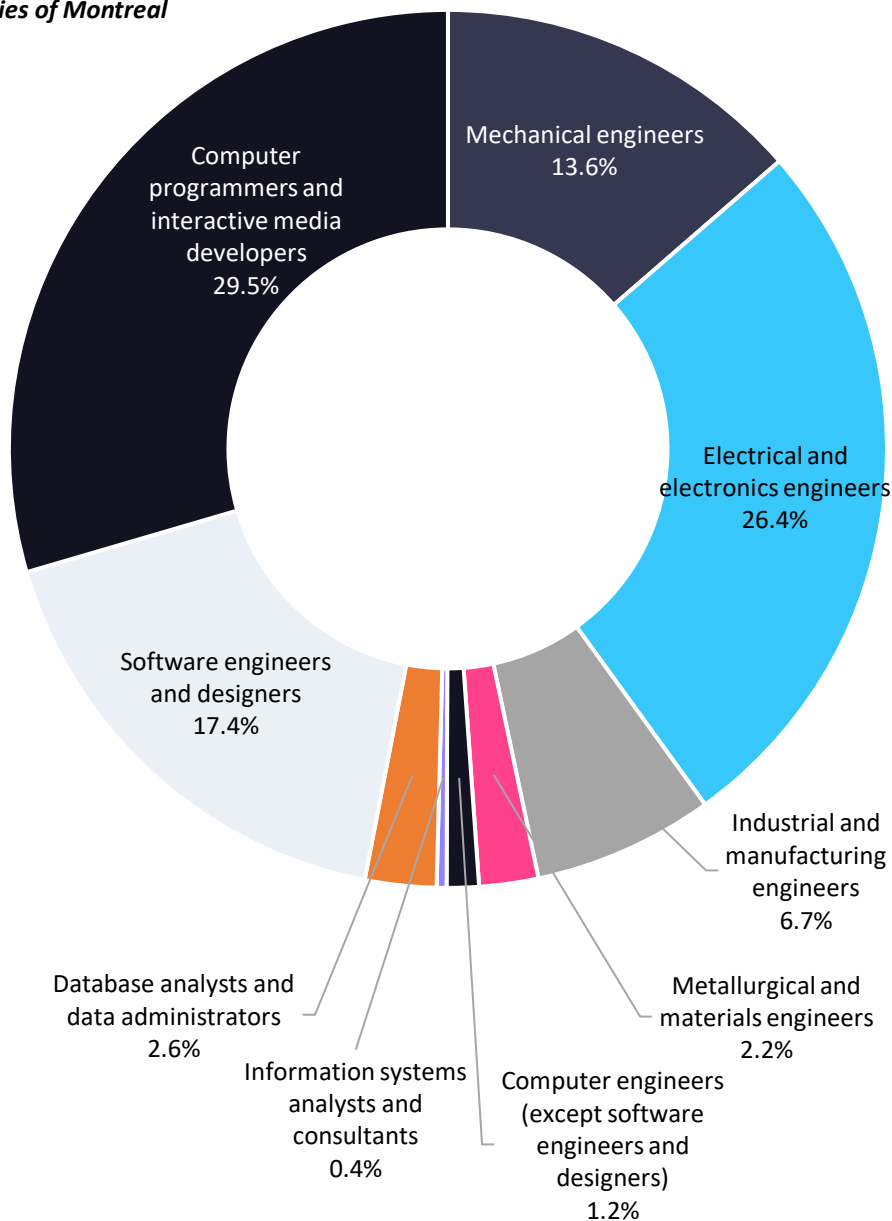


Engineering Occupations

Our analysis of engineering occupations in the region revealed two distinct specializations: those relating software development and others focused on hardware manufacturing and activities (figure 5). Within the software-related occupations, “Computer programmers and interactive media developers” represented 29.5% of the total engineering-related occupations that we sampled. In comparison, “Software engineers and designers” accounted for 17.4% of

the engineering-related occupations. Within the hardware-related engineering occupations, “Electrical and electronics engineers” and “Mechanical engineers” represented 26.4% and 13.6% of the sample, respectively. Industrial and manufacturing engineers accounted for an additional 6.7% of the total surveyed engineering occupations.

Figure 5. Occupational distribution for engineering occupations in the automotive technology companies of Montreal



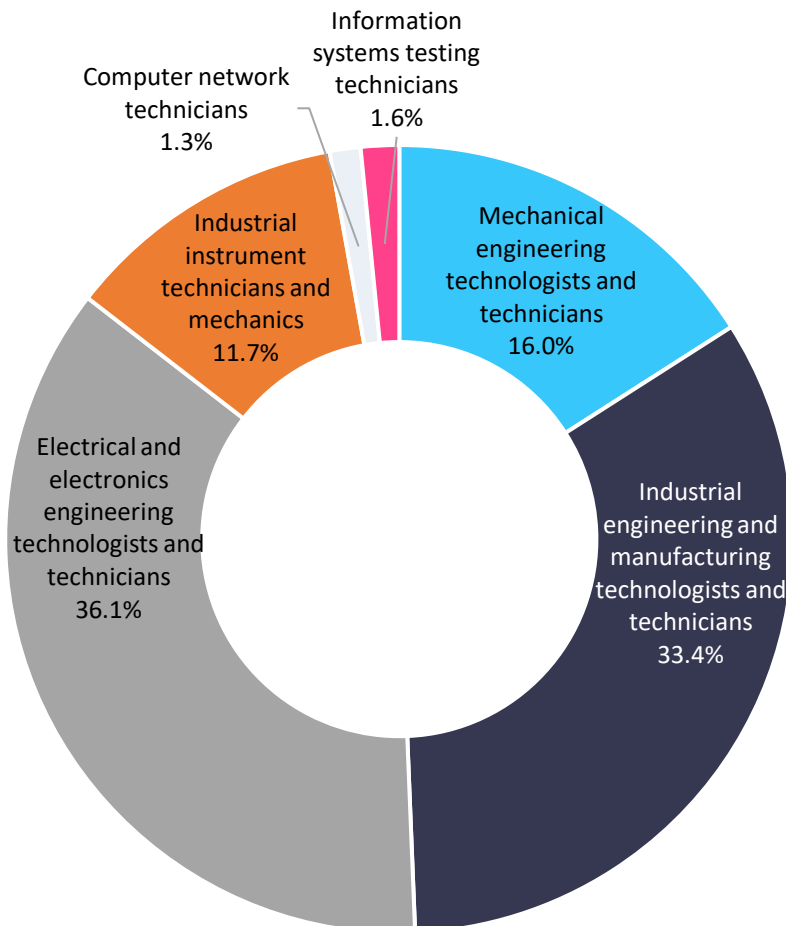
The GMA’s balance between the software engineering and the hardware engineering streams can be justified by the abundance of artificial intelligence, EV, and new production companies in the region. Our analysis of the employee profiles demonstrated that while AI companies primarily employ software engineers and programmers, EV and production technology

companies employ a broader range of staff in hardware and software-oriented engineering streams. In our analysis, most EV companies (e.g. Blue Solutions, Nordresa Motors and OPAL-RT Technologies) in the region perform both manufacturing and R&D operations relating to the development of electrified vehicle components.

Engineering Technologists and Technicians Occupations

The majority of the engineering technologist and technician profiles were found to be associated with companies performing manufacturing operations rather than software development. Of the engineering technologists and technicians occupations in our sample, the top three technical occupations included “Electrical and electronics engineering technologists and technicians” (36.1%), “Industrial engineering and manufacturing technologists and technicians” (33.4%), and “Mechanical engineering technologists and technicians” (16%) (figure 6). All three occupations contribute to automotive technology manufacturing processes, particularly in the development of electric vehicle technologies.

Figure 6. Occupational distribution for engineering technologist and technician occupations in the automotive technology companies of Montreal



HIGHLIGHTS AND CONCLUDING REMARKS ON THE MONTREAL CLUSTER

The preceding analysis demonstrated that the GMA automotive technology cluster specializes in designing and developing two main automotive technologies: battery electric & hybrid vehicle technologies and artificial intelligence & machine learning technologies. As we previously identified, the GMA's battery electric & hybrid vehicle technologies industry benefits from several competitive advantages. Those include the presence of established bus and truck assemblers in the region, growth in the electrified heavy-duty vehicle (HDV) market, the provincial government's active role in incentivizing clean vehicle technologies, and Hydro-Quebec's efforts to encourage EV development.

Additionally, our analysis demonstrated that the region specializes in AI, deep and machine learning. Several companies in Montreal's artificial intelligence cluster are targeting the automotive industry as a potential market for their solutions. Moreover, organizations such as MILA - Quebec Artificial Intelligence Institute contribute research in artificial intelligence, while also establishing industry partnerships that accelerate automotive AI technology development. DENSO's establishment of an office in the Montreal AI cluster for developing automotive AI technologies signifies that established automotive manufacturers also identify a business case for AI in their operations.

The GMA's specialization in EV and AI was reflected in our employment and occupation analysis. The region is home to both hardware and software-oriented skills and expertise. As we identified, mechanical, electrical and electronics engineers, and engineering technologists are essential workers for companies developing hardware technologies relating to electric vehicles, autonomous electronic components, and manufacturing technologies. Industrial and manufacturing engineers and engineering technologists are critical for manufacturing-related operations of EV components and automotive production technologies. Finally, software engineers, designers and programmers are crucial for AI technology development companies and other software systems or platforms relating to electric vehicles, production technologies, and autonomous vehicle technologies.

In conclusion, the GMA automotive technology cluster excels in the research, design, testing and manufacturing of two main automotive technologies: battery electric & hybrid vehicle technologies and artificial intelligence & machine learning technologies. Moreover, the cluster

hosts a mix of automotive software and hardware technology skills necessary for the development of various new automotive technology fields. Those factors are contributing to the re-emergence of an automotive cluster in the GMA; one that is increasingly oriented around the development of new vehicle technologies.

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