DRIVING SUSTAINABILITY

In-Demand Jobs and Skills in Canada's Transportation Sector

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Preface

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EXECUTIVE SUMMARY

Canada's transportation sector is a vital component of the economy and the lives of Canadians; however, it also stands as a major contributor to greenhouse gas emissions, ranking second only to the oil and gas industry. Despite a temporary decline during the COVID-19 pandemic, emissions from transportation have been steadily increasing over the years. To meet its commitments under the Paris Agreement, Canada aims to reduce emissions by 40 to 45% below 2005 levels by 2030, necessitating a shift toward cleaner transportation technologies. A decarbonized transportation sector requires a multifaceted approach, focusing on technology, regulations, infrastructure, and workforce development.

To achieve its environmental goals, ground transportation is moving toward environmentally sustainable transportation modes and technologies, including public transportation, active transportation, zero-emissions vehicles (ZEVs), and transportation modes that make use of sustainable synthetic fuels and biofuels. Digital technologies, such as the use of big data, artificial intelligence (AI), and the internet of things (IoT), play a pivotal role in the green transition by optimizing transportation systems to reduce environmental impacts and improve the efficiency of the sector. As a result, transportation professionals must adapt to a rapidly evolving industry that requires new and advanced skills related to the utilization of clean technologies and environmental sustainability.

Employers in the sector reported a high demand for talent but faced challenges in hiring employees with the right mix of skills. For example, over 80% of employers in the transportation infrastructure, electric vehicle (EV) and public transportation industries reported difficulty finding entry-level employees. These challenges may stem from competition for skilled labour between industries, the retirement of senior staff, and issues around attracting and retaining young and diverse talent to the transportation sector. As the sector undergoes a skills and knowledge shift, workforce development challenges can be addressed through understanding industry needs, labour shortages and skills gaps.

New entrants to the sector will need a unique mix of technical, digital, and environmental skills and knowledge to progress sustainability initiatives, and professionals already working in the field will require upskilling to enhance their skill sets. Transportation professionals who can combine domain knowledge with environmental awareness and advanced technical skills, like working with or improving electric vehicles, will be best positioned to navigate future trends related to environmentally sustainable ground transportation. In addition, the demand for multidisciplinary skill sets in areas like energy management underscores the opportunity for individuals with a diverse range of expertise to enter the sector.

INTRODUCTION

Transportation serves as a cornerstone for Canada's industrial landscape, crucial for facilitating the movement of goods and people, fostering community connections, promoting trade, and bolstering Canada's gross domestic product (GDP). The sector accounts for approximately $88 billion or 4.5% of Canada's GDP and is a significant driver for the Canadian labour market, providing employment opportunities for nearly 1 million individuals.[1] While transportation is undeniably essential in Canada, it is also a significant contributor to greenhouse gas (GHG) emissions. Primarily driven by GHG emissions from internal combustion engines (ICE), the transportation sector ranks as the second-largest emitter of GHG emissions in Canada, comprising 25% of total emissions.[2] This places transportation closely behind the oil and gas industry, which accounts for 28% of Canada's GHG emissions.[3] Most of these emissions come from on-road vehicles, including both light-duty vehicles (like cars, sport-utility vehicles, and pickup trucks) and medium- to heavy-duty vehicles (like larger pickup trucks, cargo vans, buses, and freight trucks), which for the most part, rely on fossil fuels. Marine and air emissions make up an additional 6%.[4]

Moreover, GHG emissions from Canada's transportation sector have increased over time. Environment and Climate Change Canada reports that transportation generated 160.03 million tonnes of GHG emissions in 2019, an increase of approximately 16% over 2005 levels.[5] As seen in Figure 1, on-road freight, which refers to the transport of cargo by road, saw the largest increase in GHG emissions from 2005 to 2019, growing by more than one-third (35%). In 2020, the industrial slowdown caused by the COVID-19 pandemic momentarily reduced trade and travel by air and land, contributing to a sudden decrease in GHG emissions from the transport sector. As economic activities recovered through 2021, emissions rebounded compared to 2020 but remained below the pre-pandemic levels.[6]

1 "Comprehensive Energy Use Database," Natural Resources Canada, https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm

2 "Canada's Action Plan for Clean On-Road Transportation," December 2022, Transport Canada, https://tc.canada.ca/en/road-transportation/publications/canada-s-action-plan-clean-road-transportation

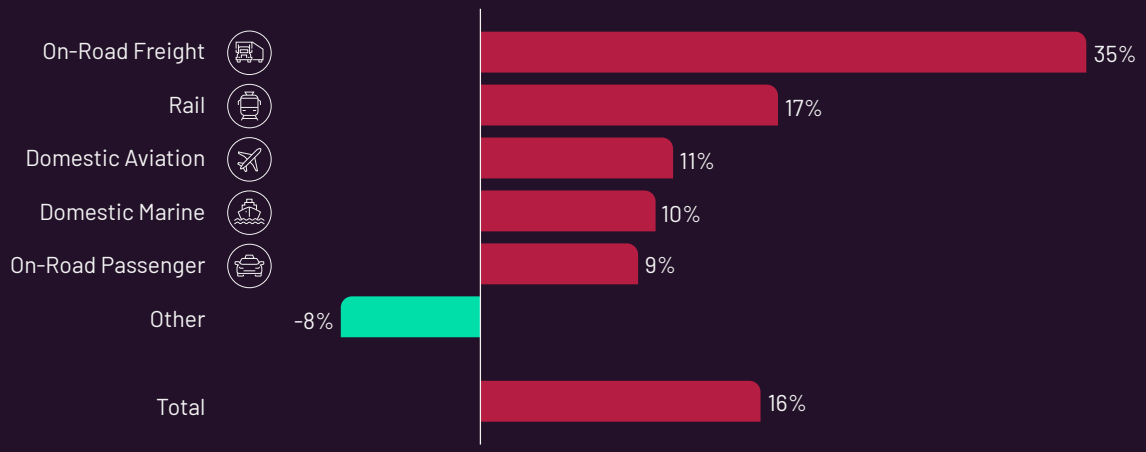
3 Ibid.

4 "Transportation in Canada 2021: GHG Emissions," 2021, Statistics Canada, https://tc.canada.ca/en/corporate-services/transparency/corporate-management-reporting/transportation-canada-annual-reports/2021/greenhouse-gas-emissions

5 "Transportation in Canada 2021: Greenhouse gas emissions," 2022, Transport Canada, https://tc.canada.ca/en/corporate-services/transparency/corporate-management-reporting/transportation-canada-annual-reports/2021/greenhouse-gas-emissions

6 "Greenhouse gas emissions," 2022, Environment and Climate Change Canada, https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html

Figure 1: Transport-related GHG emissions from 2005 to 2019



Source: Transport-related GHG emissions from 2005 to 2019. Data source: Environment and Climate Change Canada, National Inventory Report[7]

According to the Canadian Net-Zero Emissions Accountability Act, Canada's nationally determined contribution under the Paris Agreement is to reduce emissions by 40 to 45% below 2005 levels by 2030.[8] This law solidifies Canada's pledge to establish national targets for reducing emissions every five years, with the goal of reaching net-zero emissions by 2050.[9] The escalating threat of climate change underscores the urgent need to address the release of harmful GHGs from Canada's transportation sector. While transportation is indispensable to modern life in Canada, the greenhouse effect of combustion vehicle emissions, as well as the adverse health impacts and ecological repercussions of burning fossil fuels, emphasizes the need to move toward cleaner and greener transportation technologies and solutions. Key to this is Canada's Action Plan for Clean On-Road Transportation, which outlines targets such as making 100% of new light-duty vehicle sales zero-emissions vehicles (ZEV) by 2035 (with interim targets of at least 20% by 2026 and at least 60% by 2030), and Canada's target to make 100% of new medium- and heavy-duty vehicle sales be ZEVs by 2040 (with an interim target of 35% by 2030).[10]

7 "Transportation in Canada 2021: Greenhouse gas emissions," 2022, Transport Canada, https://tc.canada.ca/en/corporate-services/transparency/corporate-management-reporting/transportation-canada-annual-reports/2021/greenhouse-gas-emissions

8 "Canada's Action Plan for Clean On-Road Transportation," December 2022, Transport Canada, https://tc.canada.ca/en/road-transportation/publications/canada-s-action-plan-clean-road-transportation#_Toc117001130

9 Ibid.

10 "2030 Emissions Reduction Plan: Clean Air, Strong Economy," 2023, Government of Canada, https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030.html

Canada's ability to reduce emissions and transition toward a more sustainable transportation sector depends on an array of factors, namely recognizing the pivotal role of technology and innovation in driving sustainable transport systems, implementing requisite regulatory frameworks and supportive infrastructure, and understanding the talent requirements to progress and sustain such initiatives. Against this backdrop, this study examines the sustainable transportation value chain to discern the in-demand entry-level roles and skills that will be necessary for Canada to reduce its emissions and transition to greater sustainability in the sector. By identifying sought-after entry-level occupations and skills, this study can be used to guide post-secondary institutions in developing curricula that align with current and future industry demands in the transport sector. It can also be used to guide public and private sector organizations in upskilling and reskilling the existing labour force.

This report uses a mixed methods approach to explore the integration of sustainable transport initiatives and clean technologies and their impact on labour market needs. Secondary research includes a review of existing publications to understand the environmental impacts of the transportation sector, including sustainable transport initiatives, the implementation of clean technologies, and the impact of these on entry-level job and skill demand. Web scraping was used to understand hiring trends and skill demand across entry-level roles. Primary research comprised of interviews with 16 sustainable transportation employers and subject matter experts, a survey of 75 employers from Canada's transportation sector, and a survey of 669 Canadian post-secondary students in programs linked to sustainable transportation professions. To acquire a comprehensive understanding of Canada's transportation sector, ICTC consulted experts and employers from a variety of industries, including electric and zero-emissions vehicles, public transportation, transportation technology, multimodal transportation, power and utilities, freight and logistics, and transportation infrastructure. In addition, over the course of the project, an advisory committee composed of industry leaders met three times to contribute to and validate the research findings.

Section I of this report offers a definition of sustainable transportation by exploring the intersection of "green" and "sustainable." The section begins by establishing clear definitions for modes of sustainable transportation and explores the boundaries of sustainable transportation technologies. The latter part of the section provides an overview of the barriers to progressing sustainability in the sector and outlines current programs and initiatives for workforce development.

Section II of this report outlines the changing skill and knowledge requirements brought on by the "green transition." Informed by insights collected from interviews with transportation employers, experts, and educators, coupled with findings from ICTC's employer and student surveys and online job posting data, this section conducts a comprehensive assessment of the various roles and skills that are essential for an environmentally sustainable transportation workforce. The section begins with a discussion of influences on labour demand before identifying in-demand entry-level roles and skills for meeting the labour market needs of a more environmentally sustainable transportation sector. The section concludes by drawing on student survey results to discuss students' perspectives on jobs and considerations for attracting new entrants to the sector.

SECTION I

INTRODUCTION TO SUSTAINABLE TRANSPORT

While terms like "green transportation" and "sustainable transportation" are often used interchangeably, subtle distinctions exist between them. Green transportation, which is sometimes referred to as environmentally sustainable transportation, describes transportation modes and practices that result in environmental benefits. For example, reducing GHG emissions, improving air quality, limiting environmental degradation, reducing the depletion of natural resources, reducing waste, or promoting the resilience of natural ecosystems.

Sustainable transportation, on the other hand, refers to practices that are enduring and beneficial to both the environment and society at large, fostering economic viability and societal well-being. The term refers to a composite of the broader environmental, social, and economic considerations that create a truly sustainable ecosystem. In line with this broader definition, interviewees and advisory committee members commented that sustainable transportation is "a mode of transportation that uses low-emissions, zero-emissions, and efficiency technologies; considers people's needs, equity, and affordability; and minimizes harm to the environment." Moreover, sustainable transportation systems go beyond environmental considerations and include building accessibility and inclusion into transportation routes, fee structures, schedules, seating layouts, decisions related to lighting and noise, and contributing to broader community programs focused on issues like equity, diversity, or inclusion.

While acknowledging the importance of holistically sustainable transport systems, this report adopts a narrower view of sustainability—one that focuses mainly on reducing transportation's impact on the present and future health of the planet. It encompasses a variety of "green" or environmentally sustainable transportation modes and technologies, including zero-emissions vehicles, public transportation, active transportation, and transportation modes that make use of sustainable, zero- or low-emissions alternatives to traditional fossil fuels. Given the role that digital technologies play in making the transportation sector more efficient, this view also encompasses the use of technologies like big data, artificial intelligence (AI), and internet of things (IoT), which offer the potential to optimize transportation systems while simultaneously reducing environmental impacts.

GREEN TRANSPORTATION MODES AND TECHNOLOGIES

Interviewees in this study characterized Canada's transportation sector as being at a crucial crossroads, marked by a convergence of technological advancements, shifting consumer preferences, active transportation options, and innovative technologies. While a more detailed discussion follows, Table 1 provides a high-level summary of the types of transportation modes and technologies that interviewees considered key to achieving an environmentally sustainable transportation sector.

SOLUTION	ENVIRONMENTAL BENEFIT	EXAMPLES
Zero-emission vehicles	Provides motive transport without emitting harmful tailpipe emissions	Electric vehicles or battery-electric vehicles Hydrogen fuel cell vehicles Fuel cell electric vehicles Electric motorbikes
Low-emissions vehicles	Provides motive transport while emitting fewer tailpipe GHG emissions than traditional internal combustion engine vehicles	Hybrid-electric vehicles Plug-in hybrid-electric vehicles Alternate fuel vehicles, such as vehicles that run on biofuels or natural gas
Low-carbon-intensity fuels	Offers zero- or low-emissions alternatives to traditional fossil fuels	Electricity Biofuels, such as ethanol and biodiesel Renewable natural gas Sustainable aviation fuels Low-carbon-intensity synthetic fuels, such as hydrogen

SOLUTION	ENVIRONMENTAL BENEFIT	EXAMPLES
Intelligent transportation	Uses advanced communication technologies to make transportation systems more efficient, such as by optimizing routes or managing traffic, which can reduce emissions	Vehicle performance monitoring Connected vehicles (e.g., vehicle-to-vehicle connection or vehicle-to-infrastructure connection) Autonomous vehicles
Mass transit and shared mobility	Provides eco-friendly transportation options to reduce the overall impact of the transportation sector on the environment, such as by minimizing the number of ICE vehicles on the road or reducing the material impact of the transportation sector by reducing the number of vehicles that need to be produced	Public transportation: buses, subways, and light rail networks Car sharing or ride-sharing Mobility as a Service (MaaS)
Active transport and micromobility	Offers emissions-free and active transportation methods	Walking Using a wheelchair Bicycles Electric bicycles (e-bikes) and electric scooters (e-scooters)

Table 1. Summary of the different types of transportation progressing environmental sustainability for the sector.

Zero-Emissions Vehicles

Zero-emissions vehicles (ZEVs), such as battery-electric vehicles (EVs) and hydrogen fuel cell vehicles, were considered by interviewees to have the greatest potential to reduce GHG emissions in the transport sector. While internal combustion engine (ICE) vehicles consume fossil fuels and generate tailpipe emissions, ZEVs consume clean fuel alternatives, such as clean electricity and green hydrogen, and do not generate tailpipe emissions; because of this, ZEVs present a significant opportunity to enhance vehicle efficiency, improve air quality, and reduce GHG emissions from transport.[11]

11 "Canada's Action Plan for Clean On-Road Transportation," December 2022, Transport Canada https://tc.canada.ca/en/road-transportation/publications/canada-s-action-plan-clean-road-transportation

Due to a reliance on ICE vehicles, Canada's transportation sector primarily uses fossil fuels for energy. In 2020, for example, crude oil accounted for 90% of total final consumption in Canada's transportation sector, while electricity accounted for just 1%.[12] Because of this, many interviewees in this study stressed the urgency of transitioning Canada's transportation fleet from traditional ICE vehicles to ZEVs as quickly and extensively as possible. Replacing crude oil consumption with clean alternatives would help the transportation sector reduce scope 1—which included direct emissions from owned or controlled sources like vehicles—and scope 2 emissions, which involve indirect emissions used by the transportation assets.

The Canada Energy Regulator expects electric vehicles to play a significant role in Canada's net-zero future. In a recent report, the regulator charted two possible pathways for Canada to meet its net-zero goals by 2050, and in both scenarios, "electric vehicles [would need to] become the primary mode of on-road passenger transportation," "electricity [would need to] make up nearly 50% of energy use in the passenger transportation sector, up from below 1% in 2021," and "nearly all passenger vehicles sales [would need to be] EVs by 2035."[13] Notably, in 2022, EVs, including plug-in hybrid-electric vehicles, accounted for about 8% of all vehicle sales in Canada.[14] As of November 2023, Quebec held the largest share of commercial ZEV fleet registrations, at 43.4%, followed by Ontario, at 31.9% and British Columbia, at 15.1%.[15] British Columbia and Quebec meanwhile led the way in on-road light-duty ZEV adoption, likely due to mandates and incentives for this type of vehicle in these regions.[16]

Electric cars, trucks, and vans will need to become the most economically preferable vehicle choice for light- and medium-duty transport, given that current federal regulations will require 100% of new light-duty vehicle sales to be zero emission by 2035[17] and additional regulations are in development that will require 100% of medium-duty vehicle sales to be zero emission by 2040.[18] While the use of electric trucks and vans is increasing in light- and medium-duty freight and delivery, electrification is not expected to have as much of an impact on ground freight transportation; instead, hydrogen and biofuels are projected to contribute to reducing the emissions of heavy-duty vehicles.[19] When measured by weight, compressed hydrogen paired with fuel cells is energy dense, making it suitable for moving heavy loads across long distances.[20] It is a cleaner alternative to diesel and offers a sustainable solution for heavy-duty freight operations, particularly for long-distance trips and heavy payloads. Unlike plug-in electric battery options, which face challenges related to storage capacity and recharge times, hydrogen presents a viable and efficient alternative for decarbonization without the hurdles associated with the electrification of ground transportation fleets.

12 "Canada 2022: Energy Policy Review," 2022, International Energy Agency, https://iea.blob.core.windows.net/assets/7ec2467c-78b4-4c0c-a966-a42b8861ec5a/Canada2022.pdf

13 "Canada's Energy Future 2023," 2023, Canada Energy Regulator, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

14 Ibid.

15 "Canadian Automotive Insights," 2023, S&P Global Mobility, https://cdn.ihsmarkit.com/www/prot/pdf/1123/EV-Canadian-Newsletter-Q3-2023-2-page-with-JC-questions_Chris.pdf

16 "Electric vehicle regulations will cut emissions and give drivers more choice," December 12, 2023, Canadian Climate Institute, https://climateinstitute.ca/news/electric-vehicle-regulations-will-cut-emissions-and-give-drivers-more-choice/

17 "Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations," December 31, 2022, Canada Gazette, https://www.gazette.gc.ca/rp-pr/p1/2022/2022-12-31/html/reg1-eng.html

18 "Canada's Action Plan for Clean On-Road Transportation," December 2022, Transport Canada https://tc.canada.ca/en/road-transportation/publications/canada-s-action-plan-clean-road-transportation

19 "Canada's Energy Future 2023," 2023, Canada Energy Regulator, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

20 Ibid.

The use of hydrogen-based vehicles will need to increase as Canada develops a reliable supply of hydrogen for use in trucks, rail locomotives, and marine vessels.[21] Canada's Hydrogen Strategy sets an ambitious target to supply up to 30% of Canada's energy from hydrogen by 2050.[22] This bold initiative positions Canada to become a leading producer of clean hydrogen globally, with projections of over 20 million tonnes of clean hydrogen annually and more than 5 million fuel cell electric vehicles on the roads by 2050.[23]

Still, the technologies and markets surrounding heavy freight hauling are less evolved, making trends in the heavy freight industry more difficult to predict: "Depending how technologies and markets evolve, [Canada] may see more or less hydrogen, electricity, or other clean fuels in the future."[24] Advanced Biofuels Canada similarly reports that while the potential for electric battery transportation in the aircraft and marine transport industry remains unclear, "new aircraft and engine types that employ electricity and hydrogen are expected to enter the short-haul commercial aviation market in the next decades; they are currently being demonstrated but have no in-service commercial application."[25]

Low-Emissions Vehicles

Like ZEVs, low-emissions vehicles offer motive transportation at a reduced environmental cost. Unlike ZEVs, low-emissions vehicles generate some tailpipe emissions, though at a substantially lower rate than traditional ICE vehicles. While there are a variety of low-emissions vehicles on the market, one common example is the hybrid electric vehicle. Hybrid electric vehicles are powered using both an internal combustion engine, which uses fossil fuels, and an electric motor, which uses energy stored in batteries.[26] Depending on the type of hybrid electric vehicle, the battery can either be charged while driving, through regenerative braking and the internal combustion engine itself[27] or be plugged into an external wall outlet.[28] Hybrid-electric vehicles are a useful way for individuals and organizations to overcome common barriers to EV adoption, such as having limited flexibility to change vehicle use patterns or not having sufficient charging infrastructure locally.

While the largest share of hybrid vehicles are on-road vehicles, hybrid electric vehicle options exist for marine and water transport, too. For example, BC Ferries, which is one of the largest ferry operators in the world, recently acquired six battery-hybrid electric ferries, which use a combination of electric power and propulsion systems.[29]

21 "Canada's Energy Future 2023," 2023, Canada Energy Regulator, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

22 "Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen," 2020, Natural Resources Canada, https://natural-resources.canada.ca/climate-change/canadas-green-future/the-hydrogen-strategy/23080

23 Ibid.

24 "Canada's Energy Future 2023," 2023, Canada Energy Regulator, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

25 "Sustainable Aviation Fuel," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/sustainable-aviation-fuel/

26 "How do Plug-In Hybrid Electric Cars Work?" Alternative Fuels Data Center, U.S. Department of Energy, https://afdc.energy.gov/vehicles/how-do-plug-in-hybrid-electric-cars-work

27 "How Do Hybrid Electric Cars Work?" Alternative Fuels Data Center, U.S. Department of Energy, https://afdc.energy.gov/vehicles/how-do-hybrid-electric-cars-work

28 "How do Plug-In Hybrid Electric Cars Work?" Alternative Fuels Data Center, U.S. Department of Energy, https://afdc.energy.gov/vehicles/how-do-plug-in-hybrid-electric-cars-work

29 "The Island Class: Efficient, quiet, battery-hybrid ferries," BC Ferries, https://www.bcferries.com/in-the-community/projects/introducing-island-class-ferries

In addition to being battery-hybrid vehicles, the new ferries were designed to reduce underwater radiated noise. They are completely outfitted with LED lighting and equipped with heat recovery systems that use waste thermal energy for the interior heating of vessels.[30] In 2024, the crown corporation announced a contract for four additional vessels, bringing its battery-hybrid electric fleet to 10.[31] Additionally, while the required charging infrastructure is not yet available, in its Clean Futures Plan, the crown corporation indicated that "when electric charging technology matures to make electricity available in quantities required, BC Ferries plans to operate these ships as all-electric ferries, using only renewable energy."[32]

Another example of a low-emission vehicle is any vehicle that runs on low-carbon-intensity fuel, such as biofuel, renewable natural gas, synthetic fuel, or sustainable aviation fuel. These fuels, which are more environmentally sustainable than their gasoline and diesel alternatives, are discussed in more detail in the next section on low-carbon-intensity fuels.

Low-Carbon-Intensity Fuels

Low-carbon-intensity fuels offer zero- or low-emissions alternatives to traditional fossil fuels, such as gasoline and diesel. They are crucial for a sustainable transportation system because they help reduce the emissions intensity of traditional ICE vehicles. As noted by Canada's energy regulator, for Canada to meet its net-zero goals by 2050, emissions from ICE vehicles will need to decline.[33] Widespread adoption of ZEVs will take time, and low-carbon-intensity fuels will be needed to reduce the emissions intensity of existing ICE vehicles in the meantime. Additionally, not all transportation methods are well-suited to ZEVs: low-carbon-intensity fuels will also be important for reducing emissions in specific applications where ZEVs are not feasible.

As a result of innovation in the energy sector, there is a growing number of low-carbon-intensity fuels that can be used in a variety of vehicle types and transportation methods. In addition to electricity, low-carbon-intensity fuels include:

Biofuels—Biofuels are made using different types of plant and animal materials, which are collectively referred to as "biomass."[34] While there are a variety of biofuels on the market, ethanol and biodiesel are the most commonly used.[35] In 2019, biofuels accounted for 3% of energy consumption in Canada's transportation sector, up 150% from 2009.[36] Bioethanol accounted for 72% of biofuel consumption in 2019, while biodiesel accounted for the remaining 28%.[37] Biofuels Canada reports that ethanol accounted for 87% of biofuel consumption in 2021, while biodiesel accounted for 13%.[38]

30 "The Island Class: Efficient, quiet, battery-hybrid ferries," BC Ferries, https://www.bcferries.com/in-the-community/projects/introducing-island-class-ferries

31 "BC Ferries Awards Contract for New Hybrid Electric Vessels," January 2024, BC Ferries, https://www.bcferries.com/news-releases/bcferries-awards-contract-new-hybrid-electric-vessels-2024

32 "Clean Futures Plan," 2019, BC Ferries, https://www.bcferries.com/web_image/hda/hd5/8914291818526.pdf

33 "Canada's Energy Future 2023," 2023, Canada Energy Regulator, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

34 "Biofuel Basics," Bioenergy Technologies Office, Office of Energy Efficiency & Renewable Energy, https://www.energy.gov/eere/bioenergy/biofuel-basics

35 Ibid.

36 "Canada 2022: Energy Policy Review," 2022, International Energy Agency, https://iea.blob.core.windows.net/assets/7ec2467c-78b4-4c0c-a966-a42b8861ec5a/Canada2022.pdf

37 Ibid.

38 "Biofuels in Canada 2023: Tracking biofuel consumption, feedstocks and avoided greenhouse gas emissions," November 2023, Navius Research Inc., https://advancedbiofuels.ca/wp-content/uploads/Biofuels-in-Canada-2023-2023-11-01.pdf

- **Ethanol**—Ethanol is made using grains, municipal solid waste, and agricultural and forestry residues.[39] It can be blended with gasoline to reduce the amount of GHG emissions that result from gasoline use.[40] While there are a variety of different types of ethanol, E10 is compatible with all light-duty vehicles, and E15 is compatible with light-duty vehicles made after 2001.[41] While not directly compatible with air transportation vehicles, ethanol can also be used to make low-carbon aviation fuels.[42] In Canada, gasoline suppliers are required to make between 5% and 10% of their gasoline supply out of low-carbon-intensity fuels, such as ethanol.

- **Biodiesel**—Biodiesel is made from vegetable oils, animal fats, and recycled cooking grease and can either be blended with petroleum-based diesel or replace petroleum-based diesel altogether.[43] Biodiesel is compatible with existing diesel engines and diesel distribution infrastructure: with the exception of vehicles produced prior to 1993, biodiesel "can be used in unmodified diesel engines and with little or no change to fuelling infrastructure for blends up to 20%."[44] Diesel is notably the most common fuel in the freight sector and is a commonly used fuel for many types of large industrial vehicles.[45] For example, BC Ferries notes that they "have worked with BC-based diesel fuel suppliers to introduce renewable biodiesel blends that are acceptable for marine engine use."[46] In Canada, depending on the specific region, diesel suppliers are required to make between 2% and 5% of their diesel supply out of low-carbon intensity fuels, such as biofuels.[47]

- **Renewable Natural Gas**—Renewable natural gas is an alternative to conventional natural gas that can be made using organic materials and waste streams, such as unused crop residues, animal manure, food processing waste, forestry bio-products, and municipal solid waste.[48] Renewable natural gas meets existing standards for the use of natural gas in vehicle engines and can be used as a transportation fuel in its compressed or liquefied form.[49] For example, all of the buses in BC (British Columbia) Transit's natural gas fleet run on renewable natural gas, produced using a combination of organic waste and other renewable biomass.[50]

- **Sustainable Aviation Fuel**—Sustainable aviation fuel is made using a range of biomass materials, including vegetable oils, animal fats, forest and agricultural residues, and industrial waste gases.[51] Sustainable aviation fuel satisfies existing requirements for traditional jet fuels[52] and can be used in traditional aircraft without making significant changes to existing aircraft or engines.[53] According to the United States Department of Energy, sustainable aviation fuels are mainly used in the United States and Europe: in 2023, the United States consumed 24.5 million gallons of sustainable aviation fuels, up 390% from 2021.[54]

39 "Biodiesel," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/biodiesel/

40 "Biofuel Basics," Bioenergy Technologies Office, Office of Energy Efficiency & Renewable Energy, https://www.energy.gov/eere/bioenergy/biofuel-basics

41 "Ethanol," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/ethanol/

42 "Biodiesel," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/biodiesel/

43 "Biofuel Basics," Bioenergy Technologies Office, https://www.energy.gov/eere/bioenergy/biofuel-basics

44 "Biodiesel," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/biodiesel/

45 "Canada's Energy Future 2023: Energy Supply and Demand," 2023, Canada Energy Regulator, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

46 "Clean Futures Plan," 2019, BC Ferries, https://www.bcferries.com/web_image/hda/hd5/8914291818526.pdf

47 "Compliance with Clean Fuel Regulations," 2024, Government of Canada, https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/compliance.html#toc10

48 "Renewable Natural Gas," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/renewable-natural-gas/

49 Ibid.

50 "Sustainability," BC Transit, https://www.bctransit.com/about/sustainability

51 "Sustainable Aviation Fuel," Advanced Biofuels Canada, https://advancedbiofuels.ca/fuels-and-tech/sustainable-aviation-fuel/

52 Ibid.

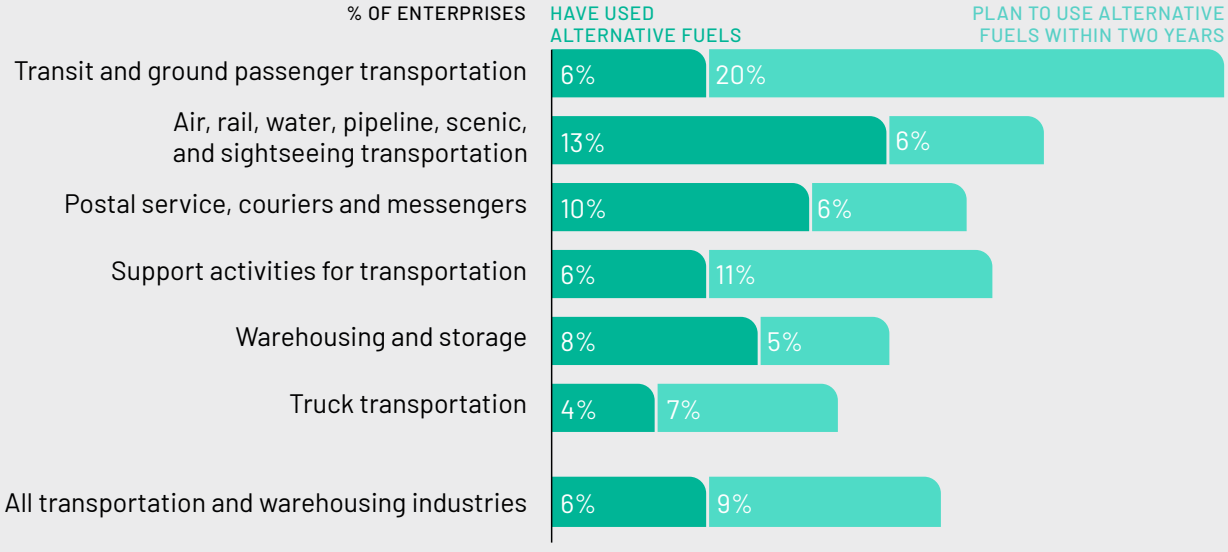
53 "Our sustainable aviation fuel (SAF) program," 2024, United Airlines Inc., https://www.united.com/en/us/fly/company/responsibility/sustainable-aviation-fuel.html

54 "Sustainable Aviation Fuel," Alternative Fuels Data Center, U.S. Department of Energy, https://afdc.energy.gov/fuels/sustainable_aviation_fuel.html

Notably, many low-carbon-intensity fuels are "drop-in fuels," meaning they can replace or be blended into existing fuel supplies without modifying existing infrastructure, vehicle fleets, or engines. This makes it possible not only to integrate sustainable fuels into existing workflows at the company or organization level but also for jurisdictions to require a certain percentage of their entire fuel supply to be low-carbon-intensity alternatives. For example, the Government of Canada requires gasoline and diesel suppliers to ensure that at least 5% of their gasoline pools and at least 2% of their diesel pools are low-carbon-intensity fuels.[55] Similarly, in Ontario, 10% of the gasoline supply and 4% of the diesel supply must be renewable; in Manitoba, 10% of the gasoline supply must be ethanol, and 5% of the diesel supply must be renewable; in Saskatchewan, 7.5% of the gasoline supply must be ethanol and 2% of the diesel supply must be renewable; in British Columbia, 5% of the gasoline supply and 4% of the diesel supply must be biofuels; and in Quebec, 10% of the gasoline supply and 3% of the diesel supply must be low-carbon fuels.[56] While targets for individual provinces vary, Advanced Biofuels Canada estimates that in 2021, renewable fuel accounted for about 6.9% of Canada's total gasoline supply and about 3.5% of Canada's total diesel supply.[57]

Statistics Canada's survey of advanced technology collects information about how Canadian enterprises are using advanced technologies, including alternative fuels. Figure 2 shows the adoption rate for alternative fuels by enterprises in the transportation and warehousing industry, in addition to a number of subindustries. As seen in Figure 2, transit and ground passenger transportation firms are the most likely to have adopted or plan to adopt alternative fuels, at 26%. This is followed by air, rail, water, pipeline, scenic, and sightseeing transportation firms, at 19%.

Figure 2: The adoption of alternative fuels by enterprises in the transportation and warehousing industries



Data Source: Statistics Canada Data. Table 27-10-0362-01 Adoption of clean technologies, by industry and enterprise size

55 "Clean Fuel Regulations," February 2024, Minister of Justice, https://laws-lois.justice.gc.ca/eng/regulations/SOR-2022-140/page-2.html#h-1358852

56 "What are Clean Fuel Regulations?" 2022, Environment and Climate Change Canada, https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/about.html

57 "Biofuels in Canada 2023: Tracking biofuel consumption, feedstocks and avoided greenhouse gas emissions," November 2023, Navius Research Inc., https://advancedbiofuels.ca/wp-content/uploads/Biofuels-in-Canada-2023-2023-11-01.pdf

Despite a growing number of sustainable fuel options and increasingly stringent regulations, gasoline and diesel still account for an overwhelming proportion of energy consumption in Canada's transportation sector. The International Energy Agency reports that in 2020, crude oil accounted for 90% of total final consumption in Canada's transportation sector, while natural gas accounted for just 5%, bioenergy and waste accounted for just 3%, and electricity accounted for just 1%.[58] Similarly, Advanced Biofuels Canada estimates that in 2021, gasoline and diesel accounted for 94% of energy consumption in Canada's transport sector; ethanol accounted for 4%; hydrogenation-derived renewable diesel and biodiesel accounted for 2%; and electricity accounted for less than 1%.[59]

For Canada to meet its net-zero goals, the supply and use of low-carbon-intensity fuels will need to expand considerably. For example, a recent report by Canada's energy regulator outlines that for Canada to meet its net-zero goals, low-carbon-intensity fuels like hydrogen and biofuels will need to account for a much larger share of freight shipping by truck, train, and ship, as well as a much larger share of total fuel consumption in the airline industry.[60]

Intelligent Transportation Solutions

Intelligent transportation solutions use advanced communications technologies to make transportation systems more efficient, which in many cases, can reduce emissions. To date, there are four main categories of intelligent transportation solutions. The first is the use of big data, IoT, and AI to monitor individual vehicle performance and health. For example, interviewees in this study indicated that data analytics for vehicle performance analysis will soon reach mainstream adoption. With the right application, these types of technologies could be used for environmental outcomes, such as lowering energy wastage, optimizing vehicle efficiency, and enhancing vehicle durability.

The second category of intelligent transport solutions is interconnected vehicles, whereby multiple vehicles are connected to communicate directly with one another, sharing information and data. The third is interconnected vehicles and infrastructure, whereby vehicles are connected to their surrounding infrastructure and are able to send and receive data and information to the infrastructure around them. The fourth is autonomous vehicles, which, instead of being directly connected to either vehicles or infrastructure, use a variety of sensors to perceive the world around them. In this study, interviewees highlighted that advancements in machine learning, AI, and computer vision are driving the development and adoption of autonomous vehicles. In terms of environmental benefits, they said that autonomous vehicles have the potential to optimize traffic flow, reduce accidents, and improve fuel efficiency through more precise driving patterns. Furthermore, connected vehicle technology, enabled by the IoT, has the potential to boost real-time communication between vehicles and infrastructure, further enhancing safety and efficiency.

58 "Canada 2022: Energy Policy Review," 2022, *International Energy Agency*, https://iea.blob.core.windows.net/assets/7ec2467c-78b4-4c0c-a966-a42b8861ec5a/Canada2022.pdf

59 "Biofuels in Canada 2023: Tracking biofuel consumption, feedstocks and avoided greenhouse gas emissions," November 2023, *Navius Research Inc.*, https://advancedbiofuels.ca/wp-content/uploads/Biofuels-in-Canada-2023-2023-11-01.pdf

60 "Canada's Energy Future 2023," 2023, *Canada Energy Regulator*, https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

Mass Transit and Shared Mobility

Mass transit and shared mobility solutions reduce the overall impact of the transportation sector on the environment by minimizing the number of vehicles on the road. They reduce emissions by lowering the number of gas- and diesel-powered vehicles that are in use and reduce material consumption by lowering the total number of vehicles that need to be produced. As described by an advisory committee member for this study, "Mass transit equals moving the most amount of people with the least amount of emissions." Some examples of mass transit and shared mobility solutions are public transportation solutions, such as buses, subways, and light rail networks, and vehicle-sharing solutions, such as car sharing, ride-sharing, bike-sharing, and scooter-sharing.

Increasingly, different types of mass transit and shared mobility solutions are being combined to facilitate end-to-end transportation using a variety of transportation modes. Mobility as a Service (MaaS) is gaining traction and transforming the way people perceive transportation. As a multimodal and demand-responsive mobility service, MaaS platforms integrate various modes of transportation—including public transit, ride-sharing, bike-sharing, and EV rentals, into a seamless, on-demand service—encouraging shared mobility and reducing the need for private vehicle ownership. MaaS is defined by three key components: (1) it offers mobility rather than transportation; (2) it offers a service that prioritizes user needs; and (3) it integrates various transportation options to offer a single channel for services, information, ticketing, and payment.[61]

Recent investments by Canadian governments confirm that mass transit and shared mobility solutions will play a considerable role in reaching Canada's sustainability goals. In February 2021, the federal government announced $14.9 billion for public transit projects over the next eight years,[62] demonstrating a commitment to environmentally sustainable transport solutions. This funding supports the expansion of urban transit systems and active transport infrastructure, as well as the electrification of bus fleets, exemplifying efforts to reduce emissions associated with transportation. In addition to this, the Canadian government is leading efforts to make existing diesel and gas vehicles cleaner by retrofitting older trucks with advanced fuel-efficiency technologies.[63] Through engine upgrades and enhancements, the government hopes to decrease emissions and improve overall efficiency so that existing vehicles can also contribute to a cleaner and more sustainable transportation system. Other initiatives seek to expand the accessibility of cleaner fuel options, such as low-sulphur diesel and biodiesel blends.

Still, interviewees in this study highlighted a growing divide between urban and rural access to public transit and shared mobility, transport infrastructure, and micromobility solutions. Programs like the Zero Emission Transit Fund, Active Transportation Fund, and Rural Transit Solutions Fund in Ontario are advancing crucial projects, contributing to cleaner and greener transportation options. The introduction of MaaS could also help to maximize community resources—particularly in rural, lower-density areas—and contribute to improvements in accessibility, environmental sustainability, and living conditions in both cities and rural areas.

61 "What is Mobility as a Service?" June 2019, Transit Protocol, https://medium.com/@transitprotocol/what-is-mobility-as-a-service-672259066c87

62 "Building Canada's public transit future: Healthy and sustainable modes of transportation for all," 2023, Government of Canada, https://www.infrastructure.gc.ca/transit-transport/index-eng.html

63 Ibid.

Active Transport and Micromobility

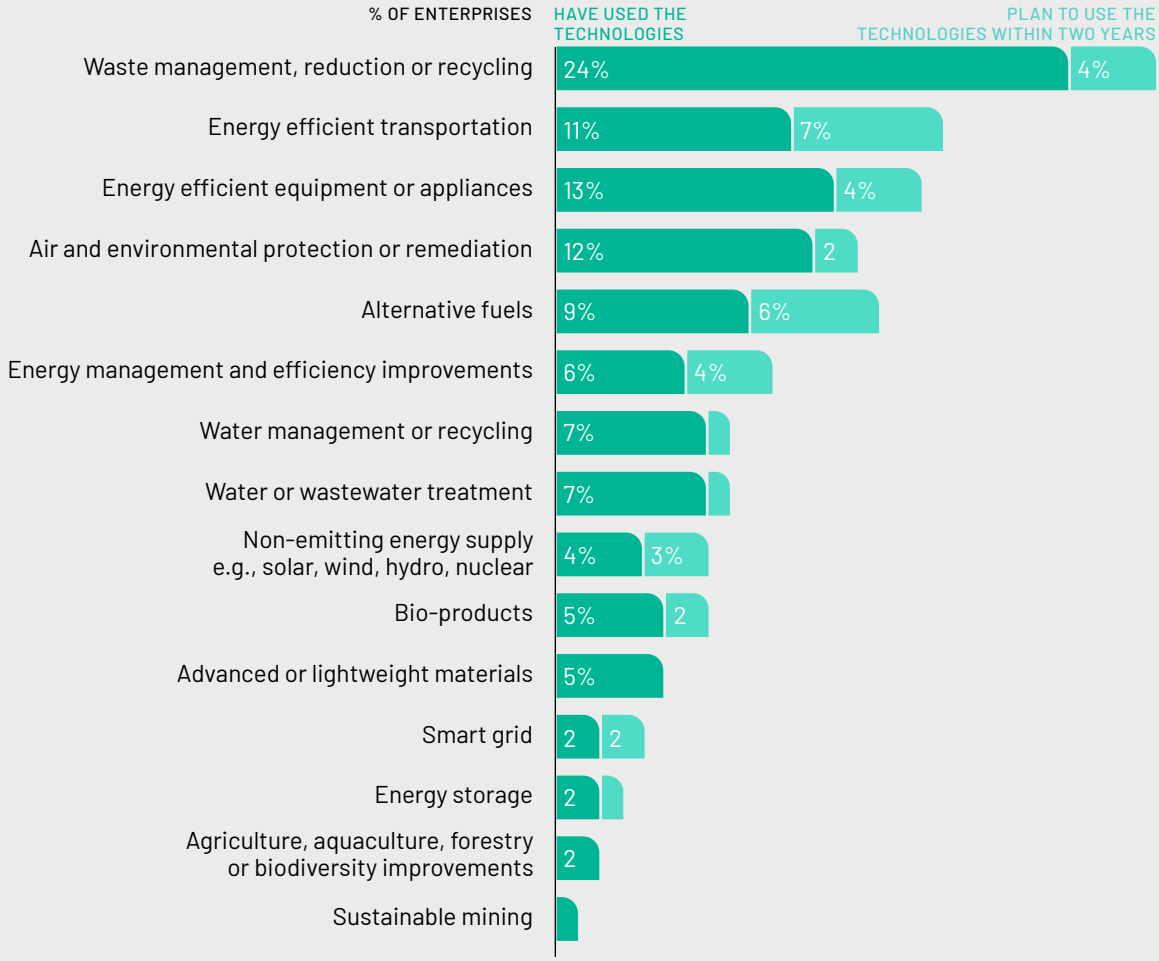
Active transport and micromobility options, such as walking, bicycling, using electric bicycles and scooters, and using a wheelchair, offer emissions-free and active methods of transportation. Active transport and micromobility solutions are useful in high-density areas, such as cities, and reduce emissions for short-distance, individual trips. These solutions are seen as a more affordable, flexible, and sustainable alternative to personal vehicles, ride-sharing services, or public buses. Currently, Canada's National Transportation Strategy is focused on empowering a modal shift away from carbon-intensive vehicles and toward active transportation, such as biking and walking. A 2022 report from EY suggests that shared e-scooters and e-bikes could serve as a bridging technology to help Canadians transition toward more active forms of transportation.[64] Developing active transportation infrastructure, such as sidewalks and bike lanes, and introducing shared micromobility options are key elements to more environmentally sustainable urban transportation systems. The availability and uptake of active transportation and micromobility options are significantly important to "green" transportation through their ability to enhance the environmental and economic efficiency of individual trips.

Other Strategies for Environmental Sustainability

While the above transportation modes and technologies represent the primary way Canada's transportation sector will become environmentally sustainable, transportation and warehousing companies across Canada are employing a range of other strategies to increase the environmental sustainability of their operations. Statistics Canada's survey of advanced technology adoption collects information about how Canadian enterprises are using advanced technologies, including several related to environmental sustainability. Figure 3 shows the adoption of a variety of clean technologies by enterprises in the transportation and warehousing industry. As seen in Figure 3, the greatest proportion (28%) of transportation and warehousing firms has adopted or plan to adopt solutions for waste management, reduction, or recycling. This is followed by energy-efficient transportation at 28%, energy-efficient equipment or appliances at 17%, air and environmental protection or remediation at 14%, and alternative fuels at 15%.

64 "The evolving landscape of eMobility: Understanding the current state and future aspirations of shared micromobiity in Canada," 2022, Ernst & Young LLP, https://www.ey.com/en_ca/energy-resources/evolving-landscape-of-emobility-in-canada

Figure 3: The adoption of clean technologies by enterprises in the transportation and warehousing industry



Data Source: Statistics Canada Data. Table 27-10-0362-01 Adoption of clean technologies, by industry and enterprise size

SECTION II

DEMAND FOR TALENT AND SKILLS IN CANADA'S TRANSPORTATION SECTOR

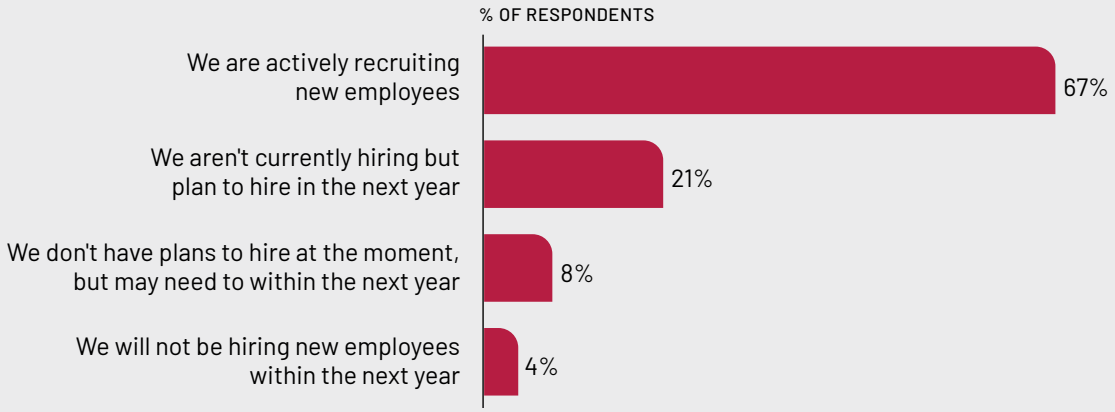
Environmental sustainability initiatives are causing a shift in the knowledge and skills that transportation workers need. RBC Capital Markets predicts that over the next 10 years, as Canada transitions to net-zero, 40% of new jobs in the trades, transport, and equipment industries will require an "enhanced" skill set.[65] In ICTC's study, interviewees similarly explained that there is a growing need for transportation workers to layer new skills into their existing competencies. For example, while transportation workers already possess many of the foundational skills that are needed to work with EVs, such as knowledge of how generators, motors, and other vehicle components work, some skill gaps remain. Most of the components that make up modern ZEVs versus traditional ICE vehicles are the same, however, a portion of these look different, while another subset is entirely new. Recognizing the importance of this labour market shift, this section of the report highlights the demand for entry-level talent and skills in the transportation sector as a result of clean technology uptake and environmental sustainability initiatives. The findings are informed by quantitative and qualitative research, including an employer survey, a student survey, key informant interviews, and job posting data.

65 "The skills revolution Canada needs to reach Net Zero," February 18, 2022, RBC Capital Markets, https://www.rbccm.com/en/insights/story.page?dcr=templatedata/article/insights/data/2022/02/green_collar_jobs_the_skills_revolution_canada_needs_to_reach_net_zero

OVERALL HIRING TRENDS

Results from ICTC's employer survey show that demand for talent in the transportation sector is high. Many businesses are currently hiring or have plans to hire new employees in the near future. As seen in Figure 4 below, more than two-thirds (67%) of respondents are actively recruiting new employees, while a further 21% plan to hire in the next year. Conversely, just 4% of respondents have no plans to hire new employees within the next year.

Figure 4: Transportation employer hiring plans

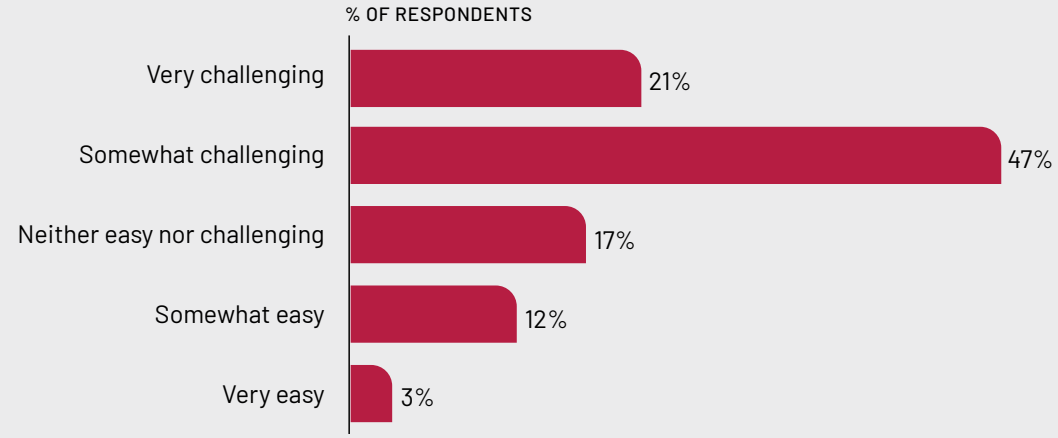


Data source: ICTC's employer survey

HIRING LEVEL OF DIFFICULTY

When asked how challenging it is to find employees with the right mix of skills, 68% of respondents indicated that it is either somewhat or very challenging. Respondents from the transportation infrastructure industry were the most likely to find it somewhat or very challenging, followed by respondents from the EV industry and then respondents from the public transportation industry.

Figure 5: Hiring level of difficulty among transportation employers



Data source: ICTC's employer survey

When asked why some transportation employers find it difficult to hire employees, interviewees highlighted high competition for skilled labour, growing retirement rates and difficulty attracting young people to trades and operations roles, difficulty attracting diverse candidates, and difficulty balancing present and future labour market needs:

High Competition for Skilled Labour—Interviewees indicated that there is high competition for skilled labour, particularly between public and private sector employers and between competing industries. For example, one employer indicated that due to overlapping job and skills needs, the energy and transportation sectors are increasingly drawing on the same limited talent pool.

Growing Retirement Rates and Difficulty Attracting Young People to Trades and Operations Roles—In 2021, the proportion of working-age Canadians between the ages of 55 and 64 and nearing retirement reached an all-time high, representing more than 20% of Canada's working-age population.[66] This aging workforce is impacting the ability of employers to retain senior talent in skilled trades roles and, in turn, limits the availability of apprenticeship opportunities. A representative from an Ontario college commented on this challenge, explaining that "demand for apprenticeship is growing purely because of an aging workforce and [senior] technicians retiring."

While demand for apprentices is growing, interviewees indicated that it is difficult to attract young talent to the transportation sector. The transportation sector involves a high proportion of hands-on, on-site work that may not be desirable to youth, particularly as opportunities for remote or hybrid work grow. When thinking about what might increase young people's interest in transportation-related roles, particularly in the trades, one interviewee, a fleet management consultant, spoke about how modern-day vehicles are essentially "computers on wheels" and suggested that the sector may become more attractive to young people as automotive trade roles expand to working with more sophisticated technology.

Difficulty Attracting Diverse Candidates—Several interviewees noted that it can be difficult to attract candidates from diverse backgrounds to the transportation sector. One employer shared that among 180 technicians at their company, just one identifies as a woman. Making jobs in the industry more attractive to women and other underrepresented groups would help alleviate labour shortages. Dismantling stigmas is key to making this happen. Newcomers may face barriers to accessing opportunities in regulated professions relevant to transportation, like engineering and the skilled trades. In past research by ICTC on the employment experience of newcomers, many noted that it can be both difficult to obtain Canadian qualifications and have "overseas" experience recognized.[67]

Difficulty Balancing Present and Future Labour Market Needs—Interviewees spoke about how small to medium-sized businesses are often constrained in their ability to balance past and future labour market trends. One interviewee noted that small, independent businesses, such as automotive repair shops, may be less likely to invest in upskilling, particularly if they see strong demand for work related to traditional ICE vehicles.

66 "In the midst of high job vacancies and historically low unemployment, Canada faces record retirements from an aging labour force: number of seniors aged 65 and older grows six times faster than children 0-14," 2022, Statistics Canada, https://www150.statcan.gc.ca/n1/daily-quotidien/220427/dq220427a-eng.htm

67 Khiran O'Neill, Mansharn Toor, "Settling for More: Matching Newcomers to Alberta's Tech Sector," Information and Communications Technology Council, November 2021, https://ictc-ctic.ca/reports/settling-for-more

DEMAND FOR SPECIFIC TYPES OF ROLES

Employers were next asked to articulate which types of entry-level roles their company or organization has hired in the last few years, which types of roles they plan to hire over the next few years, and which types of roles are most urgent for them to fill. Respondents were asked about seven categories of roles that were identified as being important to the transportation sector: operations roles; trades roles; administrative and other business function roles; digital technology roles; environmental or sustainability roles; civil and regulatory roles; and research and development, design, and engineering roles.

Overall, respondents' hiring plans for the next few years were similar to their hiring history over the past few years. Slightly more respondents plan to hire environmental and sustainability roles and regulatory roles over the next few years as compared to the last few years, while slightly fewer plan to hire trades and administrative or business function roles. In addition to findings from the employer survey, Figure 6 shows what proportion of entry-level job postings each type of role accounted for from August 2023 to January 2024. For example, research and development, design, and engineering roles accounted for approximately 43% of entry-level job postings from August 2023 to January 2024.

Figure 6: Demand for entry-level roles in the transportation industry, by role type

Data Source: ICTC's employer survey and web-scraped data from publicly available job sites

Demand for Research and Development, Design, and Engineering Roles and Skills

Research and development, design, and engineering roles relate to the design and engineering of products, processes, and facilities. They include roles like research analyst, power engineer, electrical engineer, fuel cell engineer, chemist, chemical engineer, mechanical engineer, laboratory technician, materials scientist, and industrial engineer.

Employer Demand for Labour

At 43%, research and development, design, and engineering roles accounted for the largest share of entry-level job postings from August 2023 to January 2024. The most common types of research and development, design, and engineering roles were mechanical engineers and transportation engineers, which each accounted for 15% of the job postings in this category. Power engineers, researchers, and validation engineers were also in high demand, as were civil engineers, automotive engineers, and materials scientists. The diversity of job titles in this category, as well as how prevalent research, design, and engineering roles are in the transportation industry, suggests a burgeoning industry with a variety of new technologies, including hydrogen, alternative fuels, and electric and zero-emission vehicles.

Despite accounting for such a large proportion of entry-level job postings, just 7% of respondents to ICTC's employer survey indicated that research and development, design, and engineering roles are part of their past or future hiring plans. Additionally, just 7% of respondents highlighted this category of roles as among their most urgent hiring needs. This discrepancy may be due to the high proportion of respondents from the freight and logistics, and public transportation industries in ICTC's survey. While respondents from the multimodal transportation, transportation infrastructure, and power and utilities industries were most likely to have hired or plan to hire research, design, and development roles, they represented only a small percentage of respondents overall.

In-Demand Research and Development, Design, and Engineering Roles

- Automotive Engineer
- Biochemical Engineer
- Chemical Engineer
- Chemist
- Civil Engineer
- Civil Engineering Technologist
- Commercial and Industrial Designers
- Electrical and Electronics Engineer
- Electrical and Electronics Engineering Technologist
- Fuel Cell Engineer
- Industrial Engineering Technologist
- Logistics Engineer
- Materials Scientist
- Mechanical Engineer
- Mechanical Engineering Technologist
- Mechatronic Engineer
- Metallurgic and Materials Engineers
- Microsystems Engineer
- Power Engineer
- Researcher
- Transportation Engineer
- Urban Planner
- Validation Engineer

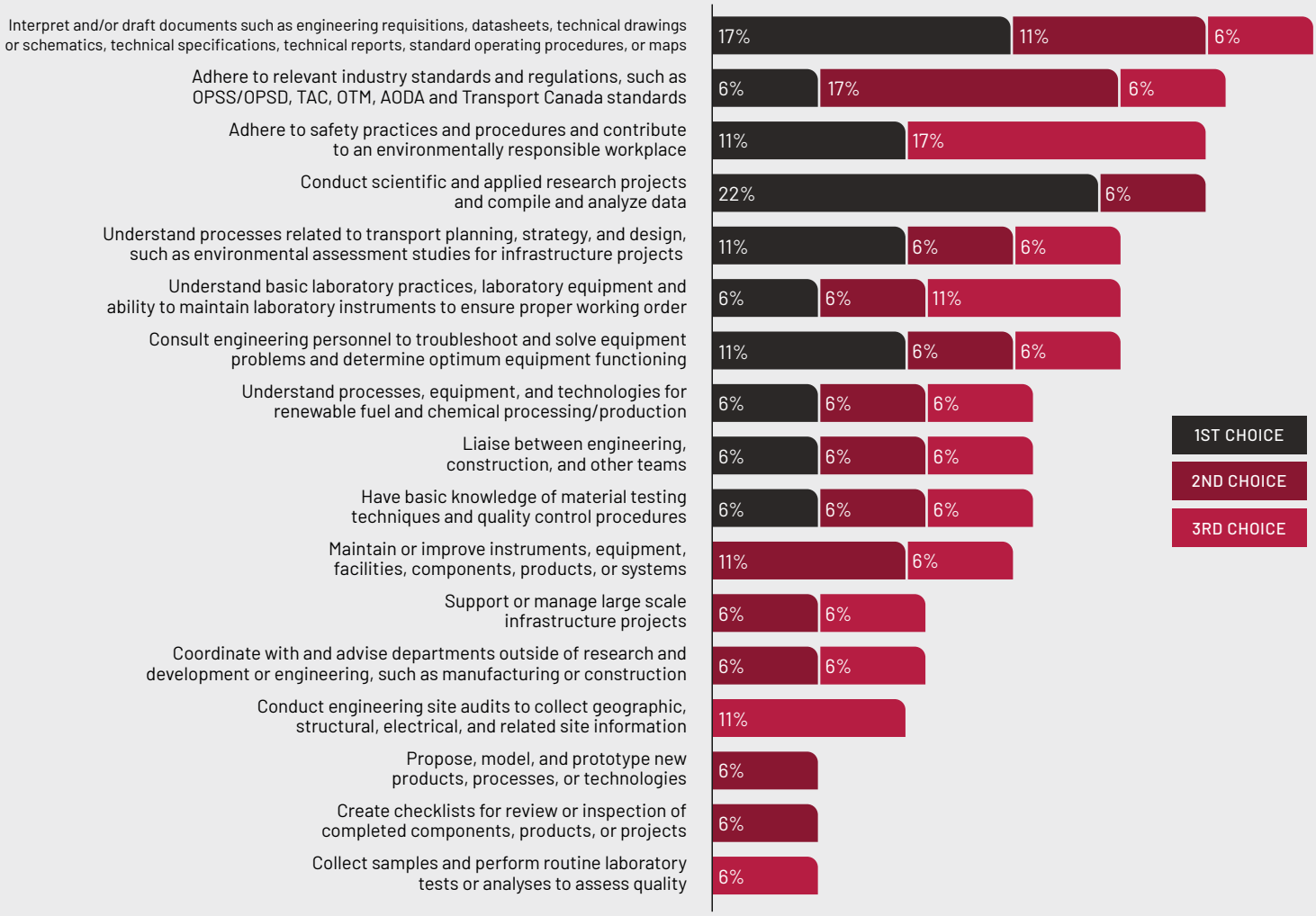
Employer Demand for Knowledge and Skills

Respondents to ICTC's employer survey were asked to rank a set of research and development, design, and engineering skills and abilities by order of importance (Figure 7). Respondents were most likely to consider the ability to "interpret and or draft documents, such as engineering requisitions, datasheets, technical drawings" as important. This skill was selected as important by 34% of them. Next, 29% of respondents selected the ability to "adhere to relevant industry standards and regulations." Meanwhile, 28% of respondents selected "adhere to safety practices and procedures" and the ability to "conduct scientific and applied research projects and compile and analyze data," respectively.

Interviewees were also asked which entry-level skills are needed for research and development, design, and engineering roles in the sustainable transportation sector. They indicated that employers increasingly expect entry-level candidates to be familiar with emerging trends in transportation, such as "new mobility" or "mobility as a service." A comprehensive understanding of these concepts enables R&D, design, and engineering professionals to contribute to the development of innovative transportation solutions that prioritize environmental sustainability, efficiency, and accessibility. Interviewees also felt that understanding the principles of electromobility is an essential knowledge area for the design, development, and optimization of infrastructure (such as charging systems) and energy efficiency in transportation networks.

Urban design is another highly valued skill set, particularly for organizations that are closely involved in public transit or urban transportation. As one interviewee shared, "We want people who are able to work with engineers and street designers, who understand street design and public spaces a bit themselves." Another interviewee explained that it is important for design and engineering personnel to understand spatial location, including how cities are organized and what this means for the location of transit stops, passenger studies, surveys, etc. They said that roles like sustainable urban planners will be tasked with reimagining towns and cities to prioritize pedestrians, cyclists, and public transit users over private vehicle owners, including designing walkable neighbourhoods, expanding bike lanes, and enhancing public transit systems. Transportation professionals who possess these skills will help lay the foundation for a future where sustainable transportation not only decarbonizes transit and mobility but also makes them more accessible and appealing to users.

Figure 7: Research and development, design, and engineering skills ranked in order of importance by respondents

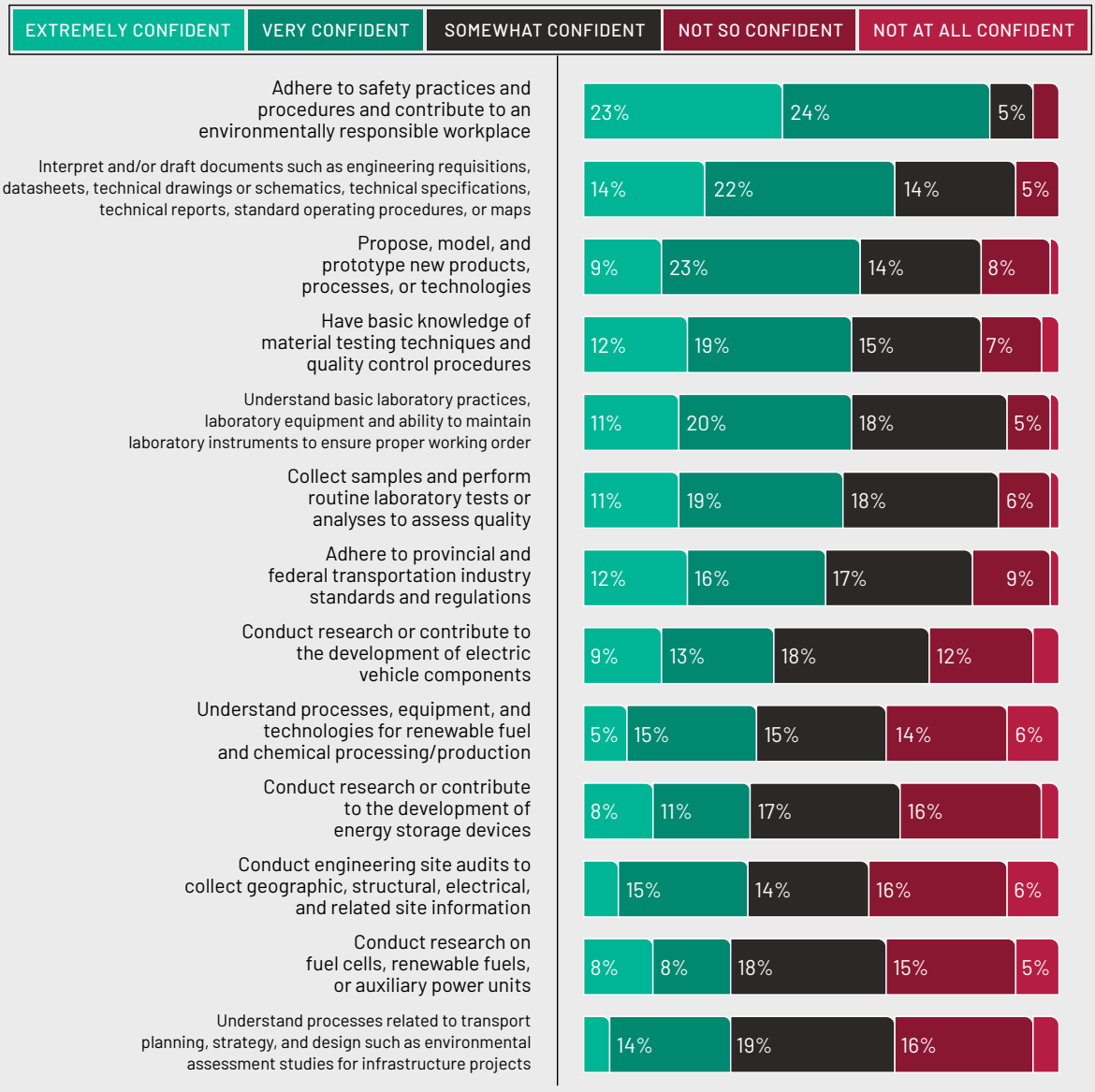


Data Source: ICTC's employer survey and web-scraped data from publicly available job sites

Student Familiarity with In-Demand Knowledge and Skills

Students and recent graduates interested in working in research and development, design or engineering transportation roles demonstrated high to moderate confidence in the associated skills. Students indicated the highest level of confidence in their ability to adhere to safety practices and procedures and contribute to an environmentally responsible workplace. This was followed by their ability to interpret or draft documents; and propose, model, and prototype new products, processes, or technologies. While student confidence in these skills was well-aligned with employer needs skills, confidence in other skills and abilities was not as well matched. For example, while employers indicated that they want entry-level talent to be able to adhere to industry standards and regulations, respondents to the student survey reported a low level of confidence in this skill. Similarly, while employers want entry-level talent who can conduct research, students reported a low level of confidence here. Students also reported low confidence in their ability to conduct engineering site audits and understand processes, equipment, and technologies for renewable fuel and chemical processing and production.

Figure 8: Research and development, design, and engineering skills and competencies



Data source: ICTC's student survey

Demand for Trades and Operations Roles and Skills

Trades roles encompass all roles that correspond with a skilled trades certification, such as automotive service technician, mechanic, electrician, pipe-fitter, or heavy-duty equipment operator. Operations roles, meanwhile, describe roles that are more hands-on, more functional in nature, or that directly relate to the operations of a transportation organization. Examples include transportation planner; inspector, tester, sorter, sampler, or weigher; light or heavy truck driver; hazardous waste technician; metre reader; and other hands-on operational roles.

Employer Demand for Labour

While trades and operations roles only accounted for 5% and 12% of entry-level job postings from August 2023 to January 2024, they were selected by the largest percentage of surveyed employers when asked about past and future hiring plans. Indeed, 27% of respondents to ICTC's employer survey had hired entry-level operations roles over the past few years and plan to hire this type of role over the next few years. For trades roles, these figures were 20% and 21%, respectively. The most probable reason for the discrepancy between publicly available job posting data and ICTC's employer survey is that many trades and operations roles are unionized and, therefore, are not posted on publicly available job sites. Trades and operations roles are often posted internally within unions or unionized organizations or through apprenticeship pathways tied to post-secondary institutions.

Looking at the employer survey data by sub-industry, EV employers and public transportation employers and EV employers were the most likely to hire trades roles. Freight and logistics employers and multimodal transportation employers were meanwhile most likely to hire operations roles. Trades and operations roles were also selected by employers as the most urgent to fill (the urgency of these roles is likely related to their immediate impact on business continuity).

In-Demand Trades Roles

- Automotive Engineering Technician
- Automotive Service Attendant / Technician
- Automotive Specialty Technician
- Chemical Technician
- Civil Engineering Technician
- Electrical and Electronic Equipment Assembler
- Electrical and Electronics Engineering Technician
- Electro-Mechanical Technician
- Engineer and Other Machine Assembler
- Fuel Cell Technician
- Industrial Engineering Technician
- Industrial Instrument Technician / Mechanic
- Industrial Machinery Mechanic
- Installer
- Maintenance and Repair Worker, General
- Manufacturing Production Technician
- Mechanical Engineering Technician

In-Demand Operations Roles

- Freight Forwarder
- General and Operations Manager
- Heavy and Tractor-Trailer Truck Driver
- Industrial Production Manager
- Light Truck Driver
- Manufacturing Manager
- Plant Operator
- Transportation Inspector
- Transportation Planner
- Transportation Worker, General

Employer Demand for Knowledge and Skills

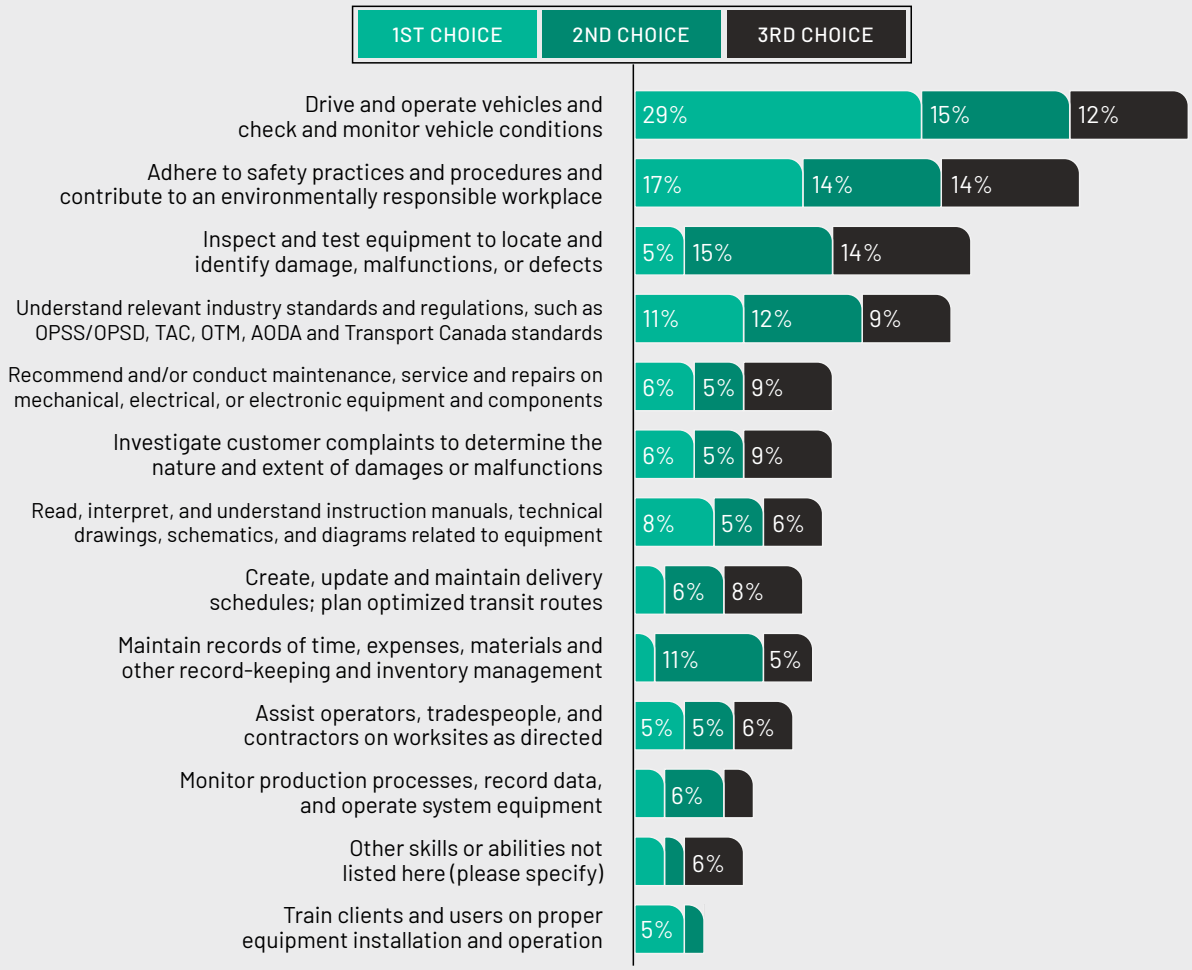
Employer survey respondents were asked to rank a set of trades and operations skills and abilities by order of importance (see Figure 9). Respondents were most likely to consider the ability to "drive and operate vehicles and check and monitor vehicle conditions" as important. This skill was selected as important by 56% of respondents. Next, 45% of respondents selected the ability to "adhere to safety practices and procedures and contribute to an environmentally responsible workplace." Meanwhile, 34% of respondents selected "the ability to inspect and test equipment to locate and identify damage, malfunctions, and defects," while 32% selected the ability to "understand relevant industry standards and regulations."

With the introduction and uptake of clean technologies in transportation, subject matter experts consulted for this study highlighted how trades and technician roles are experiencing some of the greatest changes in demand for skill sets. When asked what knowledge or skills are needed or emerging for entry-level trades or operations positions, the key informant interviewee's most commonly cited domain knowledge related to electrification. Beyond the fundamentals of industry terminology, entry-level employees working on light-, medium-, or heavy-duty vehicles must be increasingly competent in basic electrical electronics, basic diagnostics, recognizing how motors and inverters work (AC vs. DC), and understanding kilobytes and kilowatts, for example. One interviewee stated that "it comes down to a good theoretical understanding of the electrical side of things because if a student or graduate has that, then they will have the ability to work on a variety of different vehicles." In the context of electrification, interviewees discussed that mechanics and technicians working on transportation systems must be able to work with a variety of electrical systems and capable of conducting regular and preventive maintenance on battery systems, charging systems, pentagraphs or plug-in chargers, and solar energy systems.

The ability to work on these systems necessitates health and safety knowledge, which is indicated as significantly important in both the employer survey and by interviewees. For example, interviewees stated that workers entering or already in the industry should understand "the components and the level of chargers and their colour coding, where they're laid out in a vehicle, how they can affect you and how they operate." In addition to these competency requirements, interviewees highlighted that personal protective equipment (PPE) requirements are highly specific to certain compartments on a vehicle, and workers need to understand these nuances.

Interviewees also spoke about the data-driven nature of new and emerging technology and the shift to analytics over hands-on troubleshooting. As such, diagnostics and predictive maintenance were highlighted as another highly desired skill set. At the fundamental level, this requires understanding how to read diagrams and documents and make a diagnosis based on the diagram and the symptom. These fundamental requirements are expanding with the emergence of technology, such as AI systems for predictive maintenance. For example, interviewees shared that mechanics and technicians need to be able to "predict failures and breakdowns of [their] fleet using advanced technology." An employer from the public transit sector further explained that technology increasingly plays a significant role in preventive maintenance, and to intervene, employees should be able to gather and understand "what those insights mean and when [they] should be pulling that vehicle off the road."

Figure 9: Trades, operations, and functional skills ranked in order of importance by respondents

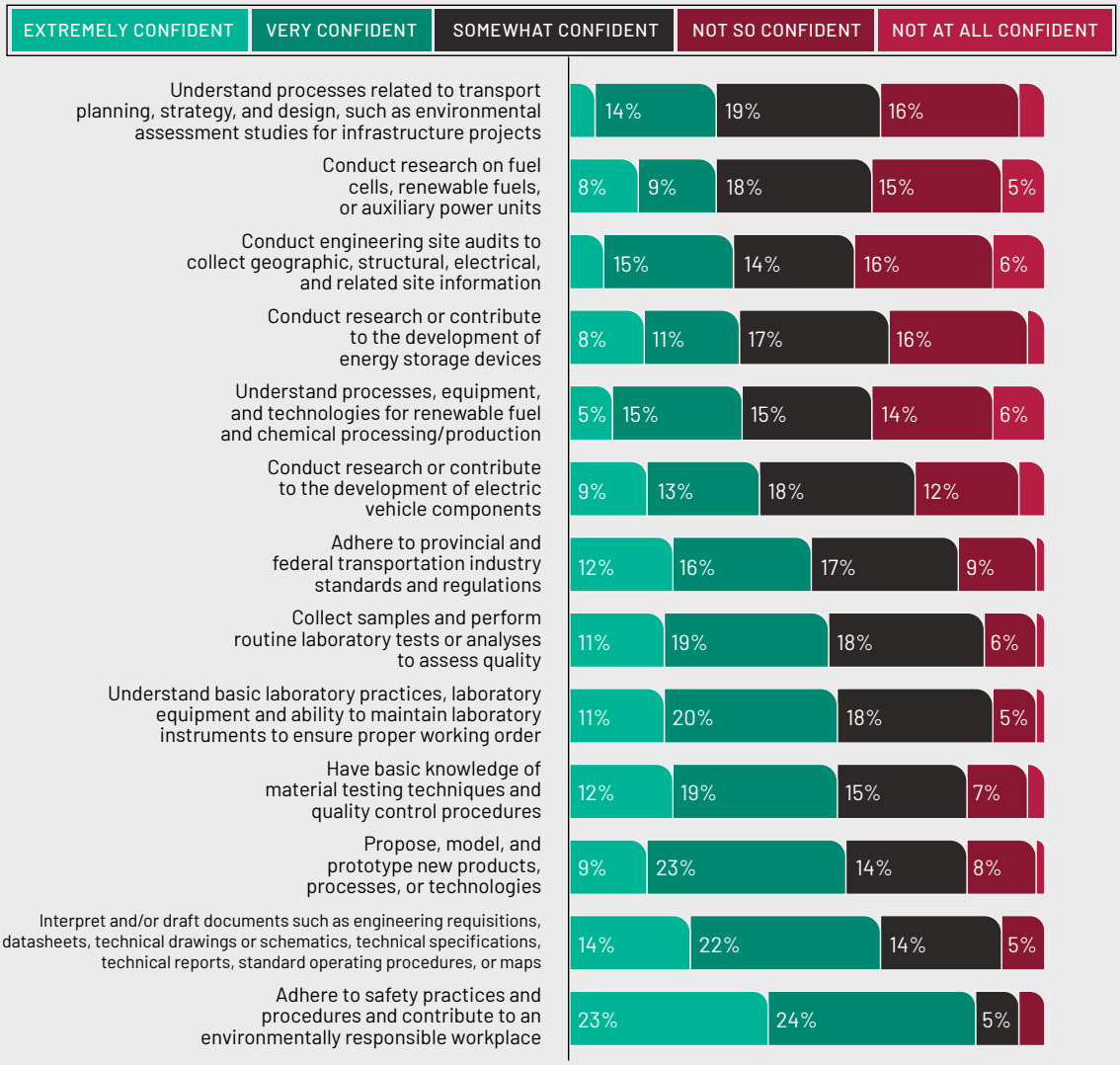


Data source: ICTC's employer survey

Student Familiarity with In-Demand Knowledge and Skills

Students and recent graduates interested in trades or operations roles felt most confident in their ability to adhere to safety practices and procedures and contribute to an environmentally responsible workplace. This was followed by record-keeping, inventory management, and operations planning skills (e.g., creating, updating, and maintaining delivery schedules). Students meanwhile reported a low level of confidence in their understanding of hydrogen storage, production, and loadout logistics, as well as how to assemble and install EV equipment, such as EV powertrains, charging stations, and vehicles. Interestingly, interviewees in this study similarly reported that students and new graduates lack familiarity with new technologies, such as EVs and EV charging stations. One interviewee referenced a "major lack in subject matter expertise," particularly related to electrification and electrical systems in general.

Figure 10: Student confidence in trades and operations skills and competencies



Data source: ICTC's student survey

Demand for Digital Technology Roles and Skills

Digital technology roles encompass all roles involved in the design, development, and deployment of digital technology solutions, including software programs, data, and ICT hardware. Examples include software developer, data scientist, data analyst, product manager, and IT specialist.

Employer Demand for Labour

Interviewees referenced digital technology roles as important in the evolution of the transportation sector. However, ICTC's employer survey suggests that when it comes to implementing technology as a core function, the transportation sector still has room to catch up. While technology roles accounted for 16% of the publicly available job postings that were collected by ICTC, only a small proportion of survey respondents had sought tech roles in recent years.

Of the jobs posted, 68% were for data analyst positions, followed by blockchain engineers (8%), robotics engineers (6%), software engineers and developers (5%), and computer network technicians (4%).

Looking closer at future hiring plans by subsector, multimodal transportation employers are most likely to hire digital technology roles. Data analyst positions are meanwhile in high demand among public transit, ride-sharing, and shared micromobility employers. One interviewee explained that emerging technologies enable transportation firms to easily collect large amounts of data, such as speed, acceleration rate, GPS location, temperature, and battery state of charge. As such, people with the ability to analyze large amounts of data are needed to make use of this data and enable business leaders to make data-informed decisions.

In-Demand Trades Roles

- Blockchain Engineer
- Computer and Information Systems Managers
- Computer Network Technicians
- Data Analyst
- Database Analysts / Administrators
- Information Systems Analysts and Consultants
- Information Systems Testing Technician
- Remote Sensing Technician
- Robotics Engineer
- Robotics Technicians
- Software Developers, Systems Software
- Software Engineers and Designers
- Transportation Modeller

Employer Demand for Knowledge and Skills

ICTC asked employer survey respondents to rank different types of software skills in order of importance (Figure 11). Three software skills were identified as most important by respondents: fleet management or transportation management systems, such as TMS', PC*Miler, XataNet, and Loadlink; business, management, and customer relations software, such as Excel, Visio, and Salesforce; and operating systems software, such as Linux, Windows, and Bash. Programming languages were not in demand among respondents, with only 7% of respondents selecting this skill as important; the two most common hard skills in digital tech job postings were SQL and Python.

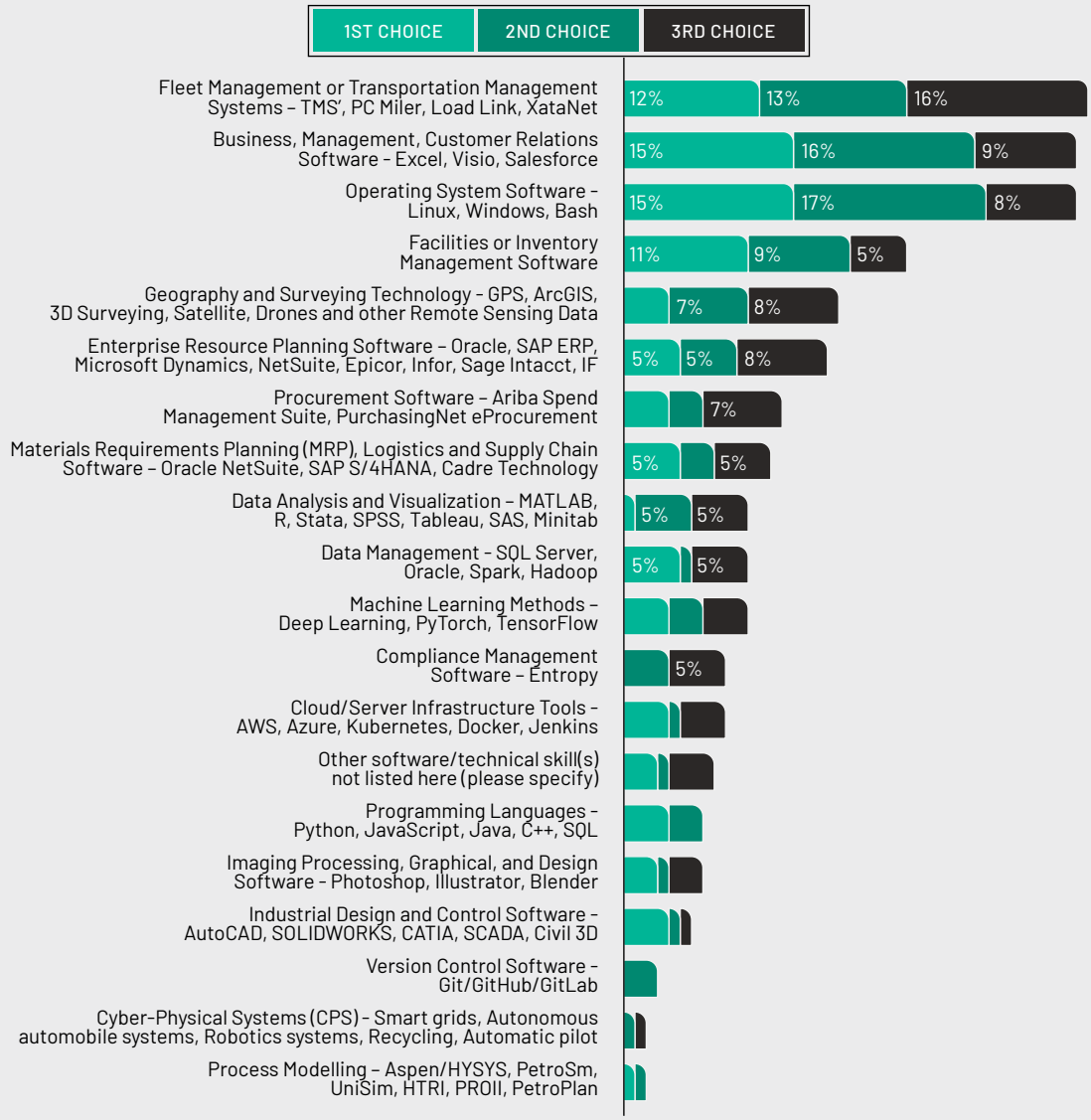
Subject matter experts consulted for this study expanded on which key digital technology skills are needed for entry-level talent in the environmentally sustainable transportation workforce. Across an array of role types, the top skill mentioned by interviewees was data analysis. The ability to analyze and interpret data is crucial for a variety of applications, from vehicle and fleet maintenance to optimizing transportation networks to assessing environmental impact and making informed decisions about infrastructure development.

Next, interviewees stated that entry-level talent with general knowledge of technologies relevant to the transportation sector is a useful asset. Some interviewees cited a "deep need" for technical knowledge in computer science and computer engineering that could then be applied to solve transportation challenges. As more advanced software becomes integrated with vehicle diagnostic systems, for example, employers also highlighted the importance of people working in trades, such as mechanics and technicians, having a general understanding of key technologies or systems.

For prospective digital tech hires in the multimodal transportation sector, proficiency in emerging technologies such as the internet of things (IoT) and familiarity with connected signalling systems are becoming essential qualifications. One employer shared that while these are skills that can be developed on the job, new entrants should still come with a basic understanding. As one employer noted, "[New hires should be] able to, at least conceptually, understand how these technologies work, [and] if they haven't had experience [with those concepts], be keen to learn more."

Interviewees also highlighted geographic information systems (GIS) and AutoCAD as foundational digital skills for entry-level R&D, design, and engineering positions. Proficiency in GIS and AutoCAD enables individuals to analyze spatial data, design transportation systems, and contribute to infrastructure development. However, while expertise with these tools is valuable, employers largely indicated a willingness to train candidates in these areas.

Figure 11: Employer perspectives on important software skills

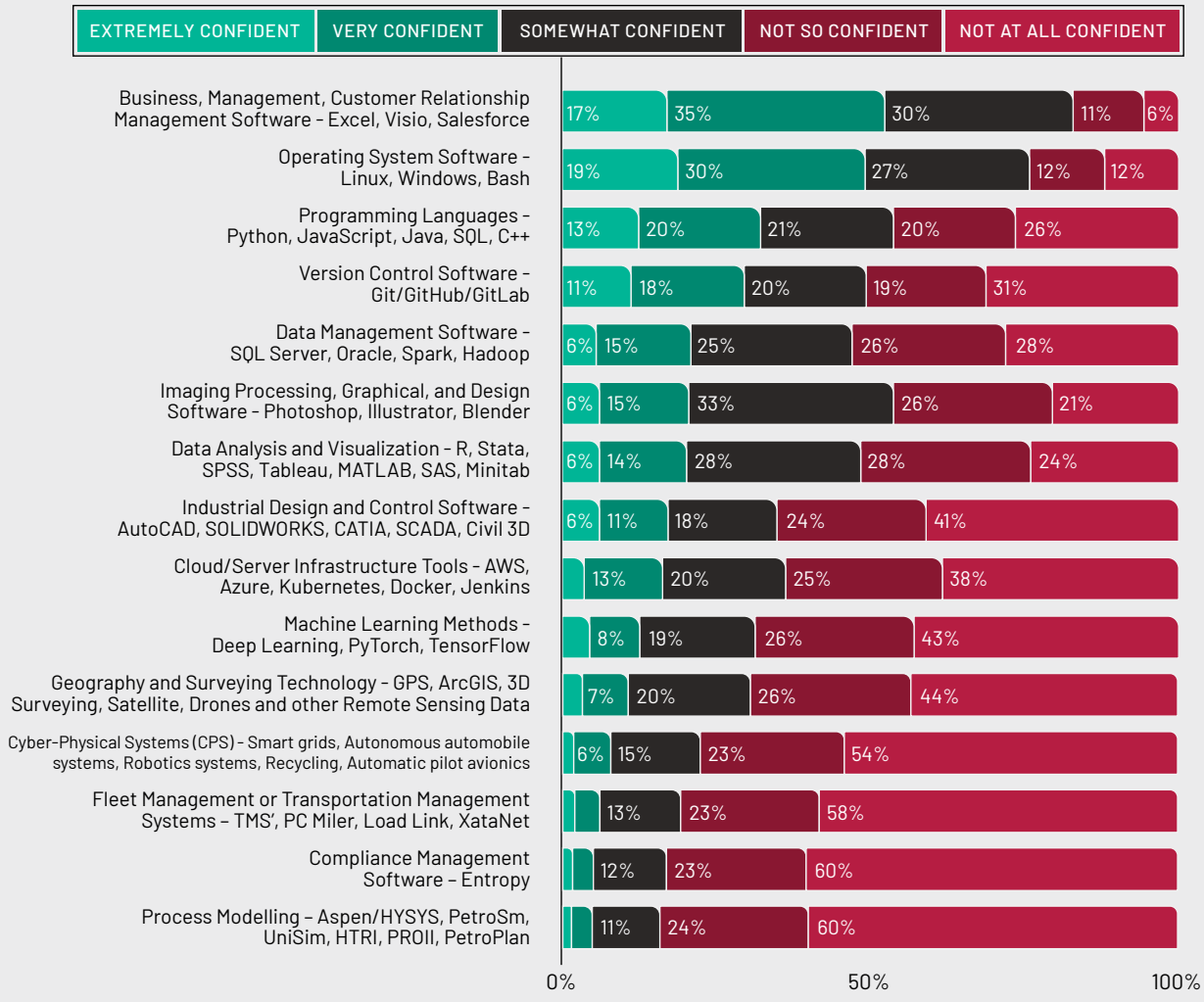


Data source: ICTC's employer survey

Student Familiarity with In-Demand Knowledge and Skills

In terms of digital technology-related skills, students generally demonstrated a lack of confidence in fleet or transportation management systems; 80% of respondents were "not so" or "not at all" confident with their skills in this area. Students reported the highest degree of confidence in business management and customer relationship management software, followed by operating system software and then programming languages like Python, Javascript, C++ and SQL. While some of these align with the priorities of some employers, others (i.e., low confidence with fleet and transportation management systems) suggest a mismatch between areas of strongest employer demand and student competence. Work-integrated learning opportunities can help students gain exposure to real-life, in-demand skills and undertake additional or supplemental training to fill gaps.

Figure 12: Student familiarity with technology-related skills.
Distribution of responses to the question, **"How confident are you using the following tools?"**



Data source: ICTC's student survey

Demand for Regulatory, Administrative and Other Business Functions Roles and Skills

Administrative and other business function roles relate to the business functions of an operation, including financial planning, organizational management, and administrative oversight. Examples include business analyst, production planning and expediting clerk, project coordinator, procurement or supply chain analyst, logistics coordinator, and other roles related to communications, marketing, sales, and customer service. Civil and regulatory roles, meanwhile, comprise roles related to regulatory compliance, government relations, or public affairs. They include roles like regulatory specialist, liaison or advisor, compliance and monitoring specialist, Indigenous relations specialist, and government relations analyst.

Employer Demand for Labour

Administrative and other business functions accounted for the fifth largest share of entry-level job postings (8%); this includes roles such as project management specialists, transportation planners or analysts, logistics analysts, health and safety coordinators, and sales workers. According to ICTC's employer survey, 19% of respondents had hired administrative and other business function roles over the past few years. When reporting future hiring plans, 21% of surveyed employers suggested they will need to hire these roles in future.

Despite consensus on the value of workers with regulatory knowledge and competence, regulatory roles themselves are highly specialized. For such roles, hiring frequency and volume tend to be low. Smaller companies may choose to outsource these roles to firms that specialize in regulatory analysis and advisory services, versus hiring these workers in house. As such, regulatory roles represent a small amount of overall hiring in the transportation sector. Regulatory affairs specialists, for example, represent just 1% of all job postings.

In-Demand Administrative and Other Business Function Roles

- Health and Safety Coordinator / Specialist
- Logistician
- Logistics Analyst
- Logistics Management Analyst
- Project Management Specialist
- Sales Worker
- Transportation Analyst
- Transportation Program Manager

In-Demand Regulatory Roles

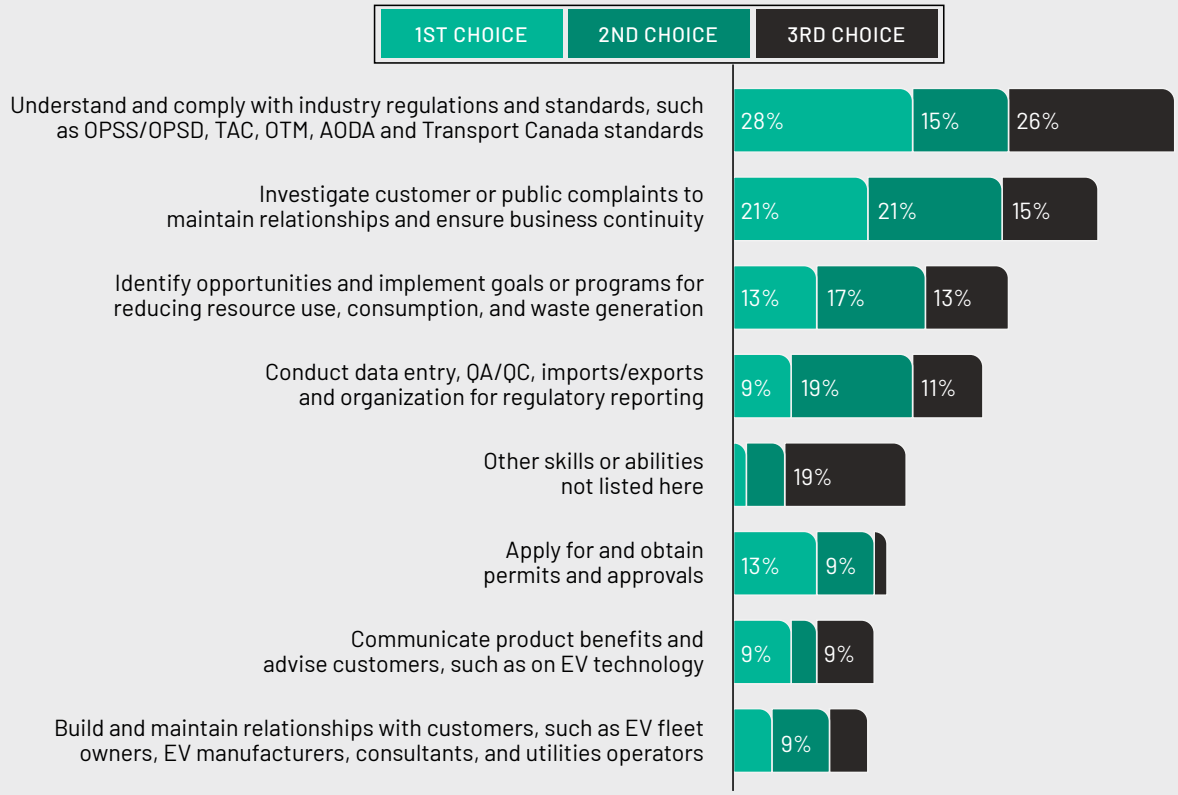
- Regulatory Affairs Specialist

Employer Demand for Knowledge and Skills

Employer survey respondents were asked to rank a set of regulatory, admin, or other business function skills and abilities by order of importance (Figure 13). Respondents were most likely to consider the ability to "understand and comply with industry regulations and standards" as important. This skill was selected as important by 69% of respondents. Next, 57% of respondents selected the "ability to investigate customer or public complaints to maintain business relationships and ensure business continuity." Meanwhile, 43% of respondents selected "identify opportunities and implement goals for programs for reducing resource use, consumption, and waste generation," and 38% selected the ability to "conduct data entry, quality assurance and quality control, and oversee regulatory reporting for imports and exports."

As revealed through interviews with subject matter experts, sales or business development skills are in high demand among sustainable transportation employers. These individuals ideally have experience in both commercial and consumer sales, but at the entry level, employers mostly look for someone who understands the industry and is skilled at building relationships. Employers also seek new hires with political acumen. As explained by one employer, it is important that talent "understands how the work we're doing fits into the current political situation."

Figure 13: Regulatory, administrative, and other business function skills ranked in importance by employers

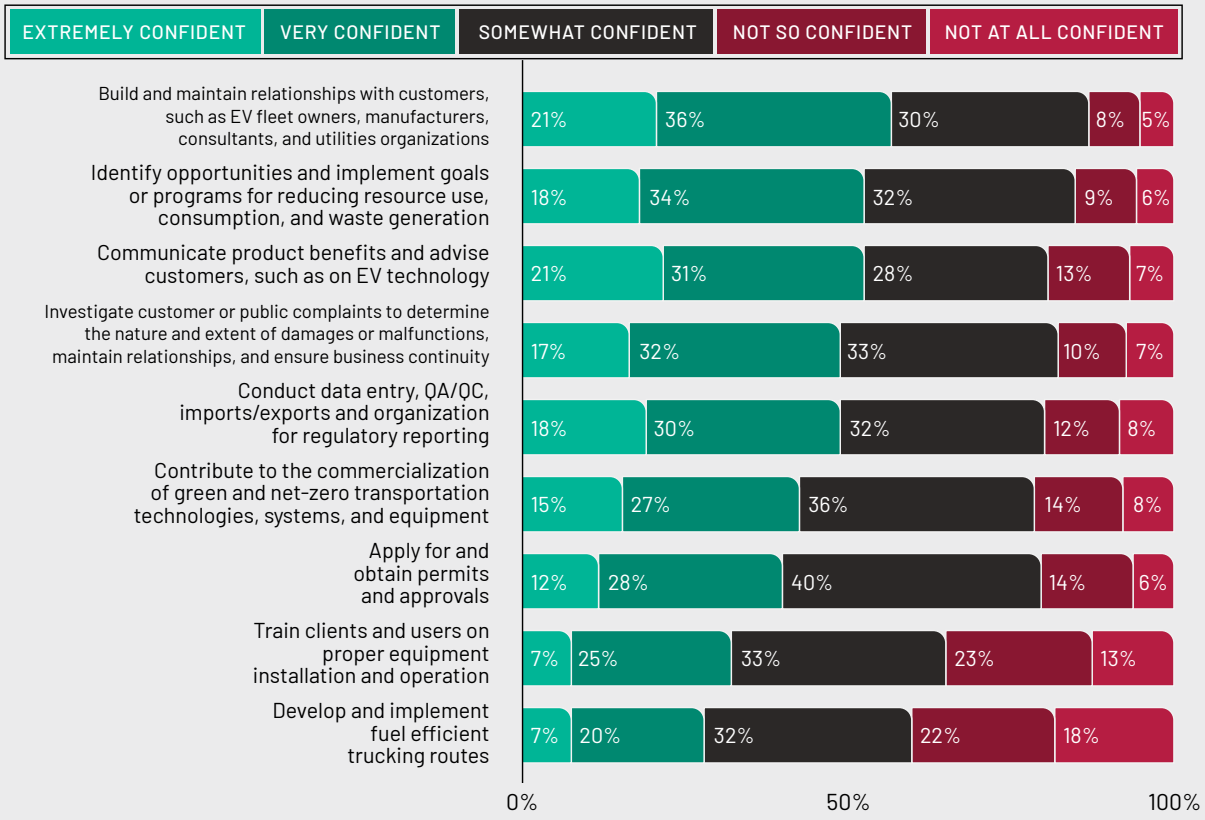


Data source: ICTC's employer survey

Student Familiarity with In-Demand Knowledge and Skills

Overall, there was an even distribution of confidence levels among students and recent graduates interested in working in regulatory, administrative, or other business function transportation roles (Figure 14). Students were most confident in their ability to build and maintain relationships, identify opportunities; implement goals or programs for reducing resource use, consumption, and waste generation; and communicate product benefits and advise customers, such as on EV technology. Conversely, respondents were least confident in their ability to apply for and obtain permits and approvals, train clients and users on proper equipment installation, and operate, develop, and implement fuel-efficient trucking routes.

Figure 14: Student level of confidence in regulatory, administrative and other business function skills and competencies



Data source: ICTC's student survey

Demand for Environmental or Sustainability Roles and Skills

Environmental or sustainability roles comprise all roles related to environmental sustainability, including roles related to environmental science, corporate environmental sustainability strategies, or sustainability reporting. Examples include environmental engineers, sustainability specialists, and industrial ecologists.

Employer Demand for Labour

Environmental or sustainability roles accounted for the third largest share of entry-level transportation job postings. However, surveyed employers' hiring plans show a slight decrease in the demand for environmental and sustainability roles over time, dropping from 10% of employers hiring over the past few years to 9% of employers planning to hire in the next few years. The subsectors most often looking to hire environmental or sustainability roles include (1) transportation infrastructure, (2) transportation technology, and (3) electric vehicle employers.

In-Demand Environmental or Sustainability Roles

- Environmental Economist
- Environmental Education Specialist
- Environmental Engineer
- Environmental Engineering Technician
- Industrial Ecologist
- Sustainability Consultant
- Sustainability Specialist

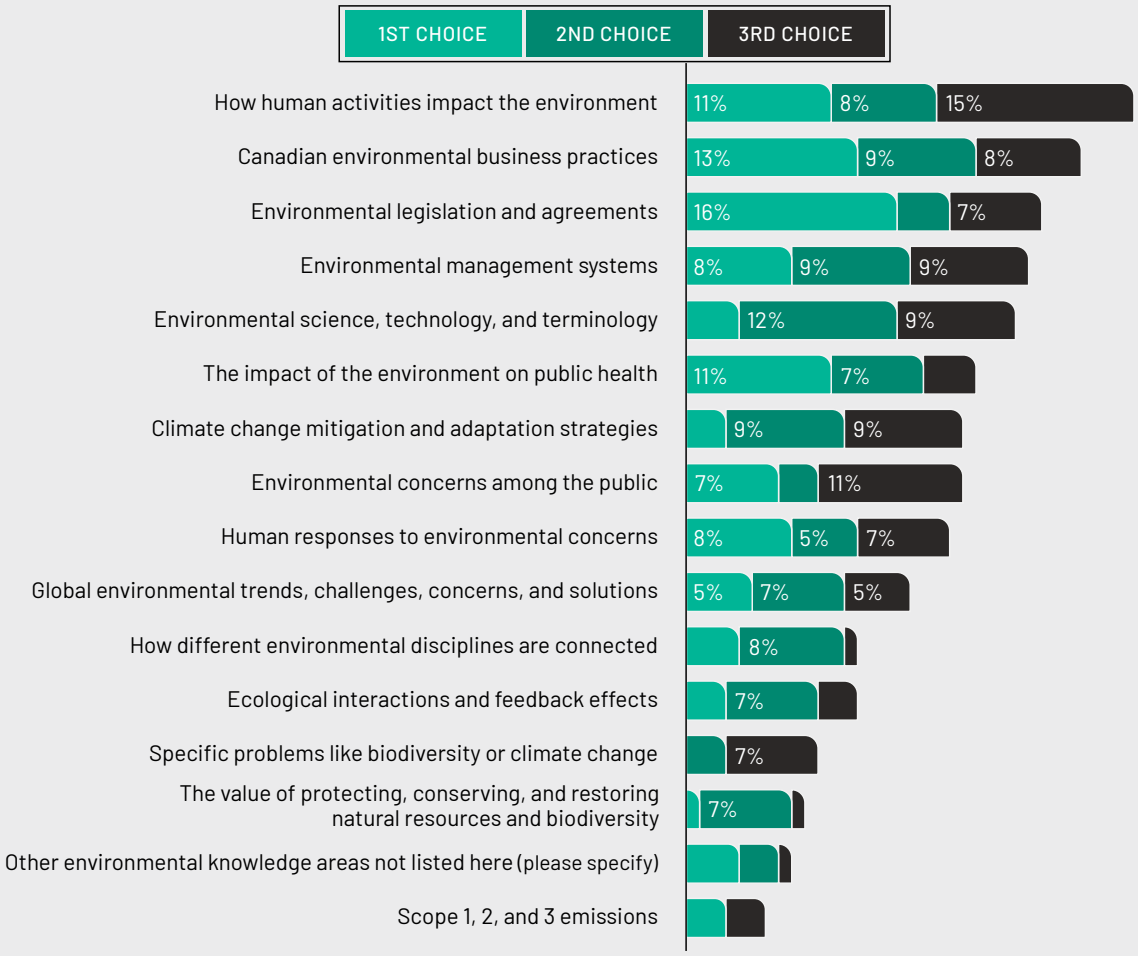
Employer Demand for Environmental Sustainability Knowledge

Employers and post-secondary students were asked to rate environmental knowledge areas and environmental skills. These competencies were adapted from ECO Canada's list of core knowledge areas for environmental workers, published in 2016.[68] Employers were asked to rank their top three environmental knowledge areas (Figure 15) and a list of environmental skills (Figure 17) by order of importance, while students were asked to self-assess their familiarity with these environmental knowledge areas (Figure 16) and skills (Figure 18).

As seen in Figure 15, employers were most likely to consider "how human activities impact the environment" as important knowledge for entry-level hires to possess, with about one-third (34%) of respondents selecting this among their top three. Knowledge about "Canadian environmental business practices" was also ranked as highly important, as were "[knowledge of] environmental legislation and agreements" and "[knowledge of] environmental management systems." Conversely, knowledge of specific areas like biodiversity or climate change, the value of protecting, conserving, and restoring natural resources and biodiversity, and GHG emission measures were considered less important for entry-level transportation talent to be familiar with.

68 "Competencies for Environmental Professionals in Canada," August 2016, *ECO Canada*, https://info.eco.ca/action/attachment/42902/f-65f916cd-d7be-432b-9bce-6f8bcbb92dce/1/-/-/-/-/NOS-for-Environmental-Professionals-ECO-Canada.pdf

Figure 15: Employer perspectives on the importance of environmental knowledge areas

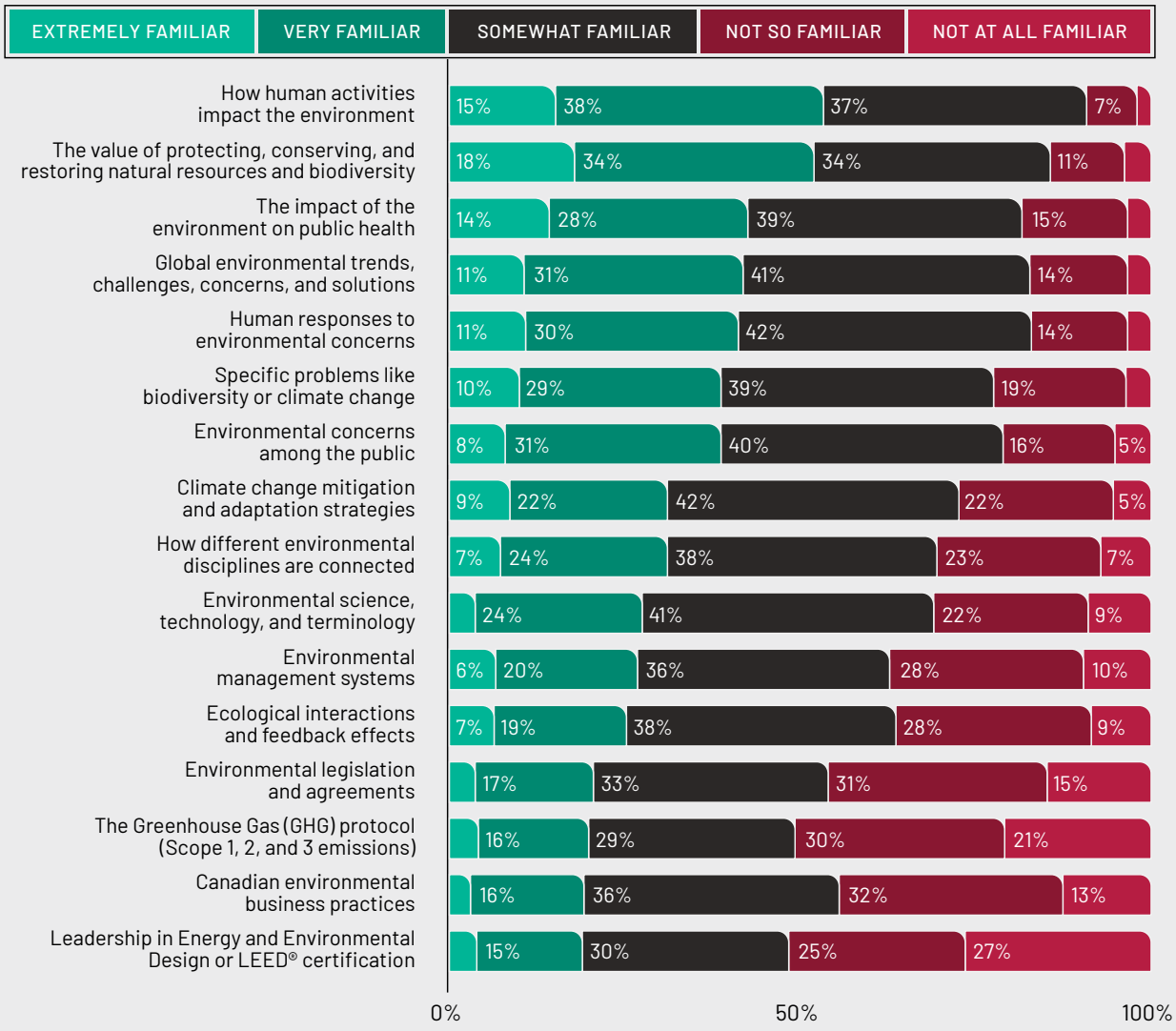


Data source: ICTC's employer survey

Student Familiarity with Environmental Sustainability Knowledge

With respect to students' knowledge of how human activities impact the environment, there is a strong match between employer demand and student familiarity. Over 50% of students indicated that they were "extremely familiar" or "very familiar" with this knowledge area. However, other survey results point to knowledge gaps, particularly related to Canadian environmental business practice: 46% of students reported "not at all" and "not so" familiar with this area; just 19% reported being "very" and "extremely" familiar with it. Students also reported a low level of familiarity with environmental management systems, environmental legislation, ecological interactions and feedback effects, GHG measurement and reporting methodologies, and best practices for environmentally sustainable design.

Figure 16: Student familiarity with environmental topics



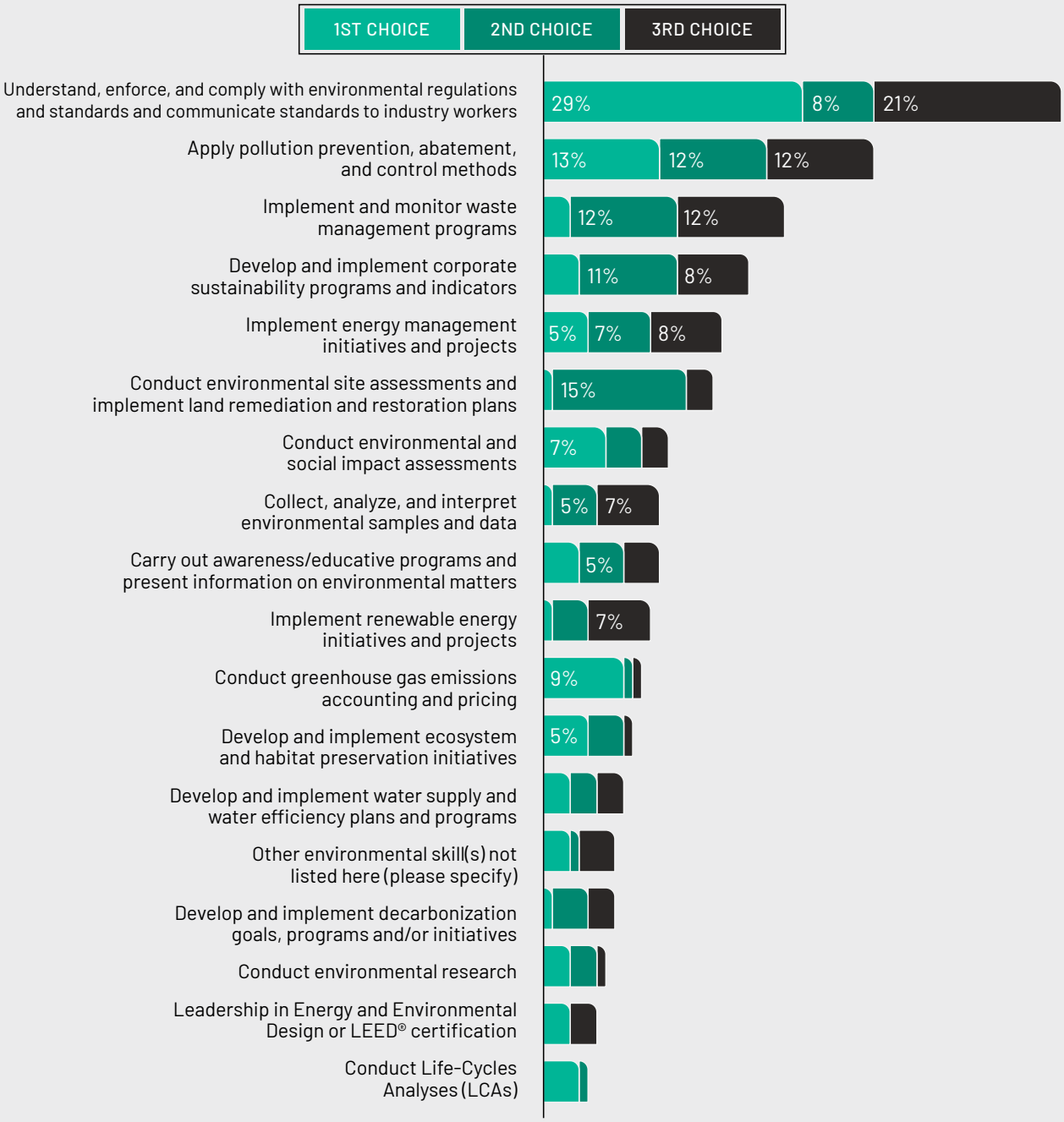
Data source: ICTC's student survey

Employer Demand for Environmental Sustainability Skills

For environmental skills, over half the surveyed employers (58%) were most likely to consider the ability to "understand, enforce, and comply with environmental regulations and standards" as important, and 37% selected the ability to "apply pollution prevention, abatement, and control measures" as important. Of lesser importance but still relevant to employers were the ability to "implement and monitor waste management programs" and the ability to "develop and implement corporate sustainability programs and indicators."

Nevertheless, some environmental skills for entry-level hires emerged in discussions with interviewees, namely as areas of future demand that will come with the broader evolution of the sector. At a high level, this includes an understanding of how transportation fits into the broader picture of environmental sustainability initiatives; the ability to think about the environmental impacts of specific products, services, or activities, such as purchasing a tire; and knowledge of what carbon budgets are and what strategies can be used to reduce GHG emissions from transportation.

Figure 17: Employer perspectives on environmental sustainability skills, ranked by importance

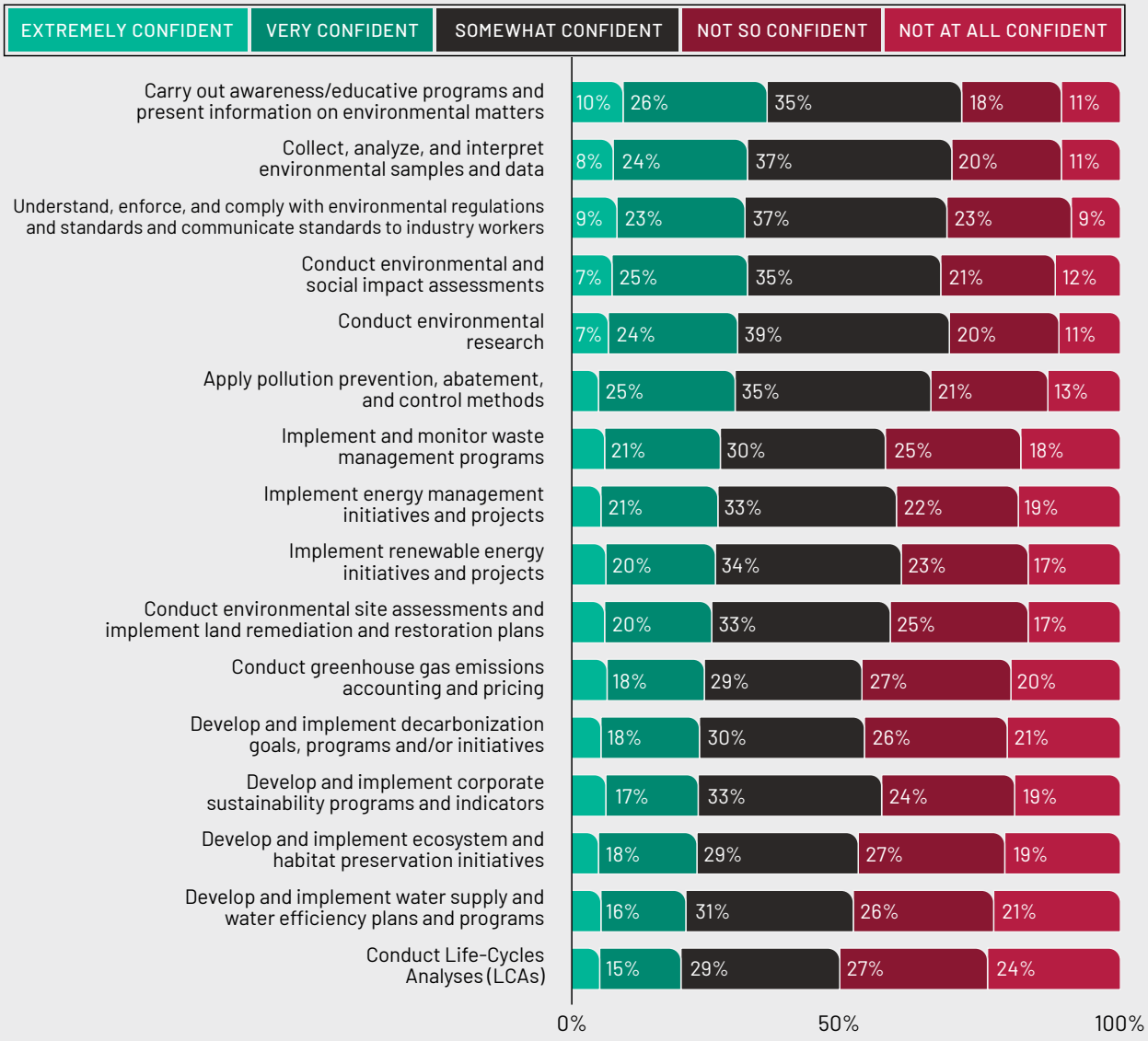


Data source: ICTC's employer survey

Student Familiarity with Environmental Sustainability Skills

Results from the student survey show mixed levels of confidence across all environmental skills, including those referenced as most important to employers. For example, while 31% of respondents felt "extremely" and "very" confident in their ability to understand, enforce, and comply with environmental regulations and standards, over one-third was only "somewhat confident" (37%) with these skills.

Figure 18: Student confidence in environmental sustainability skills



Data source: ICTC's student survey

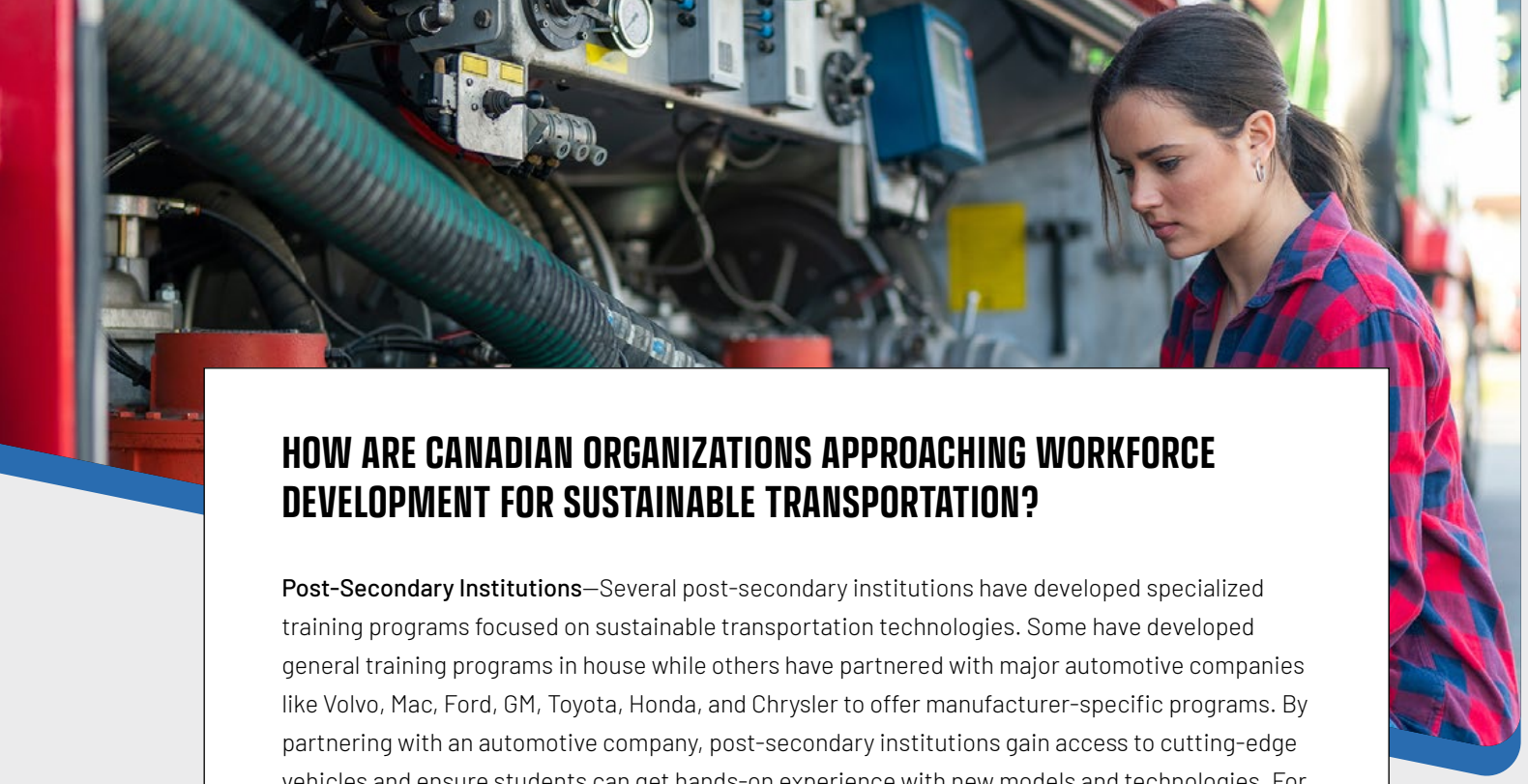
DEMAND FOR CROSS-DISCIPLINARY SKILLS

Survey respondents, interviewees, and job postings also highlighted the demand for cross-disciplinary skills—that is, skills that pertain to the entire transportation workforce as opposed to a specific job or role. Analysis of job posting data indicated a need for problem solving, written communication, and time management across different types of transportation roles. Interviewees indicated that there is a need for entry-level employees with foundational skills, such as literacy and numeracy, adaptability and problem solving, and domain knowledge related to energy and transport.

Foundational Skills— Teamwork, leadership, communication, and interpersonal skills were highly valued foundational skills across all roles. In addition to this, interviewees noted that an acceptable level of basic literacy and numeracy skills are required to advance in the hiring process for a variety of transportation roles, particularly for roles like mechanic and technician, which may not require post-secondary education.

Adaptability and Problem Solving—Many interviewees highlighted the importance of skills associated with problem solving, including flexibility, adaptability, research and analytical skills, critical thinking, and a willingness to learn. Many sustainable transportation solutions are only now being developed, making it impossible to include them in post-secondary programs. As one interviewee noted, the more sustainability is built into the transportation sector, the more adaptable the workforce will need to be. An associated skill requirement is systems thinking, which helps individuals think about real-world challenges and solve problems holistically. As one interviewee shared, "We need people to really understand systems, the building blocks of how things are constructed and how they operate… We're not training them for something that's built today. We're training them to understand the systems that are going to layer upon systems as they evolve in the future."

Knowledge of the Transportation and Energy Domains—Interviewees highlighted a strong demand for a joint understanding of the energy and transportation sectors. Sustainable transportation projects are, in many ways, energy projects. Interviewees spoke of a "marriage" between the energy and transport sectors and indicated that there is a growing need for professionals who can design, build, and maintain cross-sectoral infrastructure. Cross-sector education that informs transportation workers about energy and electricity and utilities workers about transportation operations can help meet this need.



HOW ARE CANADIAN ORGANIZATIONS APPROACHING WORKFORCE DEVELOPMENT FOR SUSTAINABLE TRANSPORTATION?

Post-Secondary Institutions—Several post-secondary institutions have developed specialized training programs focused on sustainable transportation technologies. Some have developed general training programs in house while others have partnered with major automotive companies like Volvo, Mac, Ford, GM, Toyota, Honda, and Chrysler to offer manufacturer-specific programs. By partnering with an automotive company, post-secondary institutions gain access to cutting-edge vehicles and ensure students can get hands-on experience with new models and technologies. For example, Vancouver Community College's "Zero Emissions Vehicle Service and Technology" course teaches automotive service technicians how to "safely diagnose and service high voltage EVs and hydrogen fuel cell vehicles."[69] By partnering with Toyota Canada, Vancouver Community College got access to Toyota Mirai, one of the first hydrogen fuel cell vehicles to be released in Canada.[70]

Micro-Credentials—Micro-credentials in areas like clean transportation technology, EVs, and hydrogen fuel cells have emerged. They tend to focus on niche areas of sustainable transportation technology and are helpful options for experienced professionals looking to obtain new skills, as well as students wanting to expand their training beyond traditional transportation curricula.

Original Equipment Manufacturers—Within the public sector, one of the primary sources for sustainable transport training is original equipment manufacturers (OEMs). Often, when public organizations acquire EV fleets, they will bundle training as part of their purchase. Because of this, many public transit employees receive training directly from OEMs like Proterra, New Flyer, and Ballard rather than through post-secondary or other training institutions. As one interviewee shared, "The company that sold us our electric bus fleet is responsible for training our employees, not only the operators of the buses but the mechanics and technicians as well, including understanding what's required in the way of special tools or personal protective equipment, such as clothing to prevent electrical shock." Relying on OEMs for training provides adopters of sustainable transport solutions with convenient training; however, interviewees noted that this kind of approach can be costly and risky in the long run and suggested that it will be important for large organizations to find other ways to diversify training options as EVs and other sustainable transport solutions become more commonplace.

On-the-Job Training—On-the-job training plays a pivotal role in helping existing employees develop new skills. For many transportation employees, particularly those who are in mid-career, their first contact with sustainable transportation technologies will be troubleshooting new technologies in their existing role.

69 "Zero Emissions Vehicle Service and Technology," March 2024, VCC, https://continuingstudies.vcc.ca/search/publicCourseSearchDetails.do?method=load&courseId=2387146

70 "Media Release: VCC acquires hydrogen vehicle for student training," July 2022, VCC, https://www.vcc.ca/about/college-information/news/article/media-release-vcc-acquires-hydrogen-vehicle-for-student-training.html

CONCLUSION

As sustainability initiatives and technologies permeate Canada's transportation sector, there will be a growing demand for knowledge and skills related to sustainable transportation. Changing knowledge and skill requirements could make it difficult for transportation employers to find employees with the right mix of skills for their organizations. Already, most transportation employers find it either somewhat or very challenging to find employees with the right mix of skills. The ability of transportation employers to hire entry-level talent is constrained by a number of factors, including increasing competition between the transportation and energy sectors for the same pool of qualified labour; increased retirement rates among senior employees, particularly in trades roles; difficulty attracting young people and recent graduates to careers in transportation and the trades; difficulty attracting diverse candidates, such as women and other underrepresented groups; and difficulty balancing present and future labour market needs.

Transportation employers require a wide array of entry-level talent, including trades and operations roles, research and development, design and engineering roles, digital technology roles, business and marketing roles, and environmental and sustainability roles. All of these play a unique part in navigating the evolving landscape of sustainable transport. Data from ICTC's employer survey and publicly available job postings suggest that operations roles; and research and development, design, and engineering roles account for the largest share of entry-level talent demand in the transportation sector. This is followed by trades roles, administrative and other business function roles, digital technology roles, and environmental sustainability roles. While civil and regulatory tasks are important to the transportation sector, these types of tasks are often amalgamated into other administrative roles or outsourced to regulatory firms, as opposed to being hired in house.

Across multiple types of roles, transportation employers value entry-level employees who can adhere to relevant industry standards and regulations, adhere to safety practices and procedures, and contribute to an environmentally responsible workplace. In trades and operations roles, transportation employers also value entry-level employees who can operate, inspect, diagnose, and repair different types of vehicles and vehicle components. In administrative and other business function roles, employers value entry-level employees who can investigate customer or public complaints to maintain relationships and business continuity.

In terms of environmental sustainability, employers value entry-level employees who understand how human activities impact the environment and are familiar with Canadian environmental business practices. Two other valued skill sets in the area of environmental sustainability are the ability to understand, enforce, and comply with environmental standards, legislation, and agreements and the ability to use tools like environmental management systems to reduce environmental impacts, such as pollution and waste.

In terms of digital technology skills, employers value entry-level talent who are familiar with software programs for fleet management, transportation management, business and customer relations management, operating systems, and facilities and inventory management. Employers also note that due to an influx of data, transportation employers need workers who can work with large amounts of data to derive insights, implicating skills related to data analysis.

For Canada's transportation sector to adopt environmental sustainability initiatives and technologies, it will be important for entry-level talent to be interested in job opportunities that emerge in the transportation sector and proficient in the skills and competencies that transportation employers need. Post-secondary institutions, micro-credential providers, original equipment manufacturers, and on-the-job training are all part of the puzzle when it comes to meeting employer demand for entry-level roles, knowledge, and skills.

RESEARCH METHODOLOGY AND LIMITATIONS

RESEARCH METHODOLOGY

Secondary Research

Existing Literature

This project was supported by a thorough review of available literature about the transportation industry, environmental sustainability and clean technology trends in the transportation industry, and their impact on the transport labour market. The literature review helped shape research methods and questions and provided information to help further validate the findings in the report. The initial literature review helped identify interviewees, advisory committee participation, and form a methodology for the quantitative portion of the research.

Web Scraping

ICTC's data science team used web scraping and machine learning techniques to web scrape jobs and skills-related data from online job posting sites. The scraped data was parsed and analyzed to assess the most in-demand jobs and skills related to environmental sustainability in Canada's transportation industry. While job postings provide valuable data for jobs and skills analysis, it is worth noting that web-scraped data may not be reflective of all in-demand roles due to sectoral differences in how job opportunities are shared and how employers find suitable candidates.

Primary Research

Key Informant Interviews

ICTC conducted 16 key informant interviews with diverse experts on environmental sustainability and the green transition in Canada's transportation industry. Interviews were conducted from September 2023 – January 2024. Interviewees held influential positions within their organizations, including that of Director of Fleet, Chief Technology Officer, Dean of the School of Transportation, and others. The interview questions were tailored to collect information about the interviewee's experiences within their companies and within the transportation industry, such as their opinions about sustainability practices and trends in Canadian transportation sectors and the impact of environmental sustainability on Canada's transportation labour market. The interviews were coded in NVIVO using a combined inductive and deductive approach.

Employer Survey

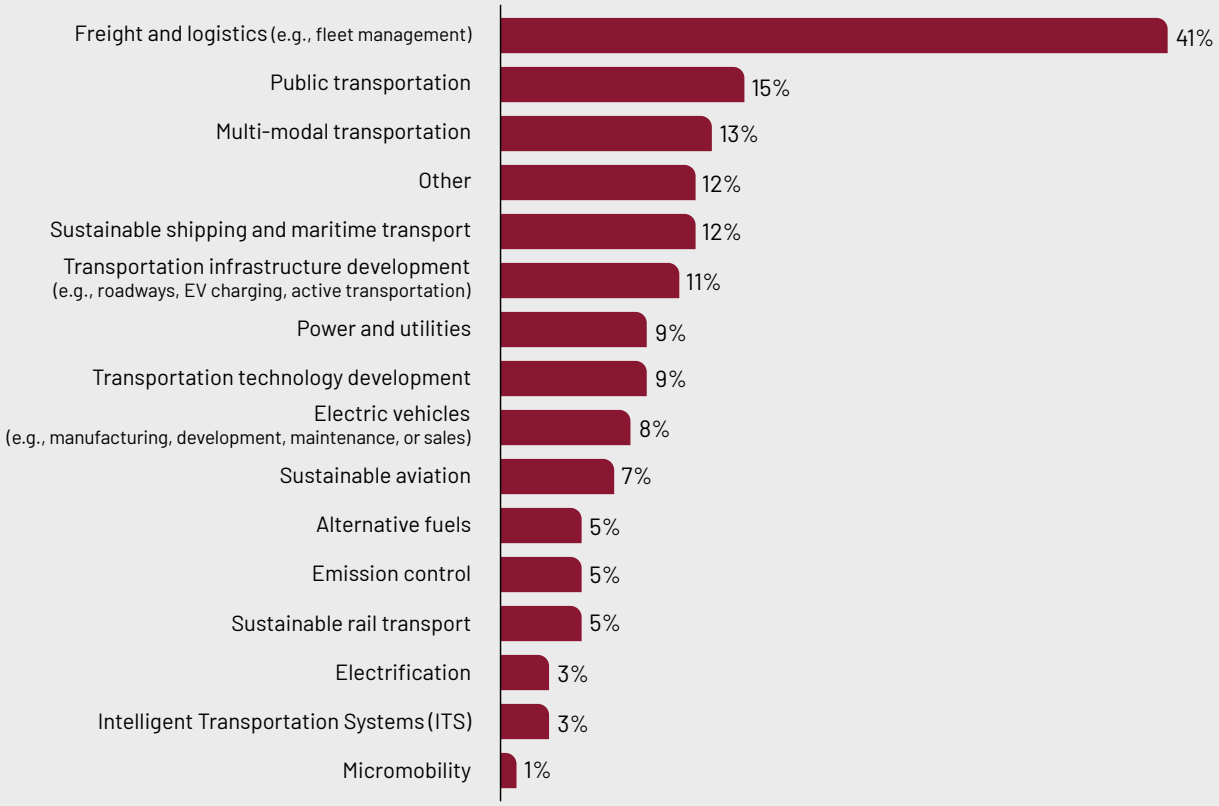
ICTC contracted a vendor to conduct a survey of 75 transportation professionals located across Canada. The survey was conducted from August – September 2023. To be included in the survey, respondents had to, at the time of responding, be involved in hiring or skills assessment for an organization doing work in or for the transportation industry, where the organization is trying to improve the environmental sustainability or efficiency of the sector. Respondents were asked about their recent entry-level hiring activity, entry-level hiring plans for the next few years, training and education preferences, and entry-level skills needs. In developing the survey questions, ICTC utilized data from O*NET Online, which is hosted by the Occupational Information Network and the United States Department of Labour, Employment, and Training. In addition to this, ICTC utilized ECO Canada's list of core knowledge areas for environmental workers, published in 2016. The employer survey questions were aligned with the questions posed in the student survey in order to allow for comparability between the survey responses.

Large businesses with 100 to 499 (19%) or more than 500 employees (35%) account for a large proportion of the survey sample (together, 54%), which could impact the applicability of the survey results to the general economy, considering that large businesses make up only a small percentage of the Canadian economy. That said, large businesses conduct a lot of hiring, making their hiring insights useful. Freight and logistics was the most common subsector among respondents, at 41%, followed by public transportation (15%), multimodal transport (13%), sustainable shipping and maritime transport (12%), and transportation infrastructure (11%).

Geographically, 41% of the respondents were located in Ontario, 21% in BC, 17% in Alberta, 9% in Saskatchewan, 4% in Manitoba, 3% in Quebec, and 1% in NB, NFL, and NS, respectively.

For 56% of the respondents, hiring and human resource management is a regular part of their responsibilities; 24% are sometimes involved in hiring or skills assessment; 16% are only involved in these activities in an advisory capacity; and 4% manage new hires.

Figure 19: Breakdown of employer survey respondents by subsector



Data source: ICTC's employer survey

Student Survey

ICTC conducted an in-house survey of 669 students across Canada who are registered in post-secondary and college programs relevant to sustainable transportation. To deliver the survey, ICTC partnered with a number of college and university faculties and departments across Canada, in addition to utilizing its own repositories of student contacts. Students were asked about their plans for future employment and education, which industries they want to work in and why, and how comfortable they are with a variety of sustainable transportation skill sets.

In developing the survey questions, ICTC utilized data from O*NET Online, which is hosted by the Occupational Information Network and the United States Department of Labour, Employment, and Training. In addition to this, ICTC utilized ECO Canada's list of core knowledge areas for environmental workers, published in 2016.[72] The student survey questions were aligned with the questions posed in the employer survey to allow for comparability between the survey responses.

72 "Competencies for Environmental Professionals in Canada," August 2016, ECO Canada, https://info.eco.ca/acton/attachment/42902/f65f916cd-d7be-432b-9bce-6f8bcbb92dce/1/-/-/-/-/NOS-for-Environmental-Professionals-ECO-Canada.pdf

RESEARCH LIMITATIONS

While efforts were made to mitigate potential biases, there are certain limitations that may be embedded in this study, nonetheless. While ICTC made a concerted effort to speak with a diverse range of sustainable supply chain stakeholders, the trends identified through key informant interviews and advisory committee meetings should be interpreted only as the experiences of those interviewed. In total, ICTC conducted 16 interviews, a sample that is too small to be considered representative of the entire industry. Similarly, while ICTC made a concerted effort to reach a comprehensive survey sample, there may be inherent biases in the data provided by survey respondents.

ICTC consulted experts and employers from a variety of industries, including electric and zero-emissions vehicles, public transportation, transportation technology, multimodal transportation, power and utilities, freight and logistics, and transportation infrastructure. However, ICTC did not consult any experts or employers focused on maritime transportation, aviation, or locomotive rail. The decision to exclude the above subsectors was determined based on the prevalence of road transportation in the "green transition," the availability of technologies, the nature of labour market changes and related workforce development needs, and the availability of information when conducting this research.