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## Palette Skills Inc.

# Upskilling for Industry Initiative – Upskill Canada

Final Report – August 2023 *Version française disponible*

# Table of Contents

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# Preface

Palette Skills Inc. ("Palette Skills") has retained Deloitte LLP ("Deloitte") ("we") to provide a macroeconomic landscape and sector analysis of the Canadian economy and the six high-growth sectors identified by Innovation, Science and Economic Development Canada ("ISED"). This report will support Palette Skills in their execution of Upskill Canada, the platform used to deliver on ISED's Upskilling for Industry Initiative Fund which aims to align the skills of the Canadian workforce with industry demand. This document is a final report which summarizes key findings from Deloitte's research and stakeholder consultations conducted from January to July 2023.

## Macroeconomic Landscape and Sector Analysis

As a preliminary step to understand Canada's existing capabilities, Deloitte has developed a report on Canada's current macroeconomic landscape, and the current state/challenges/opportunities of the six-high growth sectors identified by ISED. The report is based on both primary and secondary research as of August 11th, 2023.

The structure of this report is designed such that the analysis provided for each sector within the following chapters can be disseminated individually if desired as its own stand-alone document. To facilitate this approach certain level of repetition will be exhibited between certain segments of the various sectors analyzed. This is a deliberate construction of the white paper.

# Executive Summary

Canada is known for its highly educated and competitive labour force. Canada's labour force consistently outperforms its peers on educational attainment, women labour force participation rate, and employment rate for newcomers. However, Canada's greatest competitive advantage[1] can be lost if supply does not meet the demand of the economy. It is essential for Canada to address current hiring challenges and shortages to ensure continuous economic growth.

Although Canada's population is highly educated, labour trends have created a divergence between the skillset of available workers and industry demand. As seen on the figure below, industries are operating in an environment with relatively low unemployment rates. This would indicate that a large portion of the skills gap arises from a robust industry demand in which industries will be competing heavily for limited labour market resources.

*Figure 1: Unemployment Rates and Vacancy Rates for Two-digit NAICS Industries in 2022*
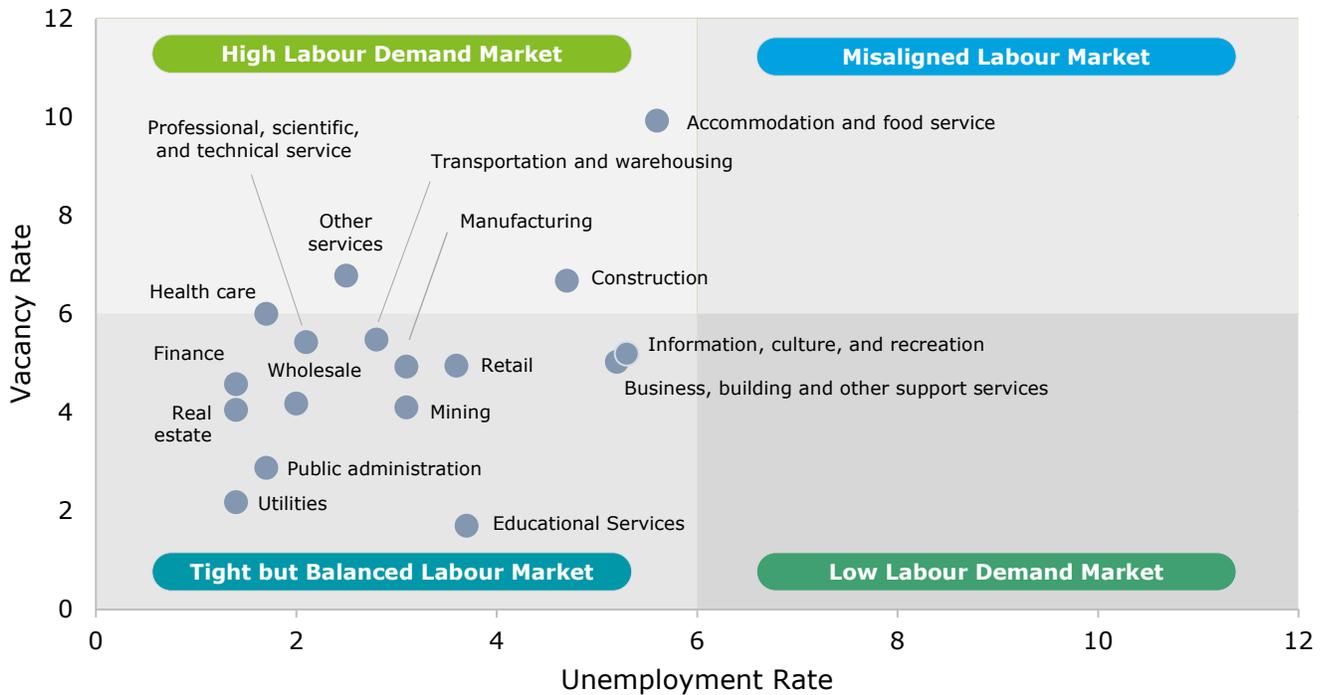


*Source: Statistics Canada, Deloitte*

Additionally, global and domestic trends such as an aging population leading to increased levels of retirement, technological advancements, movements towards a net-zero economy, and industry transformation will continue to contribute to a tight labour market. These trends can lead to an increase in demand of existing positions due to new economic activity, alter the requirements of existing occupations, create new positions, or make occupations obsolete. Consequently, workers will need to constantly adapt to a changing economic environment to remain employable over time.

As the economy continues to face these challenges it is becoming increasingly evident that more needs to be done to address the skills and occupation gaps across the economy. Governments, industry-leaders, institutions, and community groups need to partner to address this growing challenge. Part of the solution includes upskilling: a light-touch, short burst training that allows an

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[1] Deloitte, Canada's Competitiveness Scorecard, 2019

individual to augment their existing skill set aligned with the demands of Canadian businesses. While traditional training programs focus only on teaching new skills, upskilling helps workers secure a new career in a higher skill, growth, and paying job.

In 2022, Innovation, Science, and Economic Development Canada (ISED) held an open call for applications for the Upskilling for Industry Initiative, which strives to align the skills of the Canadian workforce with new industry demand. ISED expects the program to support at least 15,500 workers, including those from under-represented groups, transition into new jobs. Palette Skills was selected as the national delivery partner and launched Upskill Canada to serve as the platform to deliver on the initiative. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills in six key sectors: digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, and biomanufacturing. The six high-growth sectors chosen by ISED contribute significantly to Canada's output, export, research development and the economy's long-term economic prospects.

Deloitte has been engaged to support in Palette Skills' leadership role in Upskill Canada. The purpose of this whitepaper is to provide a macroeconomic landscape and sector analysis of the Canadian economy and the six high-growth sectors identified by ISED. The whitepaper draws upon both primary and secondary research. The primary research involved a series of roundtable sessions and interviews with both delivery partners and industry leaders to obtain a comprehensive understanding of the sector's current landscape. The secondary research consisted of quantitative analysis of existing data and comprehensive literature review to identify each sectors current state, trends, challenges, and opportunities.

Overall, the research shows that the six high-growth sectors have their own challenges and demand for skilled workers. These challenges range from difficulty attracting young workers into the manufacturing sector due to misconception of physically intensive labour to a lack of awareness of career opportunities in the clean technology sector. Nevertheless, there is a degree of commonality prevalent across sectors. Converging trends and objectives lead to crosswalks which refers to common skills or occupations that are shared amongst different sectors. Noteworthy trends that were identified includes a rise of the digital economy, transformation of industries due to automation, increase in the need for cybersecurity, and heightened demand for business skills. Upskilling programs will be increasingly important to help workers adapt to a changing working environment.

A skilled workforce will be pivotal to uphold Canada's competitiveness, productivity growth, and economic sustainability. Upskilling programs will play a significant role in driving economic growth as well as social progress. In order to be effective, upskilling programs will need to be driven and aligned to regional industry demand.

# Introduction

## Background

Canada's economic growth depends on a competitive and adaptable workforce capable of seizing new opportunities and driving development. As industries contend with a pace of technological and workplace change that needs ongoing learning to remain competitive, upskilling initiatives need to be designed to help individual's move up the knowledge value chain and contribute to their industry more fulsomely.

Upskilling is light-touch, short burst training that allows an individual to augment their existing skill set in a way that aids them in transitioning from one job or sector to another. Typically, that means transferring from a lower skill, growth, or paying job, to one that is higher skill, growth, and paying job. These types of transitions take advantage of our untapped talent and increase economic growth and productivity for industry, providing a more stable economic future for individuals. This model of upskilling is applicable across sectors in the economy. Yet, businesses often struggle to find time and capital for training, lack awareness of programs, or may not find tailored programs. Thus, despite the pronounced benefits of upskilling many businesses face challenges undertaking or participating in upskilling initiatives.

In Canada, labour trends have created a divergence between the skillset of available workers and industry demand. Whereas the demand for upskilling may vary by industry, across the economy industries face a tight labour market, increased levels of retirement, technological advancements, and industry transformation. Through the Upskilling for Industry Initiative, Innovation, Science, and Economic Development Canada (ISED) strives to align the skills of the Canadian workforce with industry demand. The objectives of the program are to strengthen Canada's training ecosystem by establishing partnership between industry and training providers and upskill workers to place them in new employment opportunities. ISED expects the program to support at least 15,500 workers, including those from under-represented groups, transition into new jobs.

In spring 2022, ISED held an open call for organizations to enter into a three-year contribution agreement of up to $250 million to lead the Upskilling for Industry Initiative. Palette Skills was selected as the national delivery partner. Incorporated in 2017, Palette Skills is a national nonprofit that aims to support Canada's companies access untapped talent through a rapid upskilling system. Palette Skills aims to 1) use their network of partners to connect businesses, post-secondary institutions, private training providers and non-profits and 2) adopt best practices in industry-led upskilling approaches.

Through the Upskilling for Industry Initiative, Palette Skills is launching Upskill Canada to help our country make the most of our competitive advantages while building a more inclusive economy in the process. Upskill Canada will connect an ecosystem of employers and training providers across the country to collaborate in new ways and help transition mid-career workers into new careers in high-demand roles. It will centre employers in the program design process and result in new talent pipelines that help address the need for workers across key high-growth sectors, providing a competitive advantage for Canadian industry.

Upskill Canada will target all regions of the country and support Canadian-based employers, with a particular focus on SMEs. It will focus on strengthening key growth sectors, including digital technology, cyber security, agricultural technology, advanced manufacturing, clean technology and biomanufacturing. Its primary objectives are to:

- Support employers located across the country, particularly small and medium-sized enterprises (SMEs) in high-growth sectors, to better address their skills need.

- Upskill mid-career Canadians, with at least three years of work experience, including those from underrepresented groups, and help them connect with new work opportunities in high-growth sectors.
- Drive lasting improvements to the upskilling ecosystem by building close collaborations across training providers, employers, and other partners to design and deliver upskilling programs and shift mindsets around talent development and utilization.

Palette Skills has identified six core components required for successful upskilling programs - referred to as the Palette Model for Upskilling. This model creates the common standard that all program proposals supported through Upskill Canada will be required to address to secure funding effectively. These six core components are: demand-driven, rapid delivery, employer-led, experiential, and industry-integrated, potential-focused recruitment, and job placement support.

The selected key growth sectors are actively involved in both technology development and adoption. Therefore, it is imperative to develop strategies that focuses on expanding these particular high growth industries and address their critical needs to mitigate any potential bottlenecks.

Each of the selected high-growth sectors have their own challenges and demands. Nevertheless, there is a certain level of commonality across many sectors. For example, digitalization, artificial intelligence (AI), and automation are becoming more prevalent across the sectors (and for that matter large portions of the Canadian economy in general), and it is critical for workers to have the proper skillset to use these technologies to achieve the expected return on investment. Along with technical skills, workers will also need foundational skills and a growth mindset to ensure that technology can meet its objectives at its core.

Effectively investing in upskilling will allow Canada to leverage the talent of all workers, ensuring they can fully participate in the economy of the future. It will also help to ensure that companies in high-growth sectors have access to the talent they need today, to keep innovating, producing, and growing.

The objective of this white paper is to provide an analysis on job and skill demand in Canada focusing on the six high-growth sectors identified by ISED. The analysis underpinning this report consists of a combination of both primary and secondary research.

## Primary Research

The primary research component of this study focused on undertaking a series of stakeholder consultations which consisted of a series of roundtable session and interviews with both delivery partners and industry leaders.

Palette Skills and Deloitte collaborated with organizations from each sector to co-host a series of roundtables. The participating co-hosts consisted of:

- Canadian Manufacturers and Exporters
- Information and Communications Technology Council
- Canadian Agricultural Human Resources Council
- Enterprise Machine Intelligence & Learning Initiative
- BioTalent
- ECO Canada

In total we held five roundtables with a total of 53 participants and 13 co-hosts. Additionally, we held 26 one-on-one interviews across the six sectors. These sessions were aimed at gaining a detailed understanding of business operations, key occupations and skills required by participants, current and future talent needs, and the challenges faced by industry to obtain the skilled workforce they require.

We used the data to 1) confirm our findings from secondary research 2) supplement any gaps from secondary research and 3) highlight key industry demand and challenges.

Palette Skills is committed to ensuring the perspectives of equity-deserving groups are considered in the Upskill Canada Industry roundtables. To understand the representation of equity-deserving communities within the roundtables we sent out a voluntary diversity equity and inclusion survey to participants. We received 27 responses, 52% which identified as men, 44% as women, and 4% as member of the 2SLGBTQ+ community. Additionally, 15% of respondents identified as racialized person, 4% identified as a person with disability, 4% identified as an Indigenous person, and 41% of respondents were born outside of Canada.

We would like to thank the support of everyone who took the time to participate in our roundtables, interviews, and survey.

## Secondary Research

The secondary research component of this study focused on quantitative analysis of existing data and a comprehensive qualitative analysis of the subject and sectors involved.

The secondary research component includes analysis for the purposes of identifying for each sector's current state and trends of employment and other labour market characteristics, occupational and skill needs, as well as skills and occupational gaps.

Complementing research findings, an analysis of available data sets (e.g., Statistics Canada, Vicinity, EMSI (Lightcast), Canadian Occupational Projection System, etc.) were used to formulate additional insights.

An analysis of the aforementioned datasets was useful in tracking economic and employment trends, occupational supply and demand, and key skill requirements. This stage of research was also instrumental in evaluating the 'crosswalks' or the cross-cutting factors that affect all sectors evaluated in this study.

A brief description of key definitions and terms used throughout this study are provided here.

## Upskilling

For the purposes of this report, we will be using Palette Skills' definition of upskilling. Upskilling is about helping move someone into a new job. While learning new skills is a core part of that process, so is gaining the professional acumen needed to succeed in a new industry and successfully navigating the job search and interview process to land a new role. This differs from traditional workplace training, which is focused on learning a new skill for the purpose of gaining new knowledge.

## Occupational Gap

An occupational gap denotes a persistent shortage of candidates possessing the necessary qualifications to fulfill specific roles within a particular market.

## Skills Gap

A skills gap arises when there is a shortage of candidates possessing the necessary skills for their respective roles.

## Industry 4.0

The generation of industry which has introduced electronics and connected devices, placing a focus on data analytics and AI to automate processes.

## Industry 5.0

The next generation of industry which places focus on the interaction and co-operation between man and machine, with human intelligence working in harmony with cognitive computing.

## Occupational and Skills Information System (OaSIS):

The OaSIS presents a comprehensive framework of the skills, abilities, personal attributes, knowledge, and interests usually required to work in different occupations. This framework is maintained by Employment and Social Development Canada. In the report, we classify the various needed skills into categories determined by OaSIS (i.e., foundational, analytical, technical, resource management (business), and interpersonal skills) and highlight any additional personal attributes or knowledge requirements that were also identified by stakeholders.

## Canadian Occupational Projection System (COPS)

The COPS provides a comprehensive projection of occupational labour demand and supply in Canada. In this report we identify occupations that may face labour shortage or surplus in the present or in the future over the projection period.

**Study Contents and Structure**

The outcomes of the research are structured as follows:

- The Landscape Today introduces the current state of upskilling and the macroeconomic landscape.
- Chapters 1 – 6 introduces each selected sector (advanced manufacturing, biomanufacturing, clean technology, agricultural technology, digital, cybersecurity), and provides an overview of the sector, labour and skills challenges and opportunities.
- Chapter 7 introduces the crosswalks between the sectors.
- The Conclusion presents considerations and next steps.

The structure of this report is designed such that the analysis provided for each sector within the following chapters can be disseminated individually if desired as its own stand-alone document. To facilitate this approach certain level of repetition will be exhibited between certain segments of the various sectors analyzed. This is a deliberate construction of the white paper.

# The Landscape Today

## Value and Importance of Upskilling

In today's rapidly evolving world, upskilling has emerged as a critical imperative for individuals, organizations, and nations. The ever-accelerating pace of technological advancements and the changing nature of work necessitate continuous learning and development. Upskilling initiatives are thus an important cornerstone in empowering individuals, driving organizational success, and fostering economic growth.

To address the skills gap challenge, the Government of Canada and various provincial governments have invested in a range of measures to empower and equip Canadian workers with the tools they need to succeed in meeting the economic challenge of today and in the future. Some recent measures by the Government of Canada showcased in Budget 2023 include:

**Labour Market Transfer Agreements**  **01**

Aiming to enable provinces and territories to deliver training and employment supports tailored to their unique labour market needs, including a $1.5 billion top-up from 2020 to get people back to work in the sectors hit hardest by the pandemic. This is in addition to the annual investment of nearly $3 billion (and a top-up of $2.7 billion) delivered to provinces and territories for training and employment supports over six years, starting in 2017-18, announced in Budget 2017.

**Union-based training**  **02**

Over $200 million to expand the Union Training and Innovation Program to train more than 30,000 additional apprentices and journeypersons.

**03**  **Employer-led training**

$250 million over three years for the Upskilling for Industry Initiative to support more than 15,000 workers, and $125 million over five years to launch the Sustainable Jobs Training Centre. In addition, Budget 2021 announced the Sectoral Workforce Solutions Program to help key sectors of the economy implement solutions to address their current and emerging workforce needs and the Apprenticeship Service to support first-year apprentices in construction and manufacturing trades by providing employers with $5,000 for upfront costs like salary and training, or $10,000 for members of underrepresented groups.

**04**  **Apprenticeship Service**

To help first year apprentices in construction and manufacturing Red Seal trades connect with opportunities at small and medium-sized employers.

**Skills for Success**  **05**

Helping Canadians at all skill levels improve their foundational and transferable skills, like problem solving and digital skills, through free training resources and online skills assessments. Financial support for adult learners of $815 million over five years through the Canada Training Credit, which covers up to 50 per cent of eligible training fees.

**Labour mobility improvements**  **06**

$595 million over six years for the Labour Mobility Deduction for Tradespeople to make it more affordable to travel to the location of their work.

13

# Benefits of Upskilling

There are many benefits associated with upskilling programs for both individuals and organizations. They include:

| | |
|---|---|
| **Enhanced employability** | Upskilling equips individuals with new and relevant skills, making them more competitive in the job market. It can also provide individuals with access to a larger pool of job opportunities. |
| **Adaptability to technological changes** | Rapid technological advancements require workers to meet the demands of the evolving technology. Upskilling programs can ensure individuals have the latest tools, technologies, and digital skills, to adapt to altering work environments. |
| **Job security** | Directly related to the above point, upskilling programs help individuals' future-proof their careers by ensuring their skills remain relevant. With technological advancements and automation, certain job roles may become obsolete. By upskilling, individuals can remain valuable and reduce the risk of job displacement. |
| **Increased productivity** | Learning new skills, can allow for employees to become more efficient and productive in their roles. Upskilling enables individuals to handle tasks more effectively, leading to improved performance and output. |
| **Career advancement opportunities** | Acquiring additional skills and knowledge can often lead to new career opportunities. Upskilling can provide individuals with the qualifications and expertise necessary for promotions or lateral moves within an organization. |
| **Increased earning potential** | Additional or enhanced skills may permit individuals to qualify for higher-paying positions or negotiate better salaries. Generally, upskilling programs can help employees increase their earning potential over time. |
| **Employee engagement and satisfaction** | Providing upskilling opportunities demonstrates an organization's investment in its employees' professional growth. This can potentially result in higher levels of job satisfaction, engagement, and loyalty among employees. |
| **Innovation and creativity** | Upskilling can foster a culture of innovation within organizations. By developing new skills, employees gain fresh perspectives and the ability to generate creative solutions to complex problems. |
| **Knowledge sharing and collaboration** | Upskilling programs often involve group activities, workshops, or training sessions. These can provide opportunities for employees to collaborate, share knowledge, and learn from one another, thereby fostering a culture of continuous learning and improvement. |
| **Organizational competitiveness** | By investing in upskilling programs, organizations can enhance their market competitiveness and agility, while also increasing their ability to respond to industry changes and challenges more effectively. |

It is worthy to note that the value of upskilling programs may vary depending on the individual, the organization, and industry context.

While the high value associated with upskilling is generally recognized, it is also important to understand the key factors that ensure that these initiatives are successful and provide the intended results. Some of the key attributes of successful upskilling initiatives include:
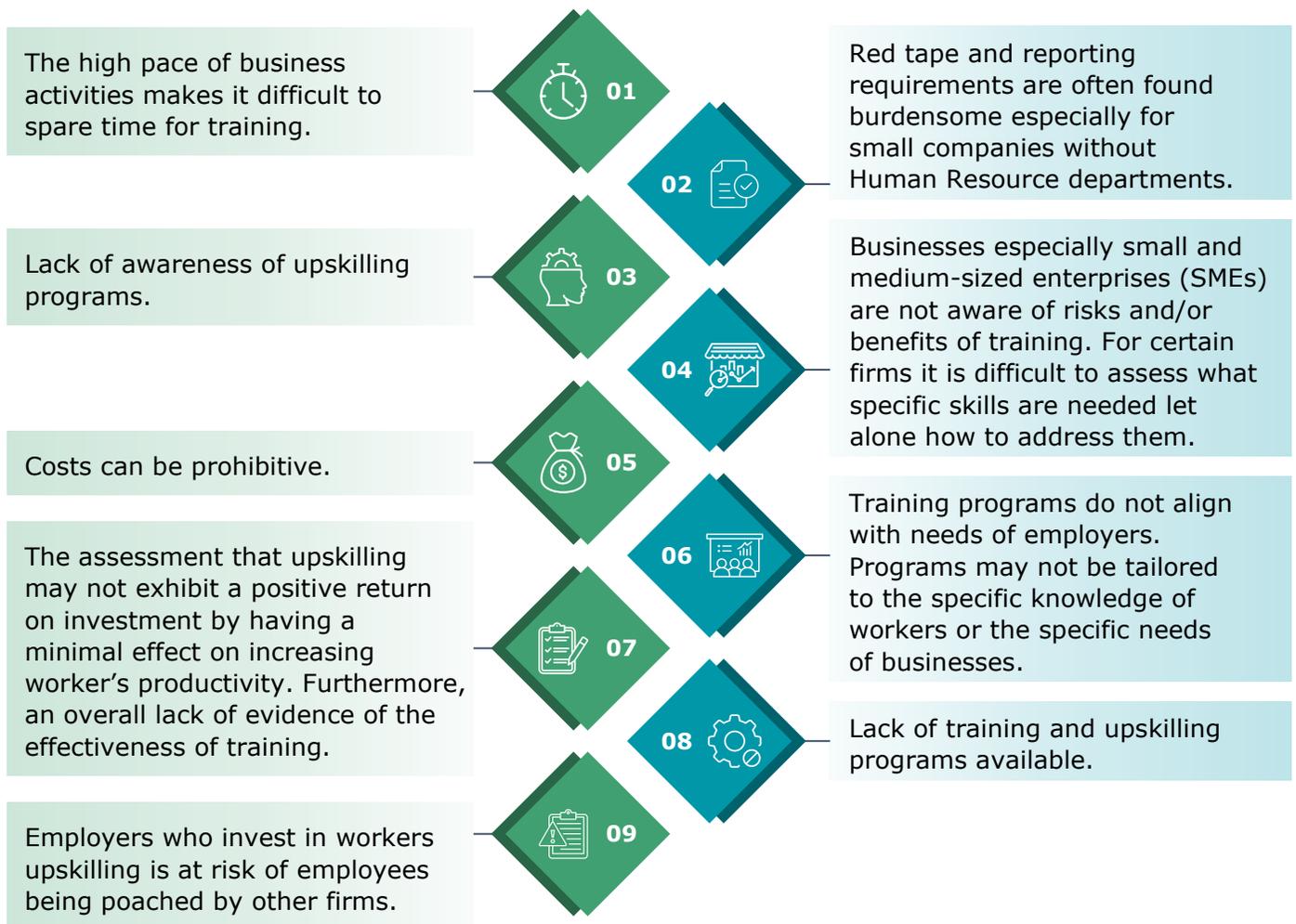
| | | |
|---|---|---|
| | **Clear Goals and Alignment** | A well-defined upskilling program should have clear objectives that align with the organization's overall strategy and the needs of the workforce.[2] |
| | **Specialized Learning Pathways** | Successful upskilling programs recognize that different industries and sectors have unique and specialized needs. They provide adaptable learning pathways, taking into account the needs of specific industries as well as their employees. This tailored and adaptable approach should aim to target the specific needs of an industry or sector and enhance engagement.[3] |
| | **Continuous Learning Culture** | Effective upskilling programs should foster a culture of continuous learning. They encourage employees to take ownership of their skill development and promote a mindset that values lifelong learning. This creates an environment where upskilling becomes an ongoing process rather than a one-time event.[4] |
| | **Measurable Outcomes and Evaluation** | An effective upskilling program includes built-in mechanisms for assessing the progress and outcomes of the upskilling initiatives. By establishing well-defined metrics and conducting regular evaluations, the program ensures that its effectiveness can be measured accurately. This approach also enables necessary adjustments to be made along the way and provides a tangible demonstration of the return on investment (ROI) achieved through the upskilling efforts. |

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[2] McKinsey & Company, The Future of Work in America, 2019
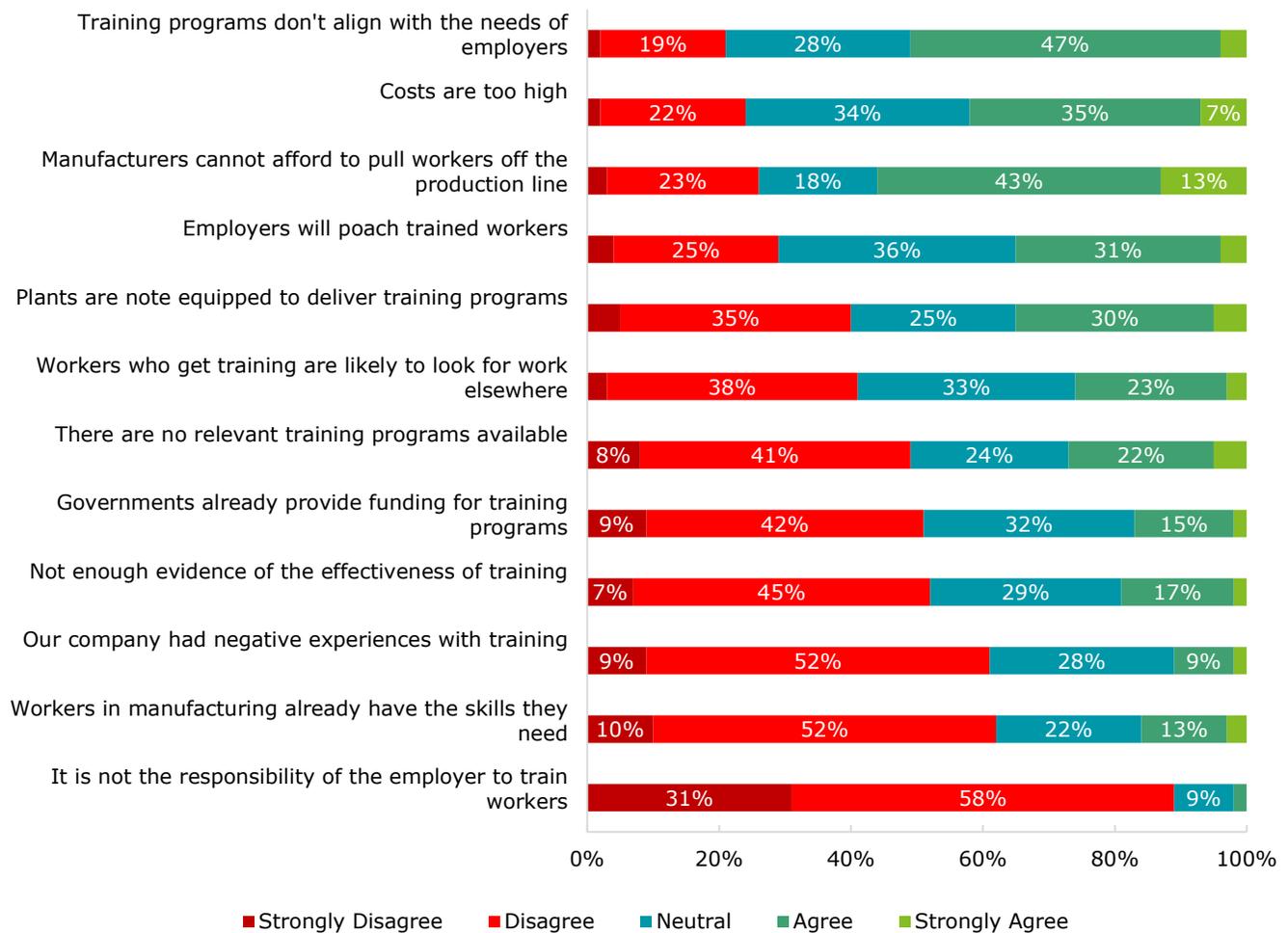[3] World Economic Forum, Towards a Reskilling Revolution: A Future of Jobs for All, 2018
[4] Deloitte, Rewriting the Rules for the Digital Age, 2017

Despite the importance and value of upskilling, certain challenges still remain for both employers and employees to obtain the full benefits. Through our research we have found that some of the key barriers for employers or employees to engage in upskilling initiatives include the following:

**01** The high pace of business activities makes it difficult to spare time for training.

**02** Red tape and reporting requirements are often found burdensome especially for small companies without Human Resource departments.

**03** Lack of awareness of upskilling programs.

**04** Businesses especially small and medium-sized enterprises (SMEs) are not aware of risks and/or benefits of training. For certain firms it is difficult to assess what specific skills are needed let alone how to address them.

**05** Costs can be prohibitive.

**06** Training programs do not align with needs of employers. Programs may not be tailored to the specific knowledge of workers or the specific needs of businesses.

**07** The assessment that upskilling may not exhibit a positive return on investment by having a minimal effect on increasing worker's productivity. Furthermore, an overall lack of evidence of the effectiveness of training.

**08** Lack of training and upskilling programs available.

**09** Employers who invest in workers upskilling is at risk of employees being poached by other firms.

During the Fall of 2020 through the Summer of 2021, the Excellence in Manufacturing Consortium (EMC) conducted a series of consultations on capabilities, skills and training necessary to implement advanced manufacturing processes and technologies. As part of these consultations the EMC conducted surveys and interviews to gain insights on upskilling needs and challenges within the manufacturing sector. One particular survey question of note inquired manufacturers as to the reasons for not investing in training. The results our found in Figure 2 below.

16

*Figure 2: Reasons for Not Investing in Training*



Training programs don't align with the needs of employers: 19% Disagree, 28% Neutral, 47% Agree

Costs are too high: 22% Disagree, 34% Neutral, 35% Agree, 7% Strongly Agree

Manufacturers cannot afford to pull workers off the production line: 23% Disagree, 18% Neutral, 43% Agree, 13% Strongly Agree

Employers will poach trained workers: 25% Disagree, 36% Neutral, 31% Agree

Plants are note equipped to deliver training programs: 35% Disagree, 25% Neutral, 30% Agree

Workers who get training are likely to look for work elsewhere: 38% Disagree, 33% Neutral, 23% Agree

There are no relevant training programs available: 8% Strongly Disagree, 41% Disagree, 24% Neutral, 22% Agree

Governments already provide funding for training programs: 9% Strongly Disagree, 42% Disagree, 32% Neutral, 15% Agree

Not enough evidence of the effectiveness of training: 7% Strongly Disagree, 45% Disagree, 29% Neutral, 17% Agree

Our company had negative experiences with training: 9% Strongly Disagree, 52% Disagree, 28% Neutral, 9% Agree

Workers in manufacturing already have the skills they need: 10% Strongly Disagree, 52% Disagree, 22% Neutral, 13% Agree

It is not the responsibility of the employer to train workers: 31% Strongly Disagree, 58% Disagree, 9% Neutral

Legend: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

*Source: Excellence in Manufacturing Consortium*

To ensure that future success in upskilling does not remain elusive, these key and vital concerns should not only be front of mind but should be addressed in any upskilling program.

## Macroeconomic Landscape

In order to understand the key drivers of the demand for upskilling, it is valuable to first understand the macroeconomic landscape that is shaping demand. The onset of the COVID-19 pandemic produced the largest shock to employment since the Second World War. Since March 2020, through a series of fiscal and monetary stimulus measures the economy has made a robust and at times bumpy recovery. Employment in Canada has made a full recovery with total employment surpassing its pre-pandemic levels. Furthermore, Canada's unemployment rate has steadily fallen, and has remained below the pre-pandemic levels since April 2022. Current labour market conditions indicate a high degree of tightness in labour markets. This tightness is showcased in signs that employers are finding it more difficult to fill vacant positions. This reduced ability to fill positions not only translates into heightened difficulties to obtain the workforce needed to meet industry demand, but it also reflects the heightened challenge firms face in obtaining and developing a skilled workforce to meet their own needs.

Firms face many headwinds in attempting to meet their needs for a skilled workforce. One of the greatest threats to Canada's labour force continues to be the aging of the country's population. Currently, over one fifth of the Canadian labour force is 55 years of age or older and nearing retirement. The ability to replace these workers, as well as replace the skills that these workers possess is of utmost importance if the Canadian economy is to be competitive in the next decade.

Having said this, coming out of the pandemic the Canadian economy appears to be the recipient of a beneficial tailwind with evidence that Canadians have used the pandemic lockdown period to upgrade skills and move into education-intensive industries.

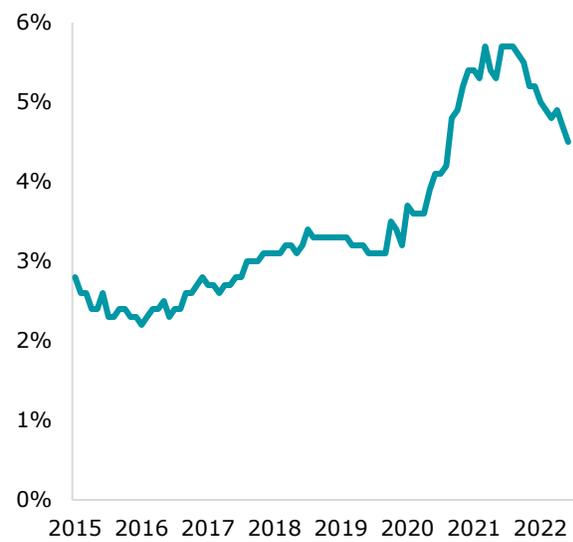*Figure 3: Monthly Employment in Canada, seasonally adjusted*
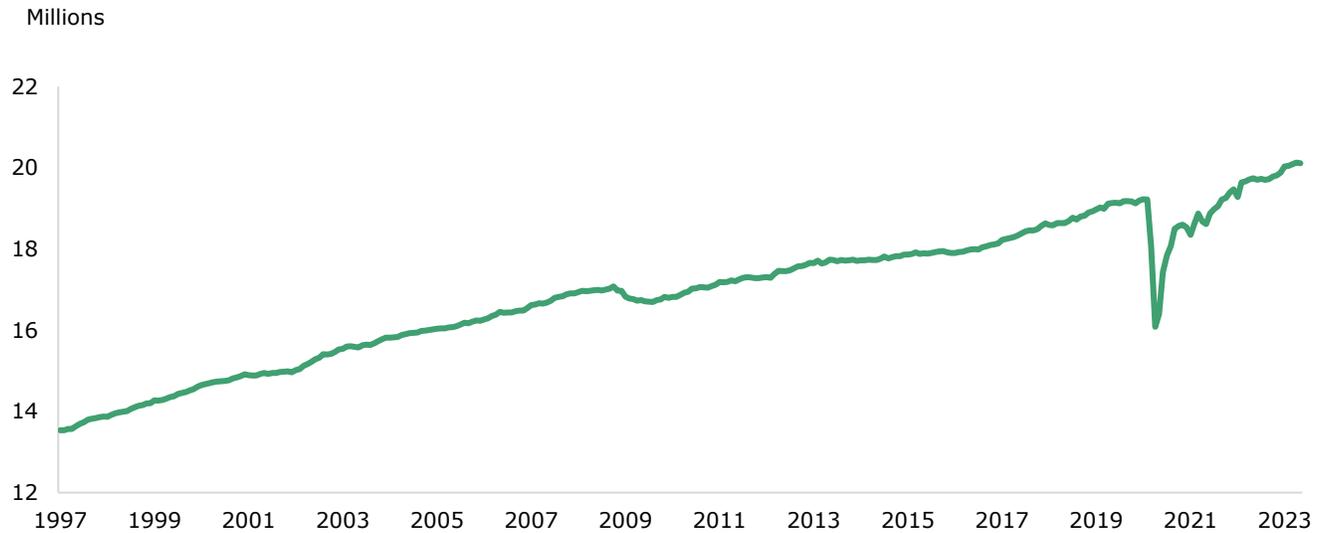


*Source: Statistics Canada*

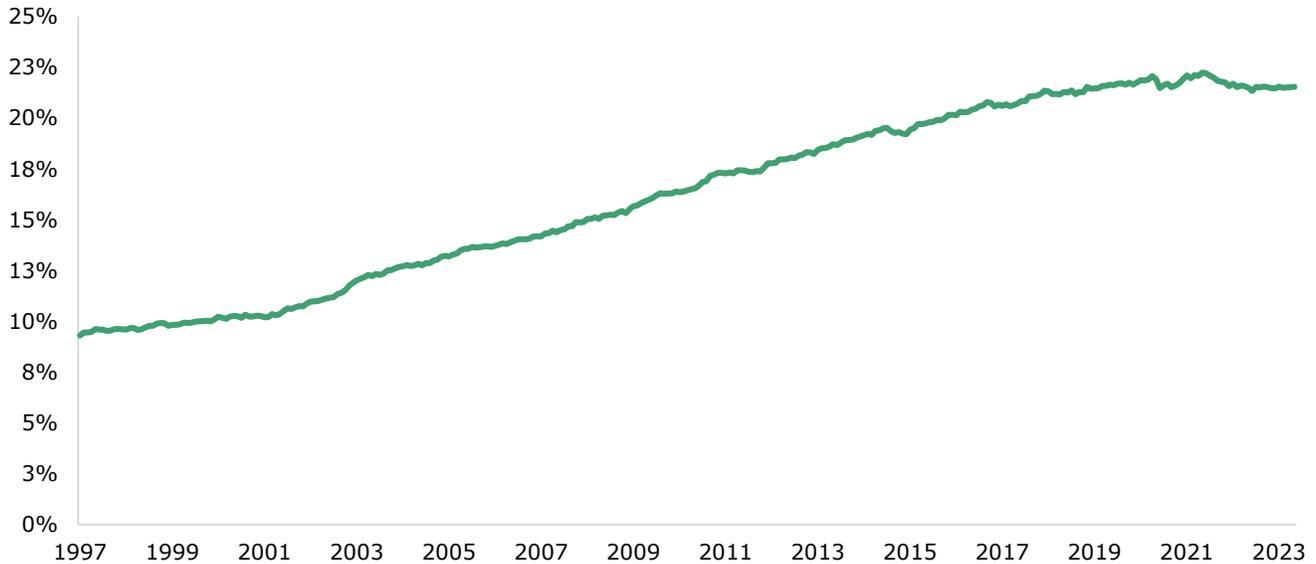*Figure 4: Monthly Unemployment Rate in Canada, seasonally adjusted*
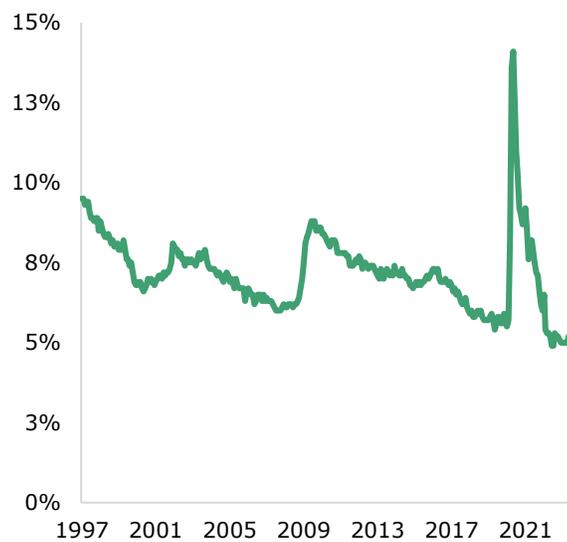


*Source: Statistics Canada*

*Figure 5: Monthly Vacancy Rate in Canada, seasonally adjusted*



*Source: Statistics Canada*

18

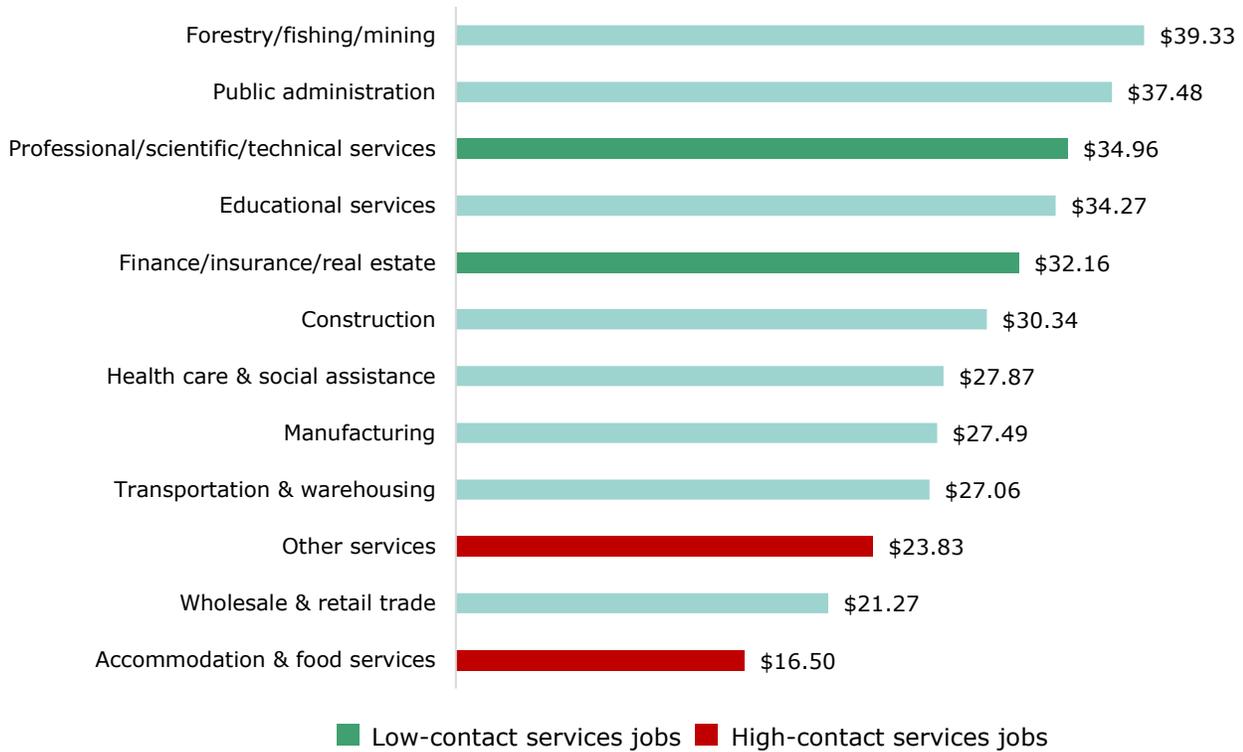*Figure 6: Share of Canadian Labour Force 55 Years and Over*



*Source: Statistics Canada*

To a certain degree, the pandemic has reshaped the nature of the labour market landscape in Canada. The pandemic restrictions disproportionately displaced workers in "high contact" industries such as travel, hospitality and food and accommodation. Some of these industries have yet to fully recover from pre-pandemic levels. For instance, in 2022, average employment in the food and accommodations industry was still 14% below 2019 (pre-pandemic) levels. This shortfall, however, is more than offset by the increase in professional and technical services jobs which increased by approximately 16% since 2019. This industry shift has benefited Canada as wages in this industry are double that of food and accommodation services on average, and with productivity twice as high.

In addition to shifting into these higher-paid industry, it appears that workers are also moving into higher-paid jobs within them. In a report by RBC Economics, they have estimated that this labour force adjustment accounted for 2% of the total 8% wage growth over two years of the pandemic. It also provided a $20 billion boost to annual household wage income. The report also demonstrates that education and upskilling was a key element for the shift to higher-paid positions to occur. Although high contact industries experienced a decline in the number of employees with post-secondary degrees or certificates over the two years from the onset of the pandemic measures, the increase in employees with post-secondary degrees or certificates within low contact (and more productive) industries has been more pronounced. This provides some evidence that many Canadians have used the pandemic as an opportunity to upskill their capabilities and reap the benefits of their efforts, and that education and training appeared to be the key for workers to enter into higher paid positions during this period.
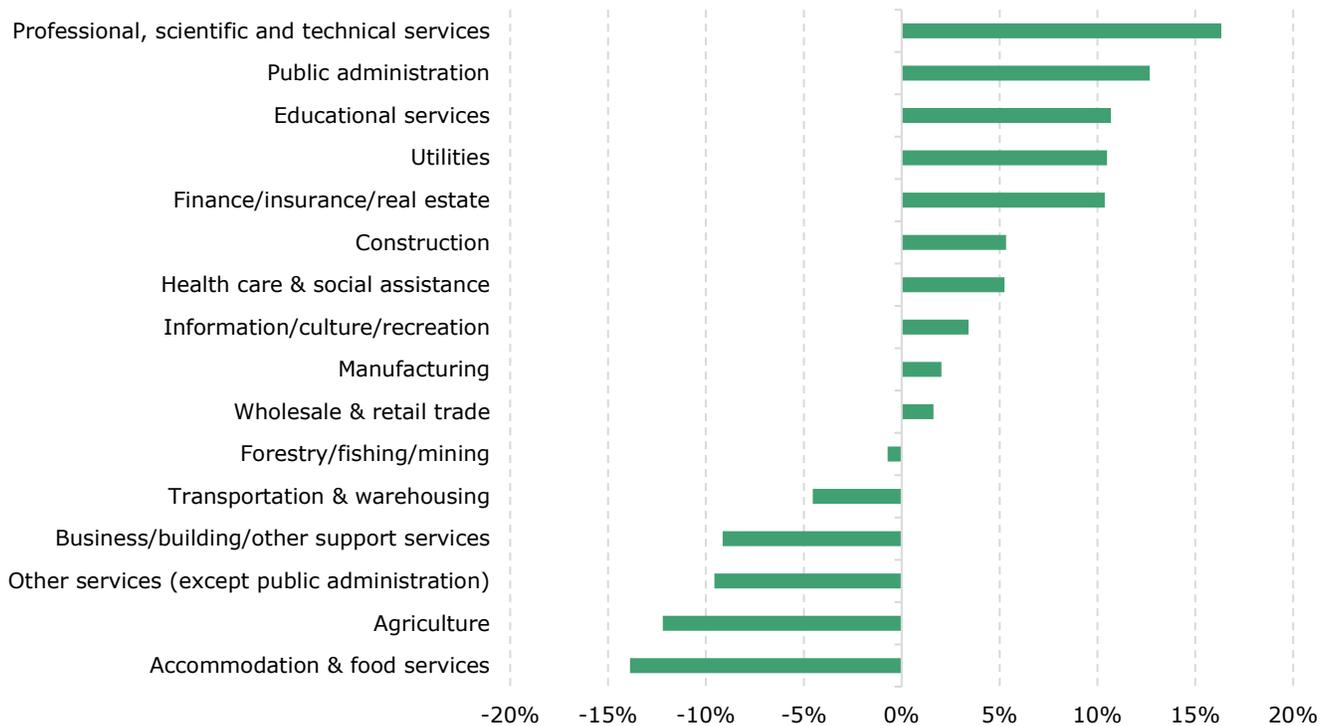
To ensure that Canada continues to obtain the economic benefits stemming from a highly skilled workforce, sustained and continuous training and upskilling of Canada's labour force is of paramount importance.

*Figure 7: 2019 Average Wage per Hour Worked*

| Industry | Wage |
|---|---|
| Forestry/fishing/mining | $39.33 |
| Public administration | $37.48 |
| Professional/scientific/technical services | $34.96 |
| Educational services | $34.27 |
| Finance/insurance/real estate | $32.16 |
| Construction | $30.34 |
| Health care & social assistance | $27.87 |
| Manufacturing | $27.49 |
| Transportation & warehousing | $27.06 |
| Other services | $23.83 |
| Wholesale & retail trade | $21.27 |
| Accommodation & food services | $16.50 |

■ Low-contact services jobs ■ High-contact services jobs

*Source: RBC Proof Point: Canada's Post-Pandemic Labour Market Shakeup*

*Figure 8: Employment Growth Rate in Canada, 2019 – 2022*

| Industry | Growth |
|---|---|
| Professional, scientific and technical services | ~16% |
| Public administration | ~12.5% |
| Educational services | ~10.5% |
| Utilities | ~10.5% |
| Finance/insurance/real estate | ~10.5% |
| Construction | ~5.5% |
| Health care & social assistance | ~5.5% |
| Information/culture/recreation | ~3.5% |
| Manufacturing | ~2% |
| Wholesale & retail trade | ~1.5% |
| Forestry/fishing/mining | ~-1% |
| Transportation & warehousing | ~-4.5% |
| Business/building/other support services | ~-9% |
| Other services (except public administration) | ~-9.5% |
| Agriculture | ~-12% |
| Accommodation & food services | ~-14% |

*Source: Statistics Canada*

*Figure 9: Change in Employment, 2020 - 2022*

| Industry | | At least a certificate | No certificate |
|---|---|---|---|
| Professional, scientific and technical services | 🟩 | 173,819 | 27,322 |
| Educational services | | 118,633 | -18,266 |
| Health & social services | | 94,294 | 10,721 |
| Finance & insurance | 🟩 | 59,446 | 740 |
| Transportation & warehousing | | 37,051 | -46,941 |
| Real estate & rental leasing | | 35,995 | -7,848 |
| Information/culture/recreation | | 33,321 | -4,582 |
| Retail trade | | 22,461 | 2,498 |
| Public administration | | -31,595 | 9,274 |
| Other services | 🟥 | -79,901 | -24,203 |
| Accommodation & food services | 🟥 | -101,615 | -109,202 |

🟩 Low-contact services jobs   🟥 High-contact services jobs

*Source: RBC Proof Point: Canada's Post-Pandemic Labour Market Shakeup*

While many industries have expressed concern over occupational and skills gaps within their operations, it is valuable to understand the general source of these gaps. Insights can be gained by observing unemployment rates at the industry level, and their corresponding vacancy rate. Generally, if an industry is experiencing a high unemployment rate matched with a high vacancy rate, then this can be considered a telltale sign of a misalignment or mismatch of skills that are demanded by industry and that could not be supplied by workers. If on the other hand we find that employment rates are low but vacancy rates are high, this would indicate that firms within an industry are experiencing high demand, however, the labour market has insufficient ability to supply industry with their demand. A low vacancy rate and low unemployment rate would indicate that labour supply is likely meeting the demand by industry but is operating in tight labour market conditions with industry at or near capacity.

When observing industry vacancy and unemployment rates at the broader two-digit North American Industry Classification System (NAICS) level (see Figure 10)[5], we find that no industry is operating in the upper right quadrant indicating that industries at the two-digit NAICS level are not generally experiencing a misalignment or mismatch between skills demanded and skills supplied. All industries are operating in an environment with relatively low unemployment rates. This would indicate that a large portion of the skills gap is emanating from robust industry demand, in which different industries and different sectors will be competing heavily with each other for limited labour market resources. Thus, it can be generally concluded that, for the most part, the current

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[5] The two-digit NAICS industry categories represented in Figure 10 are: Mining, quarrying, and oil and gas extraction, Utilities, Construction, Manufacturing, Wholesale trade, Retail trade, Transportation and warehousing, Finance and insurance, Real estate and rental and leasing, Professional, scientific and technical services, Educational services, Health care and social assistance, Accommodation and food services, Other services (except public administration), Public administration, Information, culture and recreation, and Business, building and other support services.

skills gaps do not emanate from a misalignment or mismatch skills demanded by industry and what is being supplied by the current workforce.

*Figure 10: Unemployment Rates and Vacancy Rates for Two-digit NAICS Industries in 2022*
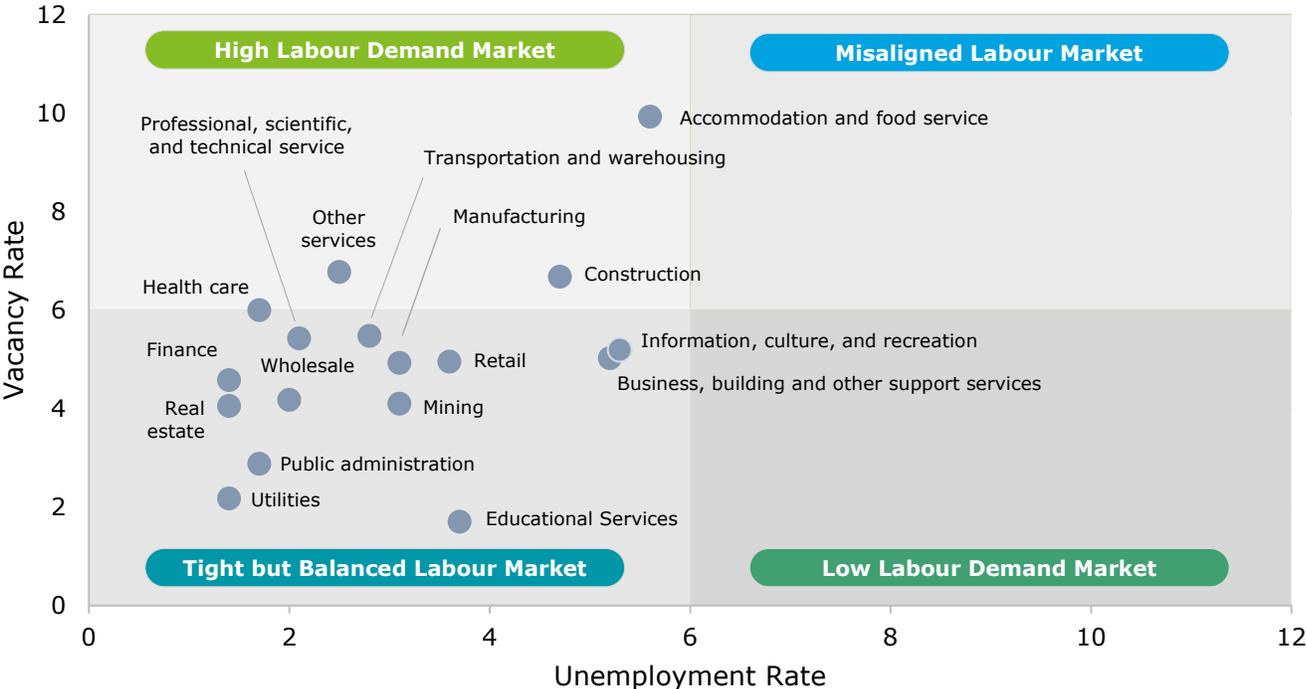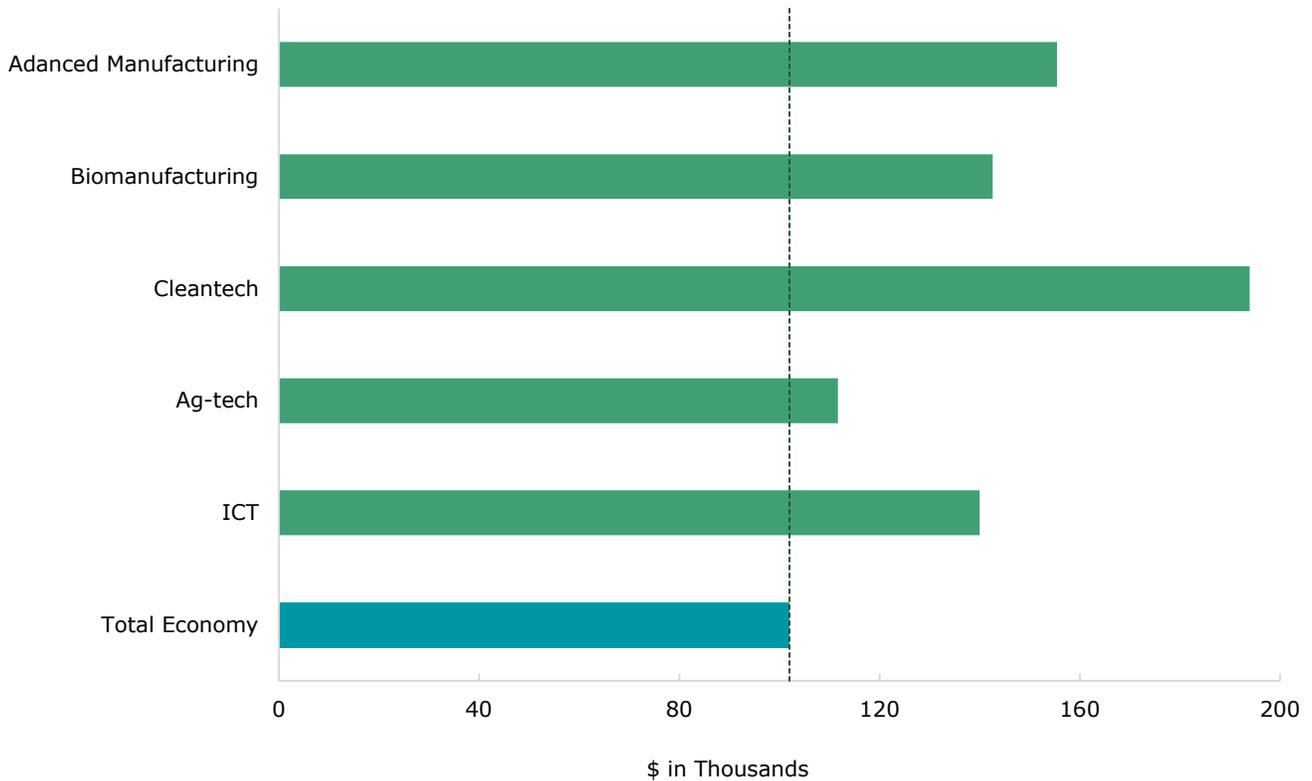


*Source: Statistics Canada, Deloitte*

Domestic macroeconomic trends such as an aging population leading to increased levels of retirement, and robust aggregate demand leading to tight labour markets are providing key conditions in driving demand for upskilling. However, there are other transformational trends that are also contributing to upskilling demand. These include technological advancements such as automation and the digitalization of the Canadian industrial landscape, movements towards a net-zero economy, globalization, and other transformative factors that are impacting the industrial landscape such as the introduction of AI and Large Language Models (LLM). These trends can lead to an increase in demand of existing positions due to new economic activity, alter the requirements of existing occupations, create new positions, or make occupations obsolete. Consequently, workers will need to constantly adapt to a changing economic environment to remain employable overtime.

## Importance of the Six Critical Sectors

The analysis in the report focuses on six key priority sectors: advanced manufacturing, biomanufacturing, clean technology, agriculture technology, digital technology, and cybersecurity. They reflect high impact segments of the economy. They are important because they tend to generate a disproportionate share of the country's output, export and R&D. Moreover, these sectors maintain relatively higher levels of productivity (as measured by Gross Domestic Product (GDP) per worker) than the average for the total economy.

*Figure 11: Sector Productivity – Real GDP per Worker*



$ in Thousands

*Source: Statistics Canada, Deloitte*

These sectors are vital to Canada's long-term economic prospects as they generally engage in critical technology development as well as technology adoption. More importantly they formulate a growing tech ecosystem that is necessary for Canada's competitiveness and future prosperity. Consequently, it is important for national and provincial industrial strategies to focus on expanding these particular high value sectors, and address critical needs to diminish any potential bottlenecks, and maximize economic potential.

# The Advanced Manufacturing Sector

CHAPTER 1

# Executive Summary

Deloitte has been engaged to support Palette Skills' leadership role related to the Industry Upskilling Initiative funded by Innovation, Science and Economic Development Canada (ISED). The purpose of Upskill Canada is to connect employers to qualified talent and help high potential untapped talent move into fast growing careers. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills for high-demand roles in six key sectors (digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, biomanufacturing). In this chapter, we outline the challenges and catalysts associated with the development of the advanced manufacturing sector, with a focus in the sector's workforce. In this report, we define advanced manufacturing as "development and adoption of innovative technologies to create new products, enhance processes, and establish more efficient and cost-effective ways of working, including production activities that depend on information, automation, computation, robotics, software, sensing, and networking".[6]

The overall manufacturing sector is a significant contributor to the diversified Canadian economy. The sector is pivotal in building a strong economy that is competitive, resilient to global fluctuations, and supports a better quality of life. In 2021, the manufacturing sector accounted for 10.6% of Canada's GDP and employed over 1.7 million people. Focusing on the advanced manufacturing sector – a more technology intensive subcomponent of the overall manufacturing sector - we observe that in 2022 it contributed $93 billion to Canada's GDP and employed 580 thousand people in 2021. Despite its robust level of employment, women, youth, and new Canadians are continually underrepresented in the advanced manufacturing labour force.

For the advanced manufacturing sector to be more competitive and a global leader, it will need to overcome existing challenges such as uneven technology adoption across the sector, rising competition, and labour and skill shortages. The sector will need to adapt and develop new technology, as well as upskill talent to lead, utilize and maintain these technologies, while continuing to fill occupation shortages in all stages of production. Currently, some of the occupations facing the biggest shortages include skilled trades (e.g., welders, industrial mechanics, machinists, machining, and tooling inspectors), general labour and assembly positions, and production management. The skills associated with these jobs were also identified as gaps in the sector, along with digital and soft skills that need to be coupled with traditional skills in the sector.

The outcomes of our research and study are structured as follows: an overview of the sector, a summary of the labour and skills analysis, challenges, implications, and opportunities for the sector. To be of benefit to the broader training and workforce development ecosystem, the findings presented in this chapter reflect the wide-ranging needs of the sector. Some occupations listed or industry opportunities might be beyond Upskill Canada's scope. This might include skilled trades occupations and those requiring certification from a professional body. Eligibility for Upskill Canada funding will be dependent on identifying demand for jobs through direct employer engagement.

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[6] Definition obtained from ISED

# Overview of the Sector

## The Advanced Manufacturing Sector

The overall manufacturing sector has consistently been a significant contributor to the Canadian economy and a source of innovation. In 2021, the manufacturing sector accounted for 10.6% of Canada's GDP and employed over 1.7 million people.[7] Although some manufacturing firms have experienced growth rates above 15%, overall the sector remains stagnant.[8] For Canada to become a leading manufacturing nation, remain competitive and productive, it needs to accelerate technology adoption and grow an inclusive and digitally skilled workforce.[9] Advanced technology and digital enablement are essential to building resilience in an evolving competitive landscape, by allowing manufacturers to respond faster to disruptions.

Worldwide, economies are experiencing disruptive technological changes. For instance, digital software and robotics entering production lines have served as an innovative force across many industries. However, as the implications of the disruptive technological change relates to the manufacturing sector, this study will focus on the subset of manufacturing industries that are considered advanced, both in terms of development and adoption of innovative and disruptive technologies.

Advanced industries, are defined as industries with significant investment in R&D and science, technology, engineering, mathematics (STEM) workers.[10] Canada's advanced industries support opportunity in various sectors, future competitiveness, productivity growth, long supply chains, and are the base of Canada's high-value economy.[11]

Advanced manufacturing, as defined by ISED, is the **"development and adoption of innovative technologies to create new products, enhance processes, and establish more efficient and cost-effective ways of working, including production activities that depend on information, automation, computation, robotics, software, sensing, and networking".[12]**

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[7] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021

[8] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

[9] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

[10] Brookings Institute, Canada's Advanced Industries, 2018

[11] Brookings Institute, Canada's Advanced Industries, 2018

[12] Definition obtained from ISED

## Advanced Manufacturing versus Manufacturing

There is no consensus definition of advanced manufacturing. Moreover, the practice of using the term 'advanced manufacturing' without defining it is quite common. Part of the reason for the lack of consensus stems from the differing foundational views in defining and measuring what are to be considered advanced industries.

Some studies and organizations tend to focus on industries associated with the development of innovative products for a definition. Others would broaden the framework view beyond product development and place additional focus on internal processes and procedures. Thus, a firm would be considered an advanced manufacturer if it could 1) integrate novel technological approaches, 2) use established techniques in a new or innovative way, or 3) apply production methods in a new domain where there are no defined best practices or experience.[13]

The approach taken in this study is aligned with the approach used by the Brookings Institute in their analysis of advanced industries in both Canada and the United States (US).[14] Their framework relies on two pillars that are essential to development and adoption of innovative technologies. The first factor is the level of R&D spending which provides a signal of innovation as it may relate to technologies, products, or processes. The second factor relates to the intensity of STEM workers in the industry. This measure is intended to indicate that the industry can apply R&D discoveries to commercialize new products and services. Putting the two together, they broadly define advanced industries as those industries that conduct significant amounts of R&D and employs a disproportionate share of STEM workers. The specific criterion used are:

- R&D spending exceeding $450 per worker, above 80th percentile of U.S. industry intensity.
- STEM worker share of industry exceeds US industry average of 21 percent.

Under this rubric, they have identified 35 specific manufacturing industries in Canada that meet this bar. Taken together, these industries are considered the advanced manufacturing sector. See Appendix A for a complete list.
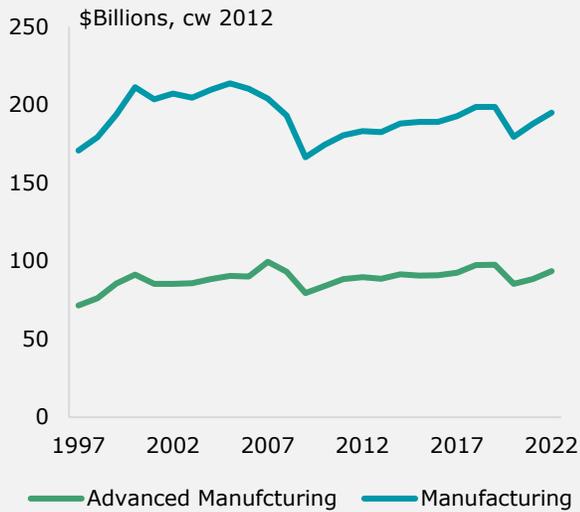
It should be noted that while it may seem a tad askew in using US benchmarks to develop a framework for measuring Canadian advanced manufacturing, there are several merits to this approach. First, the Brookings Institute has done this analysis for both Canada and the US. Thus, these benchmarks do provide a common denominator in judging against Canada's international competitors. Secondly – building on the first point – because of the common denominator, monitoring and tracking relative progress over time can be undertaken. Furthermore, results can lead themselves to provide meaningful interpretation.

The difference in economic activity between advanced manufacturing industries and manufacturing industries that are not part of the advanced category is quite marked. Advanced manufacturing comprises approximately 48% of total manufacturing GDP in 2022. From 1997 to 2022, real GDP within total manufacturing has increased by slightly more than 14%. On the other hand, over the same period real GDP in advanced manufacturing increased by over 30%. The implication of this is that manufacturing industries apart from advanced manufacturing have only witnessed an increase of approximately 3% over the same period, indicating that the subset of advanced industries has been the key driver of growth for the manufacturing sector.

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[13] Food and Drug Administration, Discussion Paper: Artificial Intelligence in Drug Manufacturing, Notice; Request for Information and Comments, 2023
[14] Brookings Institute, Canada's Advanced Industries, 2018

Figure 12: Real GDP
in Manufacturing

$Billions, cw 2012

250

200

150

100

50

0

1997  2002  2007  2012  2017  2022

—— Advanced Manufcturing    —— Manufacturing

Source: Statistics Canada, Deloitte

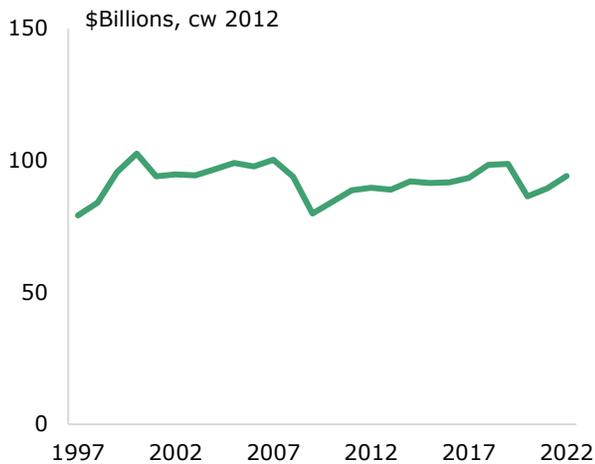Figure 13: Growth in Advanced Manufacturing
vs Overall Manufacturing

Index: 1997=100

150

125

100

75

50

1997  2002  2007  2012  2017  2022

—— Advanced Manufacturing    —— Manufacturing

Source: Statistics Canada, Deloitte

## Palette Skills' Activities in the Sector

In the past six years, Palette Skills has been developing an understanding of the needs of employers and how to best engage them in the talent development process. Palette Skills has established partnerships with sector leaders to continue to refine their understanding of the talent landscape across advanced manufacturing.

## Current State of the Sector

As observed in Figure 14 and Figure 15, as of 2022 the advanced manufacturing contributed $94 billion to the Canadian economy, and over 580 thousand jobs in 2021. The size of the sector, and levels of unemployment varies by region in the country. As seen in Figure 17, most of the jobs in advanced manufacturing are in Ontario and Quebec.

Figure 14: Advanced Manufacturing Real GDP



*Source: Statistics Canada*

Figure 15: Advanced Manufacturing Employment
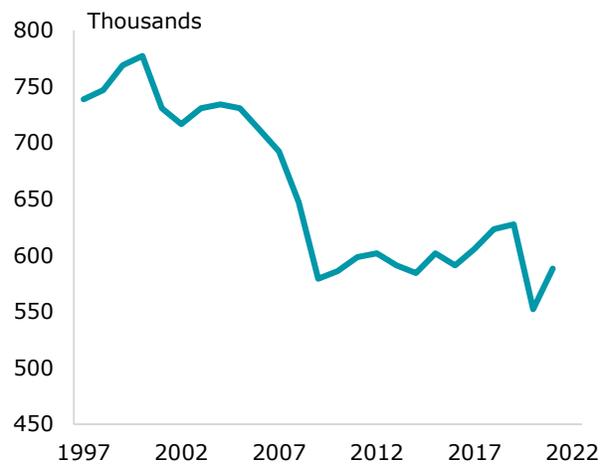


*Source: Statistics Canada*

Figure 16: Advanced Manufacturing Real GDP by Region in 2022
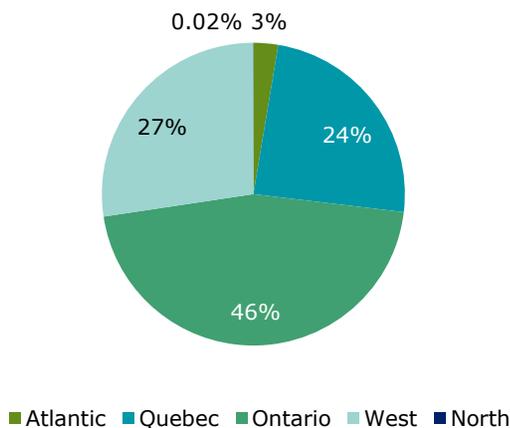


*Source: Statistics Canada*

Figure 17: Advanced Manufacturing Employment by Region in 2021
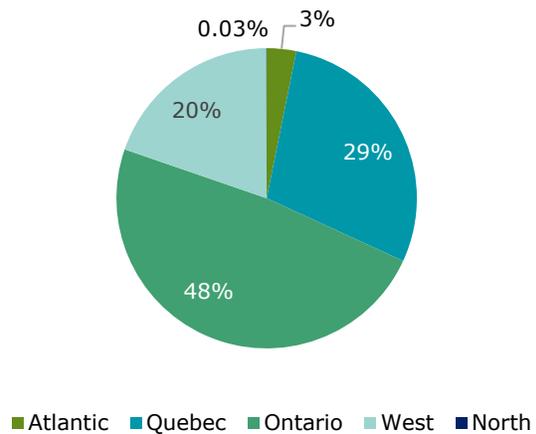


*Source: Statistics Canada*

Furthermore, the distribution of the different types of advanced manufacturing sub-industries (35 industries considered advanced) varies across the country. This implies that expertise within advanced manufacturing is also varied. For example, Quebec is a leader in the aerospace subsector while Ontario is a leader in the automotive subsector, and the Northwestern Territories and Manitoba are leaders in cold weather testing.

The manufacturing sector in general, and the advanced manufacturing sector in particular have been the recipients of material beneficiary support over time. For instance, the federal government has dedicated significant funding and several programs to grow the use of digital technologies in the manufacturing sector. As an example, the Strategic Innovation Fund provides $1.26 billion in funding over five years to support innovation in Canada's leading industries which includes advanced manufacturing.[15,16] Additionally, Next Generation Manufacturing Canada, a non-profit

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[15] Government of Canada, Canada Digital Adoption Program, 2023
[16] Destination Canada, Advanced Manufacturing, 2022

organization which aims to build world-leading advanced manufacturing capabilities in Canada, has several streams to support the strengthening of the sector with a total public funding of up to $427 million.[17]

Provincial governments have also launched their own programs to support advanced manufacturing. For example, in 2022, Ontario launched the Advanced Manufacturing and Innovation Competitiveness program a $40-million investment to support advanced manufacturers invest in new technology, capital equipment, and support skills development.[18] The support is available through funding, loans, grants, and complementary supports and services. The program is open for applicants until end of August 2023.[19]

In addition to direct government support, Canada's leading research institutions are also helping drive innovation in the sector. Institutions such as the National Research Council Canada's Advanced Manufacturing Program, and the University of Toronto's Institute for Robotics and Mechatronics are key drivers for technological development.[20]

As indicated the composition of the advanced manufacturing sector will vary across different regions of the country. As a result, there will be a diverse set of technological expertise and support programs in place across the country. As such, the key skills needed, and skills gaps observed in each region will also vary. This means that upskilling programs must be regionalized and rooted in local employer needs.

## Key Challenges

The manufacturing sector in general had been particularly impacted by the COVID-19 pandemic. Companies were forced to shut down their operations, faced a decline in demand, and significant burdened with supply chain disruptions. Although the manufacturing sector has since rebounded and recovered losses faster than some other sectors, it still faces many daunting challenges.

These daunting challenges range from external macroeconomic factors to internal operational issues. External macroeconomic challenges include increased global competition, uneven and lagging technology adoption, fluctuating commodity prices, increased protectionism, slow growth in the main export market of the US, and shortages in the supply of labour.[21] Internal operational challenges include cost control, maintaining or expanding capacity utilization, and asset management.[22]

One of the main challenges in the sector are labour shortages. The Canadian Manufactures & Exporters (CME) surveys highlight that in the past two years, more than 80% of companies have faced labour and skill shortages, as a result of the intensive effects of the COVID-19 pandemic. Labour shortages have negative implications and will have knock-on effects regarding operations within the sector. For example, there is a significant relationship between labour and skills shortage and uneven technology adoption. In essence, the lack of skills is one of the top obstacles preventing manufacturers from investing in new technology.[23]

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[17] Government of Canada, Canada's Advanced Manufacturing Cluster, 2023
[18] Ontario Government, Ontario Launches Program to Support Advanced Manufacturers Across Province, 2022
[19] Ontario Government, Regional Development Program: Advanced Manufacturing and Innovation Competitiveness Stream, 2023
[20] Destination Canada, Advanced Manufacturing, 2022
[21] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018
[22] Excellence in Manufacturing Consortium, State of Canada's Manufacturing Sector: A Map of the Manufacturing Workforce, 2022
[23] Canadian Manufacturers & Exporters, CME 2023 Technology Adoption Survey, 2023

Stakeholders shared that the adoption of technology in Canada among manufacturers remains suboptimal. As reported in the CME 2023 Technology Adoption Survey, only 13% of respondents reported that their company's digital transformation was at an advanced stage, and 47% reported an intermediate stage. Meanwhile, 28% reported that their digital transformation was just beginning, and 12% stated it had not even started.[24] Smaller companies reported lower confidence in their knowledge of technology solutions, greater difficulty in obtaining finance, and lower adoption rates compared to larger companies. This creates a challenge as Canada's manufacturing sector is predominantly composed of small businesses.[25] Therefore, a proportion of upskilling programs should also be focused to address the specific needs of small and medium sized enterprises (SMEs).

## Policy Context

International workers are an important source of labour force growth in Canada and the manufacturing sector in particular. In 2021, recent new Canadians (individuals who have been in Canada 10 years or less) made up 10% of the total employed labour force in the overall manufacturing sector.[26]

There are several opportunities for international workers to enter the advanced manufacturing workforce. For example, the Federal Skilled Trades Program, targets workers under key groups including general trades, processing, manufacturing, and utilities supervisors.[27] In order for a foreign worker to be qualified to work in a certain skilled trade, they need to pass a certification exam and meet all the requirements to practice that trade in that province or territory.[28] Workers can also join advanced manufacturing through the Canadian Experience Class. In 2023, the Government of Canada targeted trade, STEM, and transport occupations in the category-based rounds of invitations for permanent residency.[29]

Although manufacturers are increasingly tapping into the new Canadian labour force to supplement the sector's needs, industry representatives claim current immigration targets are still not enough to meet the sector's demand.[30] Additionally, employers face challenges with immigration regulations. Temporary worker programs are burdensome, costly to use, and employers are subject to cap limits on the proportion of temporary foreign workers (TFW) that can be hired in a plant.[31]

Additionally, there are barriers for new Canadians looking to join the Canadian workforce. Workers, such as engineers, may be barred from registering in their profession without Canadian work experience. Some provinces are updating their requirements to ease the transition of new Canadian workers into the labour force. For example, Professional Engineers Ontario (PEO) is the first regulated profession to remove Canadian experience as a requirement. This will allow PEO to license international applicants faster and enable international workers to join the labour force more quickly.[32]

Industry representatives suggests that higher immigration targets, and better alignment of the immigration points system to employer needs will allow immigration to further support the sector's

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[24] Canadian Manufacturers & Exporters, CME 2023 Technology Adoption Survey, 2023
[25] Canadian Manufacturers & Exporters, CME 2023 Technology Adoption Survey, 2023
[26] Statistics Canada, Immigration as a source of labour supply, 2022
[27] Government of Canada, Compare all Express Entry programs, 2023
[28] Government of Canada, What is a certificate of qualification for the Federal Skilled Trades Program, 2023
[29] Government of Canada, Express Entry rounds of invitations: Category-based selection, 2023
[30] Canadian Manufacturers & Exporters, Canadian Manufacturers & Exporters On Immigration Plan: Increase Welcomed But Insufficient to Meet Manufacturing Workforce Needs, 2020
[31] Canadian Manufacturers & Exporters, Canadian Manufacturers & Exporters On Immigration Plan: Increase Welcomed But Insufficient to Meet Manufacturing Workforce Needs, 2020
[32] Government of Ontario, Ontario Removing Unfair Work Barriers for Skilled Newcomers, 2023

needs.[33] Additionally, many respondents in the CME 2022 Labour and Skills Survey view government support and investment in automation to be a key policy to help address labour and skills shortage in the long and short term.[34]

## Emerging Trends

There are several emerging trends that are increasingly important to the advanced manufacturing sector. This includes trends such as emerging technology, environment, social and governance (ESG) priorities, and resiliency in supply chain management.

First, digital disruption and emerging technologies such as Internet of Things (IoT), AI, machine learning, cloud computing and analytics in production, are a rising trend across all sectors. Industry 4.0 (the fourth industrial revolution) is revolutionizing the way manufacturers work, increasing productivity, and improving quality.[35] As manufacturers adapt to new technology, the tools and skills that workers use will need to evolve in parallel to keep up with emerging technologies. For example, it is forecasted that approximately 25% of Canada's tradespeople will need to upgrade their skills within five years.[36] Therefore, upskill programs will need to be updated and offered frequently to address the demand in the sector.

Second, ESG policies and awareness will impact the sector's practices and priorities. In the advanced manufacturing sector, this may include increasing ESG visibility throughout the supply chain, reducing carbon footprint, industrial de-carbonization, and new product development in areas such as clean technology.[37]

Last, the COVID-19 pandemic highlighted the impacts of a disruption in supply chains, especially those that rely heavily on global production locations. A survey by CME, highlighted that nine out of 10 Canadian manufacturers are encountering supply chain issues.[38] Manufacturers are looking to re-locate supply, shorten, and create more interconnected supply chains.[39] Approximately 18% of manufacturers surveyed are looking to source more of their inputs in Canada, and 28% plan to relocate or scale-up production in Canada to mitigate supply chain bottlenecks.[40] However, numerous manufacturers are encountering obstacles due to the lack of Canadian suppliers for their key inputs.[41] A well-executed strategy for managing supply chain bottlenecks presents an opportunity to foster sector growth and competitiveness.

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[33] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022
[34] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022
[35] IBM, How Industry 4.0 technologies are changing manufacturing
[36] Royal Bank of Canada, Powering Up: Preparing Canada's skilled trades for a post-pandemic economy, 2021
[37] Next Generation Manufacturing Canada, Advanced Manufacturing in Canada: Opportunities for Growth, 2021
[38] Canadian Manufacturers & Exporters, Manufacturing Survey: Nine out of 10 Manufacturers Experiencing Supply Chain Disruptions, 2022
[39] Invest in Canada,
 in Canada Poised to Grow as Global Supply Chains Evolve, 2021
[40] Canadian Manufacturers & Exporters, Manufacturing Survey: Nine out of 10 Manufacturers Experiencing Supply Chain Disruptions, 2022
[41] Canadian Manufacturers & Exporters, Manufacturing Survey: Nine out of 10 Manufacturers Experiencing Supply Chain Disruptions, 2022

## The Potential Future of the Sector

The Government of Canada has set economic objectives for the overall manufacturing sector to fulfil, such as increasing sales by 50% by 2030, and increasing the percentage of manufacturing SME's adopting Industry 4.0 technology from 39% in 2020 to at least 75% in 2030.[42] In order to achieve these objectives, some of ISED's proposed strategies include expanding network technology adoption centers to link innovators with established manufactures, providing "hypergrowth" support for SMEs, and launching a Canadian advanced manufacturing skills and talent pathway.[43] The advanced manufacturing sector has the potential to shift Canada's manufacturing culture and re-establish Canada's competitiveness on the world stage.[44]

In order to achieve Canada's manufacturing goals, the Government of Canada forecasts that 60,000 additional advanced manufacturing jobs will be need within the next nine to ten years. [45] These jobs will have a high demand of advanced skills, and knowledge of emerging technologies.[46] Likewise, as an increasingly large proportion of workers retire, it will be key to ensure the sector is able to recruit younger workers and tap into underrepresented pools of talents such as women and other equity-deserving groups.

## Implications to the Sector

The Canadian manufacturing sector is stagnant and facing increasing competition as it fails to adapt to new technologies and drive innovation. The current uneven technology adoption in the sector is a barrier to remain competitive at a global scale. Technology positively impacts manufacturers, by lowering operating costs, increasing flexibility, reducing waste, and increasing overall productivity.[47] A slow adoption of technology may leave many 'technology laggards' behind.

To maintain competitiveness and attain a leadership position, the sector must embrace technology creators who drive product quality and solutions, establish a sustainable global value chain, attract capital investment, and address prevailing occupational and skills shortage.[48] Access to skilled talent is a significant consideration for companies looking to invest in manufacturing capacity and adopt new technology.[49] A lack of skilled talent can lead to a decrease in capital projects, slow adoption of technology, and heighten the current barriers faced by the sector. Moreover, the sector is unable to produce if they have shortages in key occupations such as skilled trades and general assemblers.

In the following sections, we will explore the sector labour market, identify hiring and upskilling challenges, implications, and opportunities.

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[42] Excellence in Manufacturing Consortium, Future of Advanced Manufacturing Skills Needs and Gaps – Report, 2020-21

[43] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

[44] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

[45] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

[46] Excellence in Manufacturing Consortium, Future of Advanced Manufacturing Skills Needs and Gaps – Report, 2020-21

[47] Canadian Manufacturers & Exporters, CME 2023 Technology Adoption Survey, 2023

[48] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

[49] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018

# Sector Labour Market and Occupations/Skills Analysis

## Overview of Job Supply and Demand

The advanced manufacturing labour market is impacted by both supply and demand factors. Some key supply factors impacting the supply of labour in the sector are renumeration and working conditions. As identified in the CME 2022 Labour and Skills Survey, 70% of survey participants have dealt with labour shortages by increasing wages and benefits, which is consistent with data that shows a significant wage growth in manufacturing.[50] However, due to current labour shortages, working conditions in the manufacturing sector have not been optimal. Work-related stress and poor mental health were cited as major reasons for absenteeism, occupation disability, and early retirements.[51]

Meanwhile, some of the key factors impacting the demand for labour in the sector is technology adoption, the productivity of labour, and the overall level of economic activity in the sector.

Overall, as identified in page 30, labour shortage is a significant challenge to the sector. The sector is facing a continued shortage of labour, and none of the sector's key occupations (as identified in the table below) were flagged to be oversupplied in the Canadian Occupational Projection System (COPS) dataset. Without intervention it is likely that these gaps will continue to persist. In this sub-section, we look to identify the key occupations, occupation gaps, and future occupations in the advanced manufacturing sector. Similarly, we look to identify the key skills, skill gaps, and future skills that will be needed for the success of the advanced manufacturing sector.

## Occupations

### Key Occupations

For the advanced manufacturing sector, workers are key for both the development and maintenance of new technologies and the production process. The production process itself interconnects a series of process, procedures, and types of workers together – both from within the firm as well as its suppliers – to produce a final product.

Given the interconnected nature of the sector, an occupational gap in one specific occupation can have compounding affects and can create material bottlenecks downstream in the production process. While our research has indicated the top occupations within the sector, our research and consultations have also indicated that gaps in lesser technical occupations (such as forklift drivers) can have as much of an impact in the production process as higher technical roles. Therefore, ensuring companies have the skilled workers that they need throughout the process chain and supply chain is key for the sector's success.

Furthermore, as identified in the overview of the sector, different regions of the country have different areas of expertise and focus on the production of different goods. Therefore, the specific key occupations for advanced manufacturing (e.g., type of engineer) may differ across Canada.

Through our research and stakeholder consultations, the following occupations were identified as being key to the sector's growth and competitiveness:[52,53,54]

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[50] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022

[51] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022

[52] The Information and Communications Technology Council, Canada's Growth Currency, 2019

[53] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021

[54] Lightcast, 2023

| Key Occupations | Top Associated Skills[55, 56] |
|---|---|
| Application engineer | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Additive manufacturing designer | • *Product Design*<br>• *Proficiency with Digital Tools*<br>• *Knowledge of emerging technology* |
| Aerospace and control engineer | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Carpenters | • Management of Material Resources<br>• Numeracy<br>• Operation and Control |
| Construction millwrights and industrial mechanics | • Preventative Maintenance<br>• Repairing<br>• Operation Monitoring of Machinery and Equipment |
| Data Scientists | • Digital Literacy<br>• Numeracy<br>• Systems Analysis |
| Drafting technicians | • Critical Thinking<br>• Instructing<br>• Learning and Teaching Strategies |
| Electrical and electronics engineer | • Critical Thinking<br>• Decision Making<br>• Numeracy |
| Electrical and electronics engineering technologists and technicians | • Equipment and Tool Selection<br>• Troubleshooting<br>• Numeracy |
| General labour and assembly positions | • Setting Up<br>• Operation and Control<br>• Operation Monitoring of Machinery and Equipment |
| Industrial electricians | • Preventative Maintenance<br>• Repairing<br>• Setting Up |
| Industrial engineering and manufacturing technologists and technicians | • Numeracy<br>• Product Design<br>• Quality Control Testing |

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[55] The top associated skills are defined based on the top three skills related to the occupation in the Occupational and Skills Information System (OaSIS).
[56] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Key Occupations | Top Associated Skills[55, 56] |
|---|---|
| Machinists and tooling inspectors | • Equipment and tool selection<br>• Quality control testing<br>• Troubleshooting |
| Managers and supervisors in forest products processing | • Management of Material Resources<br>• Management of Personnel Resources<br>• Monitoring |
| Managers and supervisors in motor vehicle assembling | • Management of Material Resources<br>• Management of Personnel Resources<br>• Setting Up |
| Managers and supervisors in other mechanical and metal products manufacturing | • Management of Material Resources<br>• Management of Personnel Resources<br>• Monitoring |
| Managers and supervisors in plastic and rubber products manufacturing | • Management of Material Resources<br>• Management of Personnel Resources<br>• Monitoring |
| Managers and supervisors in supply chain, tracking and scheduling co-ordination occupations | • Coordinating<br>• Time Management<br>• Evaluation |
| Material handlers | • Operation and Control<br>• Operation Monitoring of Machinery and Equipment<br>• Preventative Maintenance |
| Mechanical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Plant managers | • *Monitoring*<br>• *Quality Control Testing*<br>• *Critical Thinking* |
| Production labour | • *Coordinating*<br>• *Management of Material Resources*<br>• *Monitoring* |
| Production technicians | • *Coordinating*<br>• *Management of Material Resources*<br>• *Monitoring* |
| Purchasing agents and officers | • Negotiating<br>• Management of Financial Resources<br>• Management of Material Resources |
| Software engineer | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| Technical sales specialists - wholesale trade | • Management of Material Resources<br>• Negotiating<br>• Persuading |
| Tool and die makers | • Quality Control Testing<br>• Critical Thinking<br>• Equipment and Tool Selection |
| Welders and related machine operators | • Equipment and Tool Selection |

| Key Occupations | Top Associated Skills[55, 56] |
|---|---|
| | • Operation and Control<br>• Preventative Maintenance |

**Industry Perspective**

Although digital and STEM occupations are key to building innovation in the sector, stakeholders highlighted the importance of traditional operators, general assemblers, and skilled trade in the manufacturing sector. This is because the occupation gap in one area can have a compounding effect and create bottlenecks throughout the production process. Although the actual duties and skills needed in these jobs might change and evolve as technology changes, these occupations will remain key for the health of the sector.

## Occupation Gaps

Occupation gaps are a constant challenge in the manufacturing sector and were exacerbated during the COVID-19 pandemic. In 2022, 82% of participants in the CME 2022 Labour and Skills Survey reported that they were facing labour shortages.[57] Approximately two-third of businesses reported that they were unable to find sufficient workers in skilled trade professions, and about 60% of workers were unable to fill general labour and assembly positions.[58] As a result, manufacturers are faced with delivery delays, unfulfilled orders, and stagnant growth.

Through our research, potential causal factors for the labour shortage are the aging population resulting in increased levels of retirement, digital disruption in the sector requiring the heightened demand for specific skills, misperception problem associated with working in the sector resulting in limited supply of job candidates, a lack of representation of youth, and a lack of diversity which limits the size of the available pool of applicants. These challenges are further explored in page 45.

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[57] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022
[58] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022

Through our research and stakeholder consultations, the following occupations gaps were identified: [59,60,61]

| Occupation Gaps | Top Associated Skills[62] |
|---|---|
| Business management | • Evaluation<br>• Persuading<br>• Systems Analysis |
| Carpenter | • Management of Material Resources<br>• Numeracy<br>• Operation and Control |
| Electrical and electronics engineer | • Critical Thinking<br>• Decision Making<br>• Numeracy |
| Electrical mechanics | • Equipment and Tool Selection<br>• Operation Monitoring of Machinery and Equipment<br>• Preventative maintenance |
| General labour and assembly positions | • *Setting Up*<br>• *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment* |
| Industrial electricians | • Preventative Maintenance<br>• Repairing<br>• Setting Up |
| Information Technology (IT) workers (business analysts and cybersecurity) | • *Critical Thinking*<br>• *Decision Making*<br>• *Digital Literacy* |
| Machinists | • Equipment and Tool Selection<br>• Operation and Control<br>• Troubleshooting |
| Maintenance | • *Preventative Maintenance*<br>• *Quality Control Testing*<br>• *Repairing* |
| Manufacturing Manager | • Management of Financial Resources<br>• Management of Material Resources<br>• Time Management |
| Material handlers | • Operation and Control<br>• Operation Monitoring of Machinery and Equipment<br>• Preventative Maintenance |
| Millwrights | • Preventative Maintenance<br>• Repairing<br>• Operation Monitoring of Machinery and Equipment |

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[59] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022
[60] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020
[61] CERIC, How Eastern Ontario is Addressing Gaps in the Manufacturing Workforce, 2019
[62] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Occupation Gaps | Top Associated Skills[62] |
|---|---|
| Researchers | • *Critical Thinking*<br>• *Decision making*<br>• *Digital Literacy* |
| Sales, marketing, and customer services | • *Learning and Teaching Strategies*<br>• *Negotiating*<br>• *Oral Communication: Active Listening* |
| Scientists | • *Critical Thinking*<br>• *Decision making*<br>• *Digital Literacy* |
| Software engineer | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| Supervisors | • *Management of Material Resources*<br>• *Management of Personnel Resources*<br>• *Coordinating* |
| Supply chain management | • Coordinating<br>• Time Management<br>• Evaluation |
| Technologists and technicians | • *Equipment and Tool Selection*<br>• *Critical Thinking*<br>• *Evaluation* |
| Tool die makers | • Quality Control Testing<br>• Critical Thinking<br>• Equipment and Tool Selection |
| Welders | • Equipment and Tool Selection<br>• Operation and Control<br>• Preventative Maintenance |

**Industry Perspective**

Three major themes arose in stakeholder consultations. First, stakeholders highlighted that general labour, assembly position, machine operators, and skilled workers are a huge gap in the sector, mirroring the sentiment expressed in the CME 2022 Labour and Skills Survey.[64]

On the other side of the spectrum, stakeholders shared that there is a current gap in senior positions, such as quality engineers and senior quality technicians. These occupations are key for inspection and quality control.

Finally, stakeholders also discussed the current gap of workers in the IT space, who would support integration and operate different digital platforms. As work becomes more digital there is an increasing occupation gap related to technology such as cybersecurity, as manufacturers will need to ensure secure data assets.

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[63] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022

## Future Occupations

It is important for the sector to both address current gaps, but also consider future occupations that will be increasingly important. It is worth to note that the occupations and the top associated skills will evolve with emerging technologies.

Through our research and stakeholder consultations, the following occupations were identified as increasingly important in the future: [64,65,66]

| Future Occupations | Top Associated Skills[67] |
|---|---|
| Data analysts | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Electrical and electronics engineer | • Critical Thinking<br>• Decision Making<br>• Numeracy |
| General labour and assembly positions | • *Setting Up*<br>• *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment* |
| Industrial engineer | • Decision Making<br>• Evaluation<br>• Monitoring |
| Manufacturing managers | • Management of Financial Resources<br>• Management of Material Resources<br>• Time Management |
| Production support | • Coordinating<br>• Learning and Teaching Strategies<br>• Monitoring |
| Scientists and researchers | • *Critical Thinking*<br>• *Decision making*<br>• *Digital Literacy* |
| Skilled workers | • *Equipment and Tool Selection*<br>• *Operation and Control*<br>• *Preventative Maintenance* |
| Virtual design | • *Product Design*<br>• *Digital Literacy*<br>• *Numeracy* |

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[64] Canadian Manufacturers & Exporters, 2020 Management Issues Survey, 2020
[65] Brookings Institute, Canada's Advanced Industries, 2018
[66] Analysis was conducted to identify whether key occupations in the advanced manufacturing sector will be in shortage in the future based on the Canadian Occupation Projection System dataset.
[67] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

**Industry Perspective**

As with key occupations and occupation gaps, stakeholders highlighted that skilled workers, general labour and assembly positions will be key occupations in the future. Without these workers, the sector will face a bottleneck in production.

# Skills

## Key Skills

As is the case for occupations, the key skills demanded for the advanced manufacturing sector varies across regions in the country. For example, the technology used and the demand for associated skills will depend on the expertise, companies, and clients in each region.

Through our research and stakeholder consultations, the following skills were identified as being key to the sector's growth and competitiveness:[68,69,70,71]

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[68] Royal Bank of Canada, Powering Up: Preparing Canada's skilled trades for a post-pandemic economy, 2021
[69] We also conducted an analysis of the key occupations identified, and the key skills identified in those occupations from the Lightcast database.
[70] Excellence in Manufacturing Consortium, Future of Advanced Manufacturing Skills Needs and Gaps – Report, 2020-21
[71] Plant, Summer 2022 Canada's Manufacturing Magazine, 2022

## Key Skills

**Foundational Skills**
- Digital literacy
- Digital skills in:
  - Simulation
- Digital modelling

**Analytical Skills**
- Critical thinking
- Problem solving

**Technical Skills**
- Preventative maintenance
- Digital production
  - Capacity to use digital tools/ technologies such as:
    - Electronic-testing equipment
    - 3D technology
    - Digital diagnostic tools
    - Digital inspection tools
    - Database systems
    - Digital twin
    - ERP systems
    - Manufacturing computer aided design
    - Software
    - Programming
- Skilled trades[72]

**Resource Management Skills**
- Planning skills
- Project management
- Supervisory/monitoring
- Change management
- Management of financial resources

**Interpersonal Skills**
- Managing communication
- Negotiating

**Personal Attributes**
- Leadership
- Creativity
- Collaboration
- Adaptability

**Knowledge**
- Sales
- HR and labour relations

**Industry Perspective**

During the consultations, stakeholders highlighted the importance of skills in skilled trades. Additionally, stakeholders shared that it is important for workers to have both the technical skills required, and soft skills such as collaboration, teamwork, and communication.

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[72] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.

## Skill Gaps

In the CME 2022 Labour and Skills Survey, one of the main barriers highlighted that manufacturers face is finding candidates with the appropriate technical skills.[73] The skill gaps and number of workers training and upskilling varies across Canada. For example, Alberta faced a steep decline in registration for skilled trades. Meanwhile, Quebec and Ontario saw increased registration in 2019. Although, all regions are experiencing shortfalls, some regions in the country may require more upskilling than others.[74]

Through our research and stakeholder consultations, the following skills gaps were identified:
[75,76,77,78]

| Skills Gaps | |
|---|---|
| **Foundational Skills**<br>• Digital literacy<br>  – Understand current technology and how to use them<br>  – Ability to use computerized machinery<br>  – Operate electronic-testing equipment<br>  – Use digital diagnostic tools<br><br>**Technical Skills**<br>• Digital production<br>  – Capacity to use digital tools/technologies such as:<br>    • 3D technology<br>    • Industrial IoT<br>    • Emerging technology such as battery technologies<br>    • Software and programming<br>• Cybersecurity<br>• Skilled trades[79]<br>• Skills in engineering, and industrial engineer[80] | **Resource Management Skills**<br>• Project management<br>• Change management<br>• Management of financial resources<br><br>**Interpersonal Skills**<br>• Managing communication<br><br>**Personal Attributes**<br>• Leadership<br>• Collaboration |

[73] Queens University, Kingston, Ont. Focusing on skills, education for an EV-centric future, 2023
[74] Royal Bank of Canada, Powering Up: Preparing Canada's skilled trades for a post-pandemic economy, 2021
[75] Royal Bank of Canada, Powering Up: Preparing Canada's skilled trades for a post-pandemic economy, 2021
[76] The Information and Communications Technology Council, Additive Manufacturing in Canada: The Impending Talent Paradigm, 2017
[77] Excellence in Manufacturing Consortium, Future of Advanced Manufacturing Skills Needs and Gaps – Report, 2020-21
[78] Plant, Summer 2022 Canada's Manufacturing Magazine, 2022
[79] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.
[80] Skills in engineering and industrial engineer encompass a diverse skill set. It is not classified in OaSIS.

## Future Skills

To ensure the sector remains competitive, and forward-looking it is also important to consider future skills demanded and in shortage in the future. Through our research and stakeholder consultations, the following skills were identified as increasingly important in the future: [81,82,83]

| Future Skills | |
|---|---|
| **Foundational Skills**<br>• Analytical skills<br>  – Data analytics and connection<br><br>**Technical Skills**<br>• Digital production<br>  – Capacity to use digital tools/ technologies such as:<br>    • 3D printing/systems<br>    • Nanotechnology<br>    • AI<br>    • Cloud computing<br>    • ERP systems (management/operation)<br>    • Manufacturing computer aided design<br>    • Machine operating skills<br>    • Automation<br>    • Information and communication tech<br>    • Artificial Skills and machine learning<br>    • Robotics<br>• Cybersecurity<br>• Skilled trades[84] | **Resource Management Skills**<br>• Project management<br>• Change management<br><br>**Knowledge**<br>• Sales and marketing<br>• Green manufacturing/energy saving/emissions reduction<br>• Supply chain integration |

**Industry Perspective**

Stakeholders shared that the tools and skills workers use will significantly change in the future as the sector adapts to emerging technologies and will depend on what the sector looks like in future. Consequently, the integration of social and emotional skills (i.e., the ability to recognize, express and regulate one's emotions) will be essential to continuously build an inclusive workplace strategy.

Additionally, stakeholders shared that IT competencies will be increasingly important to support the integration of emerging technologies in the sector on a wide scale.

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[81] Ontario's Universities, Partnering for a Better Future for Advanced Manufacturing, 2019

[82] Brookings Institute, Canada's Advanced Industries, 2018

[83] Excellence in Manufacturing Consortium, Future of Advanced Manufacturing Skills Needs and Gaps – Report, 2020-21

[84] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.

# Challenges and Barriers to Upskilling

## Key Employer Challenges

For employers, challenges in obtaining skilled and unskilled labour are twofold. First, the sector faces labour shortages and challenges in recruiting workers into the sector. The sector faces a perception problem, seen as physically intensive, repetitive, and poorly paid, that prevents many individuals from taking up an interest in the sector. For example, youth are increasingly unprepared and uninterested in working in manufacturing.[85] Additionally, specific populations are underrepresented in the manufacturing sector. In skilled trades, women and new Canadians are underrepresented. In 2019, only 5% of apprenticeship registrations were women.[86] In 2018, only 8.7% of apprentices were new Canadians, while they make up more than 21% of Canada's population.[87] A lack of ability to attract workers into the sector, coupled with an ageing workforce and a high retirement in the sector heightens the labour shortages challenges employers face.

Second, employers face challenges in upskilling and training of their existing employees. Companies may not invest in training because it does not align to their needs. At times, companies cannot afford to pull workers off the production line, or they do not have the budget to pay for continuous staff training. In some cases, training programs may not be available in a convenient location, and as result makes it too costly and time-intensive to train employees. [88] In general, industries and firms most impacted by the COVID-19 pandemic, such as the manufacturing sector, were more likely to report resource-related challenges to train new or current employees.[89]

Additionally, stakeholders have indicated that a major reason why employers are not investing in training is because existing programs are not addressing their current needs. Many companies feel overwhelmed, especially SMEs, and the upskilling programs that are of interest to them are those that will help them achieve their goals in the short-term, rather than focusing on forward-looking goals of the long-term future.

## Key Employee Challenges

Employees are faced with a variety of challenges including the mismatch of skills, and layoff from companies as their technical skills become obsolete.[90] Many employees find the current pace of digitalization difficult to adapt. The fast-paced environment may lead some employees to choose to avoid digital tasks and delegate tasks to younger or more tech-savvy workers. [91] Other challenges include limited finances to fund upskilling courses, and inability to take time off work due to salary impacts. [92]

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[85] McMaster University, Analysis: Canada needs to encourage more youths to pursue skilled trade jobs, 2022
[86] Royal Bank of Canada, Powering Up: Preparing Canada's skilled trades for a post-pandemic economy, 2021
[87] Royal Bank of Canada, Powering Up: Preparing Canada's skilled trades for a post-pandemic economy, 2021
[88] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020
[89] Future Skills Center, Employer-Sponsored Skills Training, 2023
[90] Future Skills Center, Helping displaced workers reskill in advanced manufacturing, 2020
[91] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020
[92] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020

## Challenges in Upskilling

After the COVID-19 pandemic, a spike in training activity occurred in the manufacturing sector. This may reflect an employer's attempt to adjust to high staff turnover, increase adoption of emerging technology, or changes in business practice.[93] Among some of the main industries in the country, manufacturing was the most likely to encourage on-the-job training, and offer training for internal career opportunities. [94] However, there is room for improvement in the delivery of current programs. For example, for skilled workers, current challenges in existing training programs include relevancy of content, communication barriers, and comprehensiveness of the material.

First, some training courses are being taught at a higher level than workers need. For example, for tradespeople, some courses are being taught by engineers who may not provide them with the day-to-day training they need to succeed in the job. Workers highlighted the importance of ensuring the right people are teaching the program.[95]

Second, it was highlighted that intergenerational communication is a challenge as apprentices today are digitally savvy and older journeypersons[96] may prefer verbal communication. Therefore, miscommunication can limit on-the-job learning.[97]

Additionally, firm-specific training on digital technologies is often highly specialized. Comprehensive training, available across all brands, is limited, and therefore workers are challenged with keeping their skills up to date and are unable to move from one firm-specific technology to another.[98] The lack of transferrable skills from one technology to another creates barriers to post-certification of digital upskilling for workers. Furthermore, there is often a temporal lag between emerging technologies used in the sector and those learned in digital upskilling technologies.[99] This may hold workers back and prevent them from staying current in their field.

# Implications to the Sector

Occupational and skill shortages may have negative consequences to the manufacturing sector. Given the interconnectedness of production workflow, occupations with relatively smaller share of the total workforce can create bottlenecks in production if demand is not met. This includes lost or declined contracts, delivery delays, postponed or cancelled capital projects, increased costs, and mental health impact on current employees.[100]

Therefore, occupation and skills shortages have a direct impact in the growth of the sector. In the CME 2022 Labour and Skills Survey, companies reported combined losses of over $1.1 billion in 2021 due to lost or turned down contracts, and penalties for late deliveries.[101] Additionally, companies surveyed reported a total of $844 million in delayed or cancelled capital projects over

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[93] Future Skills Center, Employer-Sponsored Skills Training, 2023

[94] Future Skills Center, Employer-Sponsored Skills Training, 2023

[95] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020

[96] As defined by Statistics Canada, a journeyperson is a "recognized as a qualified and skilled person in a trade and is entitled to the wages and benefits associated with that trade. A Journeyperson is allowed to train and act as a mentor to a registered apprentice."

[97] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020

[98] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020

[99] The Conference Board of Canada, Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem, 2020

[100] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022

[101] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022

the past year.[102] This illustrates how occupational and skill shortages are impacting the potential of the sector.

If the sector fails to fill the current occupation and skill shortages, it will not have the workforce needed to increase sales to meet the Government of Canada's objectives of 50% by 2030. Likewise, the sector would not have the skills necessary to continuously integrate technology and reach the Government's objective of increasing the percentage of manufacturing SME's adopting Industry 4.0 technology from 39% in 2020 to at least 75% in 2030.

Upskilling workers and filling current gaps could potentially reduce the impacts of skills and occupational shortages, such as minimize delivery delays, lower manufacturers' costs, and have a positive impact in the mental health of current employees. Moreover, the ability of the sector to keep up with changing skills will impact its potential to adapt to new technologies. As a result, upskilling will play a key role in impacting the sector's ability to evolve with emerging technologies, grow and remain competitive and sustainable.

# Opportunities

## Emerging Trends in the Sector Related to Skills and Occupations

### Emerging Technology

As outlined on page 33, emerging technology is a continuous trend in the sector that will lead to changes in key skills and occupations in the sector, requiring continuous need of upskilling. As technology evolves, the sector will have to identify new skills needed and optimal approaches for training.

Companies that want to remain competitive in the sector will need to continuously adapt to emerging technologies. Surveys reveal that employers who adopt to new technologies are more likely to invest in training than those who do not.[103]

### Changing Workforce

Across the economy, Canada is experiencing the effects of an aging population through increases in retirements. In 2012, the Canada worker-to-retiree ratio was 4.2 to one, and projections estimate that in 2036 the number will be closer to two to one.[104] The manufacturing labour force is particularly impacted by an aging population as approximately 20% of their workforce is eligible to retire in the next ten years.[105] Therefore, attracting new workers into the sector will be key to overcoming labour shortages.

Moreover, the majority of Canada's labour force growth comes from foreign workers. Therefore, the advanced manufacturing sector will need to develop a strategy to attract more foreign workers into the sector. Specifically, the sector will need to consider how they can leverage common standards, terminology, and assessment tools. Moreover, the sector also has the opportunity to advocate for immigration reforms that better aligns with the key skills and gaps of the sector. [106]

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[102] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022
[103] Future Skills Center, Employer-Sponsored Skills Training, 2023
[104] Government of Canada, Backgrounder: Growing Canada's Economic Future, 2017
[105] Plant, Summer 2022 Canada's Manufacturing Magazine, 2022
[106] Canadian Manufacturers & Exporters, CME 2022 Labour and Skills Survey, 2022[107] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018  [108] BioTalent Canada, LabourMarketIntelligence, 2021

The advanced workforce is changing both as workers retire and the workforce becomes more diverse. The sector will need to understand how to create working environments that are diverse, equitable, and inclusive in order to ensure higher retention in the sector.

## Upskilling Opportunities

### Delivery Opportunities

The delivery of programs through business-led training can be effective for the sector. Research by the Conference Board of Canada in 2020 reports that 62% of manufacturing employers support employees to pursue essential skills training during the workday. It will be key to ensure this type of opportunity remains and grows in the sector.

Stakeholders outlined that there is an opportunity for short-term programs to establish standards, deliver certifications, and micro credentials. Employers are often looking for short programs that have a quick return on investment.

Another opportunity highlighted by stakeholders is to train employees in groups and clusters in a project type of scenario. This format allows individuals to both learn skills from an operational or technical aspect but also teaches them soft skills such as communication and teamwork.

### Partnership Opportunities

Stakeholders highlighted the opportunity for a community-based approach for upskilling. Companies should partner with educators to develop and fine-tune program curriculum and awareness of the sector. The partnership would provide companies with a direct access to a continuous supply of young talent, and act as a bridge between industry, training, and students.

For example, one opportunity is for trade schools to incorporate within their curriculum more hands on training and real-life case studies. Additionally, institutions can partner with secondary schools to start embedding work skills such as communication and teamwork early on in an individuals' careers.

### Audience

There is an opportunity to increase the effective engagement of youth, women, and under-represented groups in the advanced manufacturing sector. The opportunity includes addressing the bias and misperception of what work is like in the manufacturing sector. The sector can focus on exposing Canadians to advanced manufacturing through early learning programs, conferences, and events to outline manufacturing processes and possible manufacturing careers.[107] This can be in the form of industry-led capacity-building partnerships that work with areas and schools with families from underrepresented backgrounds in advanced manufacturing.

### Regional Lens

Across Canada, regions have different areas of expertise and focus on the production of different goods. Therefore, it will be critical to account for local considerations when launching upskill programs. Regions have different occupations and skills demanded and so they require different upskill programs.

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[107] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Advanced Manufacturing, 2018  [108] BioTalent Canada, LabourMarketIntelligence, 2021

## Skills

As identified by our research, analysis, and validated by roundtable interviews, there are key skills that should be targeted in the sector. Specifically, stakeholders outlined some of the most achievable upskilling opportunities in the short term include training of skilled trades, digital value chains, supply chain, and cybersecurity.

Moreover, it will be increasingly important to ensure that soft skills are not neglected during the development of programs. Cultivating a growth mindset and culture where individuals strive to develop within the organization are essential for the resilience of the sector.

# Conclusion

A skilled workforce is key to ensure future competitiveness, productivity growth, and sustainability in the advanced manufacturing sector. If the sector fails to upskill and attract workers it will continue to face barriers in growing operations, adapting to emerging technology, and reaching the objectives set out by the Government of Canada.

For the sector to grow to its full potential, it will be essential to overcome the shortage of workers and skills. Upskilling programs and workforce initiatives should be consistently aligned with the demand of employers. Currently, the sector must ensure it fills gaps not only in highly technical roles, such as certain types of engineers, but it must also fill in the gaps related to roles in the skilled trades and general assembly line workers. To ensure future competitiveness, the workers in the sector must proactively adapt their skills to emerging and evolving technologies.

# The Biomanufacturing Sector

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CHAPTER 2

# Executive Summary

Deloitte has been engaged to support Palette Skills' leadership role related to the Industry Upskilling Initiative funded by Innovation, Science and Economic Development Canada (ISED). The purpose of Upskill Canada is to connect employers to qualified talent and help high potential untapped talent move into fast growing careers. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills for high-demand roles in six key sectors (digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, biomanufacturing). In this report, we define biomanufacturing as the manufacturing processes or technology that utilizes biological systems to produce commercially important biomaterials and biomolecules, recovered from natural sources (e.g., blood, microbes cultures, animal cells, plant cells) for use in medicines, food and beverage processing, and industrial applications.

The biomanufacturing industry as a whole plays a significant role in shaping the Canadian economy, serving as a pivotal player in the field of research and innovation while fostering competitiveness and elevating the overall standard of living. In 2021, the industry employed an impressive workforce of over 104 thousand individuals across Canada and made a substantial contribution of over $16 billion in real GDP in 2022.

For the biomanufacturing sector to enhance its competitiveness and emerge as a global leader, it must address various prevailing challenges. One significant hurdle is the need to overcome the misconception regarding educational requirements, ensuring accurate information reaches potential candidates, and highlighting the diverse career opportunities available in the field. Additionally, bridging the gap between employer expectations and candidate skill sets, particularly in SMEs, is crucial. Efforts should be made to showcase the value of marketing and sales skills alongside technical expertise, attracting individuals with a broader skill set and enabling comprehensive support for the industry's growth. Furthermore, fostering an inclusive environment that actively promotes representation from diverse backgrounds can further diversify and strengthen the biomanufacturing workforce. Emphasis should also be placed on upskilling programs that address the fast-paced nature of the sector, keeping employees updated with the latest advancements and equipping them with the necessary skills. Lastly, the exploration of partnerships between academic institutions and industry stakeholders to provide practical training and align curriculum with industry demands is essential to bridge the gap between academic knowledge and industry requirements. By effectively addressing these challenges, the biomanufacturing sector can position itself as a global leader and drive innovation and growth in the field.

The findings and results of our research and analysis are organized into several sections: an overview of the sector, a summary of the labour and skills analysis, challenges, implications, and opportunities for the sector. To be of benefit to the broader training and workforce development ecosystem, the findings presented in this chapter reflect the wide-ranging needs of the sector. Some occupations listed or industry opportunities might be beyond Upskill Canada's scope. This might include skilled trades occupations and those requiring certification from a professional body. Eligibility for Upskill Canada funding will be dependent on identifying demand for jobs through direct employer engagement.

# Overview of the Sector

## The Bioeconomy and the Biomanufacturing Sector

**The Bioeconomy and the Biomanufacturing Sector**

**Biohealth**
The biohealth subsector comprises the commercial development and production of therapeutics, prevention, diagnostics, and health administration bioproducts.

**Bioenergy**
The bioenergy subsector comprises the commercial development and production of renewable fuels through conversion of organic material into heat or power.

**Bioindustrial**
The bioindustrial subsector comprises the commercial development and production of goods for industrial use.

**Agribio**
The agribio subsector comprises the commercial development and production of new or modified products resulting from the alteration of plants, animals, and/or other food sources.

The bioeconomy is a growing share of Canada's economy, the bioeconomy encompasses four distinct subsectors. In line with the biomanufacturing strategy outlined by the ISED department, the focus of this chapter is primarily directed towards the biomanufacturing aspects within each subsector. It is important to note that the analysis only considers talent and skills pertinent to biomanufacturing NAICS (later outlined), excluding talent and skills from each subsector that do not relate to the specific NAICS. Consequently, this narrowed focus on biomanufacturing may result in a potential underestimation of talent and skills in comparison to sources such as BioTalent Canada or other references encompassing all aspect of the four subsectors.

The bioeconomy in Canada encompasses a diverse range of economic activities related to biobased products, biotechnology, and R&D. Within this framework, the biomanufacturing sector holds significant importance, contributing to the invention, development, and production of biobased products.[108] Despite the potential for growth and innovation, the biomanufacturing sector faces several challenges, particularly in attracting and retaining talent.

Biomanufacturing, as defined by ISED**, is the manufacturing processes or technology that utilizes biological systems to produce commercially important biomaterials and biomolecules, recovered from natural sources (e.g., blood, microbes cultures, animal cells, plant cells) for use in medicines, food and beverage processing, and industrial applications**.[109] In this report, the biomanufacturing sector is defined using the following NAICS: animal food manufacturing (3111), pharmaceutical and medicine manufacturing (3254), soap, cleaning compound and toilet preparation manufacturing (3256), medical equipment and supplies manufacturing (339110), and measuring, medical and controlling device manufacturing (334512).

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[108] BioTalent Canada, LabourMarketIntelligence, 2021
[109] Definition obtained from ISED

## Palette Skills' Activities in the Sector

In the past six years, Palette Skills has been developing an understanding of the needs of employers and how to best engage them in the talent development process. Palette Skills has established partnerships with sector leaders to continue to refine their understanding of the talent landscape across biomanufacturing.

## Current State of the Sector

The COVID-19 pandemic revealed a significant shortage of resiliency in Canada's bioeconomy, specifically in biomanufacturing and processing capacity. The country initially struggled to meet the demand for personal protective equipment (PPE) and lacked domestic vaccine production capabilities. By 2029, Canada will require an additional 16 thousand biomanufacturing workers due to a gap in biomanufacturing and processing capacity highlighted by the COVID-19 pandemic, while the projected talent supply is estimated to cover only a quarter of this demand.[110] This gap highlights the urgent need for strategic measures to address the shortage, including training workers from other sectors and actively recruiting from underrepresented groups. These efforts are essential for the biomanufacturing sectors' growth and resilience, emphasizing the importance of skills development and upskilling to meet future demands effectively.

*Figure 18: Biomanufacturing Real GDP*
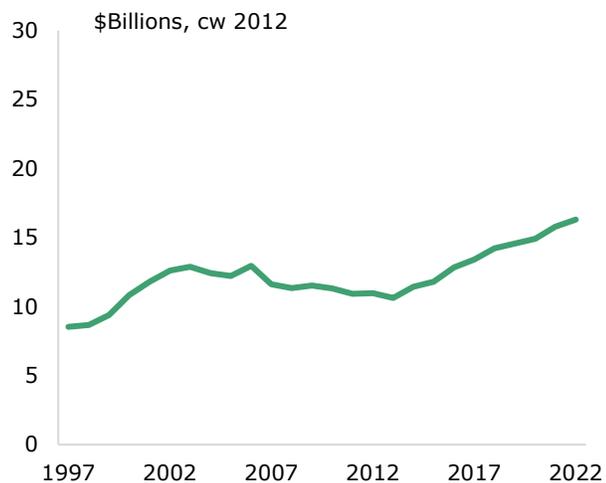


*Source: Statistics Canada, Lightcast, Deloitte*

*Figure 19: Biomanufacturing Employment*
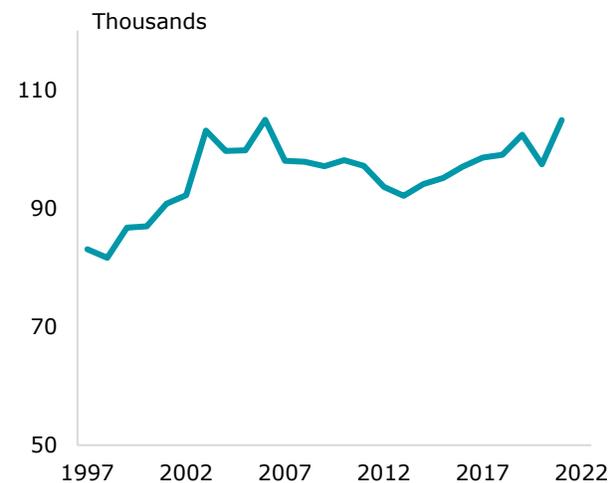


*Source: Statistics Canada, Lightcast, Deloitte*

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[110] BioTalent, Demand and Supply Outlook, 2021

*Figure 20: Biomanufacturing Real GDP by Region in 2022*



*Figure 21: Biomanufacturing Manufacturing Employment by Region in 2021*



*Source: Statistics Canada, Lightcast, Deloitte*
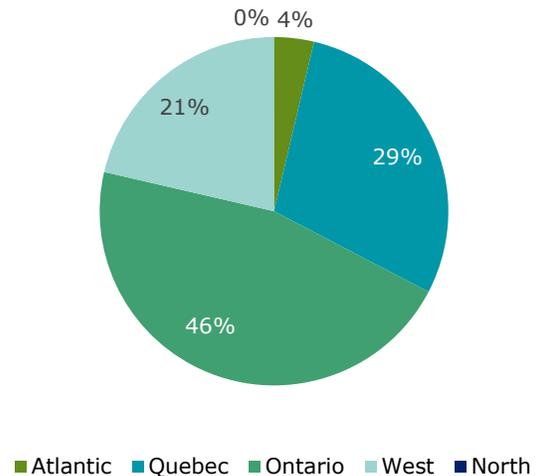
*Source: Statistics Canada, Lightcast, Deloitte*

As depicted in Figure 18, in 2022, the biomanufacturing sector made a notable contribution of $16 billion to Canada's real GDP. In 2021 it is estimated that the sector accounted for over 104 thousand jobs.

The biomanufacturing sector, exhibits diversity and uniqueness both regionally and within the composition of its industries. Regarding regional distribution, as demonstrated in Figure 20, Ontario and Quebec emerge as the primary contributors, accounting for 48% and 25% of the biomanufacturing sector's real GDP in Canada in 2022, respectively. Consequently, it becomes crucial to tailor training and upskilling efforts to specific regions and target industries within the biomanufacturing sector.

## Key Challenges

The biomanufacturing sector in Canada faces several prominent challenges that require attention to ensure its growth and development. A significant concern is the shortage of skilled workers, particularly in manufacturing and production, distribution and logistics, and management, finance, and administration roles, presenting another challenge to the sector. Factors such as a declining proportion of domestic students and low awareness of bioeconomy careers contribute to this shortage.[111]

Human resource related issues pose another major obstacle to the sector's development. Majority of employers in the bioeconomy report shortages in management-level skills, general labour, as well as skills in research and technical areas. Complicating matters further, most bioeconomy companies lack dedicated HR departments, making it challenging to address these shortages effectively.[112] A further key challenge faced by the sector is the necessity to enhance supply chains in strategically important areas, aiming to safeguard national security and decrease reliance on foreign imports.

Addressing these challenges will be vital for the growth and success of the biomanufacturing sector. By focusing on skills development, enhancing HR infrastructure, bridging the gap in

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[111] BioTalent, Demand and Supply Outlook, 2021
[112] BioTalent, Demand and Supply Outlook, 2021

practical skills, and dispelling misconceptions about job requirements, the sector can overcome these obstacles and thrive in the evolving bioeconomy landscape.[113]

## Policy Context

The broader policy context plays a crucial role in shaping the labour force of the biomanufacturing sector in Canada. One key strategic policy consideration aspect is the need to augment supply chains in strategically important areas, ensuring national security and reducing reliance on foreign imports.[114] The Canadian Government view Canada's natural resources and industrial manufacturing base as assets to establish a unique advantage and secure domestic supply in the biomanufacturing sector. To advance Canada's capabilities and create robust supply chains in the sector, a four-point framework will be employed. This framework focuses on:

1. Leading innovation and promoting clean growth through investments in R&D and technology development to drive technological advancements aligned with climate objectives and economic sustainability.

2. Attracting new investments to support the growth and development of firms, technologies, and infrastructure, enabling scalability and capacity expansion.

3. Establishing targets and actions to enhance national security by reducing reliance on foreign imports during health crises and fostering a resilient life sciences sector for economic growth.

4. Building strategic alliances and diversifying international trade partners to address critical gaps, achieve economic sustainability, and unlock innovation opportunities across the supply chain. By implementing this comprehensive framework, Canada aims to strengthen its biomanufacturing capabilities, ensure supply chain resilience, and position itself as a leader in the industry.[115]

The expected labour shortages in the sector are compounded by the diminishing proportion of domestic students enrolling in bioeconomy-related programs. The sector increasingly relies on international students to meet its labour demands. While there has been a commendable 73% surge in international enrollments in Canadian undergraduate bioeconomy-related degree programs between 2012-2013 and 2016-2017, the low rate of international students transitioning to permanent residency (less than 30%) restricts their representation in the biomanufacturing workforce.[116] To overcome this challenge, it is imperative to establish robust pathways and implement supportive policies that facilitate a seamless transition of international students and professionals into the workforce. By leveraging the talent and diverse perspectives of international workers, the biomanufacturing sector can effectively mitigate labour shortages, foster innovation, and bolster Canada's global competitiveness in this critical sector.[117]

## Emerging Trends

As the biomanufacturing sector looks towards the future, certain trends are shaping the landscape and influencing strategic investments. The COVID-19 pandemic has emphasized the need for preparedness in the biomanufacturing sector. Investments in flexible vaccine platforms, such as synthetic mRNA and virus-like particles, have proven vital in rapidly developing vaccines and scaling up production. Strengthening domestic production capacity for these newer flexible platforms is crucial for future pandemic response, while also contributing to Canada's economic objectives and job creation.[118]

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[113] BioTalent, Demand and Supply Outlook, 2021
[114] Government of Canada, Canada's biomanufacturing and Life Sciences Strategy, 2021
[115] BioTalent, Demand and Supply Outlook, 2021
[116] BioTalent, Demand and Supply Outlook, 2021
[117] BioTalent Canada, Labour Market Intelligence, 2021
[118] Government of Canada, Canada's biomanufacturing and Life Sciences Strategy, 2021

Canada's next phase of investment strategy in the biomanufacturing sector emphasizes building strength in emerging technology areas that hold high potential for solving current and future health challenges. This includes focusing on precision medicines like cell and gene therapies, Ribonucleic acid (RNA) and viral vectors, and monoclonal antibodies. Leveraging strengths such as AI, Canada aims to drive health innovation and develop cutting-edge platforms that offer more precise disease targeting. Investments in facilities, supply chains, and talent are vital to ensure Canada's position at the forefront of medical technology advancements.[119]

Stakeholders in the biomanufacturing sector have emphasized the critical need for Canada to be creative and responsive to sector demands to attract leading companies, making the country a preferred destination. To meet this challenge, it is crucial to produce a pipeline of domestic talent equipped, not only with theoretical knowledge but also, with hands-on and essential skills. Investing in talent development will empower individuals to succeed in their careers and contribute to the growth of the biomanufacturing sector.

In addition, stakeholders within the sector mentioned the importance of being aligned with the advent of Industry 5.0, also known as the Fifth Industrial Revolution, which signals the convergence of advanced technologies and AI-powered robots working alongside humans to enhance workplace processes.[120] Stakeholders highlighted the importance of upskilling the workforce to adapt to this new era of industrialization. By equipping individuals with the necessary skills and knowledge to collaborate effectively with advanced technologies, the biomanufacturing sector can remain at the forefront of innovation and productivity.

## The Potential Future of the Sector

Present projections and forecasts of the biomanufacturing sector's future labour force demographics highlight several important factors shaping the sector. The sector is currently facing a talent shortage, with an increasing demand for skilled workers due to existing infrastructure and upcoming investments. According to BioTalent Canada's 2021 National Report, the biomanufacturing sector in Canada will require just over 16,000 workers and more than 5,000 in biohealth manufacturing by 2029. [121] However, at the current pace, it is estimated that only 25% of these roles will be filled, emphasizing the urgent need to address the labour shortage.[122]

## Implications to the Sector

The biomanufacturing sector in Canada is facing several implications that require strategic attention and action to ensure its growth and development. The COVID-19 pandemic exposed significant gaps in the country's biomanufacturing and processing capacity, particularly in relation to the production of PPE and vaccines. This highlights the urgent need to address the labour shortage by implementing measures such as upskilling workers from other sectors and actively recruiting from underrepresented groups.[123]

Key challenges faced by the sector include addressing the skill deficits and resolving HR related issues. To overcome these challenges, the sector must focus on skills development, enhance HR infrastructure, bridge the practical skills gap, and dispel misconceptions about job requirements. These efforts are essential to ensure the growth, success, and resilience of the biomanufacturing sector in the evolving bioeconomy landscape.

The policy context also plays a crucial role in shaping the labour force of the biomanufacturing sector. Augmenting supply chains in strategically important areas, reducing reliance on foreign

[119] Government of Canada, Canada's biomanufacturing and Life Sciences Strategy, 2021
[120] The Welding Institute, WHAT IS INDUSTRY 5.0?, n.d.
[121] BioTalent Canada, Labour Market Intelligence, 2021
[122] BioTalent Canada, Labour Market Intelligence, 2021
[123] BioTalent Canada, Labour Market Intelligence, 2021

imports, and strengthening domestic capabilities are vital aspects that need to be addressed. Additionally, the sector faces labour shortages in critical areas such as manufacturing, production, distribution, logistics, and management. Establishing supportive policies and pathways for international students and professionals to transition into the workforce can mitigate these shortages and enhance innovation and global competitiveness.[124]

In the sector, there are job opportunities in manufacturing and management that do not necessarily require advanced STEM or health backgrounds. Skills from other sectors can be transferable, offering a chance to address labour shortages by upskilling and providing training programs. BioTalent Canada's Essential Skills Fundamentals, for example, ensures new employees quickly gain required skills. These strategies enable employers to develop candidates into ideal employees with tailored training for specific positions, contributing to the growth and success of the bioeconomy.[125]

In the following sections, the sector labour market will be explored, identifying hiring and upskilling challenges, implications, and opportunities.

# Sector Labour Market and Occupations/Skills Analysis

### Overview of Job Supply and Demand

The bioeconomy faces significant challenges in meeting its labour demand due to supply factors. The declining proportion of domestic youth in the Canadian population limits the availability of students enrolling in biomanufacturing related programs, highlighting the growing reliance on international students. While international enrollments have increased by 73%, the low rate of transitioning to permanent residency and the limited representation of internationally educated professionals and new Canadians in the bioeconomy workforce contribute greatly to the labour shortage. Additionally, the lack of mobility among Canadian university graduates and limited awareness of biomanufacturing careers further strains the labour supply. To address these challenges, recommendations by BioTalent Canada include boosting work-integrated learning, diversifying recruitment practices, creating a wage subsidy program for new Canadians, facilitating pathways for international students and professionals, and raising awareness of career opportunities through targeted outreach.[126]

The growing bioeconomy in Canada is driving the demand for a diverse range of skilled workers. In the biomanufacturing sector alone, just over 16,000 additional workers will be needed by 2029, with only a quarter of those positions expected to be filled by the predicted supply.[127] This shortage calls for innovative strategies to address the talent gap, including upskilling workers from other industries and actively recruiting from non-traditional labour pools. The need for skilled workers extends beyond scientific expertise, as many positions require post-secondary education and specialized knowledge in areas such as IT, management, finance, and legal and regulatory affairs. Currently, there is little opportunity for people with only a high school education to find a position in biomanufacturing. However, the growing demand for talent could prompt employers to reassess their hiring requirements.[128] The key occupations may vary across the country as the key activities of the bioeconomy differ per region with significant concentrations in Ontario, Western Canada (including Alberta and British Columbia), and Quebec. The distribution remains relatively uniform across the four sub-sectors.

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[124] Government of Canada, Canada's biomanufacturing and Life Sciences Strategy, 2021
[125] BioTalent Canada, Labour Market Intelligence, 2021
[126] BioTalent, Demand and Supply Outlook, 2021
[127] BioTalent, Demand and Supply Outlook, 2021
[128] BioTalent, Demand and Supply Outlook, 2021

In general, as indicated on page 56, the biomanufacturing sector is confronted with a significant labour shortage, with no oversupply of essential occupations identified in the Canadian Occupational Projection System (COPS). Without intervention, these gaps are expected to persist. The following section aims to identify the crucial occupations, occupation gaps, and future occupation needs within the biomanufacturing sector. Likewise, this section will identify the key skills, skill gaps, and future skills required for the advancement and prosperity of the biomanufacturing manufacturing sector.

## Occupations

### Key Occupations

For the biomanufacturing sector, having skilled workers encompassing diverse roles is paramount for sector advancement. It is imperative to not only have individuals dedicated to the technical roles but also workers skilled across the entire supply chain. This can include production, management, finance, and business development roles.

Through our research and stakeholder consultations, the following occupations were identified as being key to the sector's growth and competitiveness: [129,130,131]

| Key Occupations | Top Associated Skills[132] |
|---|---|
| Administrative assistants | • Writing<br>• Coordinating<br>• Critical Thinking |
| Budget analysts | • *Management of Financial Resources*<br>• *Numeracy*<br>• *Oral Communication: Active Listening* |
| Chemical Technologist Technicians | • Equipment and Tool Selection<br>• Critical Thinking<br>• Evaluation |
| Chemists | • Critical Thinking<br>• Digital Literacy<br>• Operation monitoring of machinery and Equipment |
| Compliance specialists | • *Management of Personnel Resources*<br>• *Monitoring*<br>• *Coordinating* |
| Customer service representatives | • Learning and Teaching Strategies<br>• Negotiating<br>• Oral Communication: Active Listening |
| Data analysts | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |

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[129] BioTalent Canada, Labour Market Intelligence, 2021
[130] Lightcast, 2023
[131] The top associated skills are defined based on the top three skills related to the occupation in the Occupational and Skills Information System (OaSIS).
[132] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Key Occupations | Top Associated Skills[132] |
|---|---|
| Distribution coordinators | • *Persuading*<br>• *Instructing*<br>• *Negotiating* |
| Executives | • *Management of Material Resources*<br>• *Coordinating*<br>• *Digital Literacy* |
| HR specialists | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| IT support specialists | • *Oral Communication: Active Listening*<br>• *Repairing*<br>• *Troubleshooting* |
| Laboratory technicians | • Quality Control Testing<br>• Equipment and Tool Selection<br>• Operation and Control |
| Lawyers | • Critical Thinking<br>• Negotiating<br>• Oral Communication: Active Listening |
| Logistics managers | • *Coordinating*<br>• *Time Management*<br>• *Evaluation* |
| Manufacturing managers | • Management of Financial Resources<br>• Management of Material Resources<br>• Time Management |
| Marketing specialists | • Coordinating<br>• Decision Making<br>• Negotiating |
| Material handlers | • Operation and Control<br>• Operation Monitoring of Machinery and Equipment<br>• Preventative Maintenance |
| Medical laboratory technicians | • Equipment and Tool Selection<br>• Operation and Control<br>• Operation Monitoring of Machinery and Equipment |
| Patent agents | • Oral Communication: Oral Comprehension<br>• Reading Comprehension<br>• Coordinating |
| Pathologists' assistant technicians | • Oral Communication: Oral Comprehension<br>• Coordinating<br>• Critical Thinking |
| Programmers | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |

| Key Occupations | Top Associated Skills[132] |
|---|---|
| Quality assurance auditors | • *Quality Control Testing*<br>• *Equipment and Tool Selection*<br>• *Operation and Control* |
| Quality control analysts | • *Quality Control Testing*<br>• *Equipment and Tool Selection*<br>• *Operation and Control* |
| Quality control technicians | • *Quality Control Testing*<br>• *Equipment and Tool Selection*<br>• *Operation and Control* |
| Research directors | • *Critical Thinking*<br>• *Decision making*<br>• *Digital Literacy* |
| Sales managers | • Management of Financial Resources<br>• Management of Material Resources<br>• Negotiating |
| Social media strategists | • Coordinating<br>• Decision Making<br>• Negotiating |
| Software and web developers | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| Trial coordinators | • *Digital Literacy*<br>• *Numeracy*<br>• *Reading Comprehension* |

## Occupation Gaps

Within the biomanufacturing sector, the occupation gap challenge poses an ongoing concern. All four sub-sectors of the bioeconomy (health, manufacturing, agri-bio, bioenergy) compete for highly skilled workers amongst themselves and with companies in other STEM sectors.[133] Biomanufacturing organizations also face competition from all sectors of the larger economy for personnel with non-technical skills in industries like HR, marketing, and logistics.

Through our research and stakeholder consultations, the following occupations gaps were identified:

| Occupation Gaps | Top Associated Skills[134] |
|---|---|
| Distribution and logistics jobs | • Coordinating<br>• Management of Material Resources<br>• Monitoring |
| Management, finance and administration jobs | • Coordinating<br>• Instructing<br>• Management of Personnel Resources |
| Manufacturing and production jobs | • Preventative Maintenance<br>• Decision Making<br>• Quality Control Testing |
| Quality control and assurance | • Quality Control Testing<br>• Equipment and Tool Selection<br>• Operation and Control |

**Industry Perspective**

Stakeholders have highlighted that the standout gap in the biomanufacturing sector lies in the shortage of operators in quality control and quality assurance roles. These roles were described as paramount to establishing and maintains robust quality management systems.

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[133] BioTalent Canada, Labour Market Intelligence, 2021
[134] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

While addressing current gaps, the sector must also consider jobs that will become increasingly crucial in the future. It is a pivotal reminder that as new technologies develop, so will the professions and the top skills associated with them. It is possible that the daily responsibilities, the skills required to perform a job, or the occupation itself will change dramatically.

Through our research and stakeholder consultations, the following occupations were identified as increasingly important in the future:

| Future Occupations | Top Associated Skills[135] |
|---|---|
| Medical laboratory technologists | • Equipment and Tool Selection<br>• Operation and Control<br>• Operation Monitoring of Machinery and Equipment |
| Medical laboratory technicians | • Equipment and Tool Selection<br>• Operation and Control<br>• Operation Monitoring of Machinery and Equipment |
| Pathologists' assistants | • Oral Communication: Oral Comprehension<br>• Coordinating<br>• Critical Thinking |
| Software engineers and designers | • Digital Literacy<br>• Digital Production<br>• Evaluation |

# Skills

## Key Skills

Through our research and stakeholder consultations, the following skills were identified as being key to the sector's growth and competitiveness:

| Key Skills | |
|---|---|
| **Analytical Skills**<br>• Problem solving<br>• Information Handling<br>• Data modeling and visualization<br><br>**Knowledge**<br>• Regulatory knowledge | **Technical Skills**<br>• Equipment and Tool Selection<br>• Operation Monitoring of Machinery and Equipment<br>• Researching and Investigating<br><br>**Interpersonal Skills**<br>• Collaboration |

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[135] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

**Industry Perspective**

Various stakeholders within the biomanufacturing sector underscored the significance of marketing, finance, and business development skills in driving the sector's growth and success. It was highlighted that since many organizations in the sector are SMEs, they often lack dedicated HR teams. Instead, highly educated, and specialized professionals often oversee multiple functions.

Moreover, there is a pressing need in finding individuals proficient in marketing and sales to effectively promote biomanufacturing products in a competitive market. With a deep understanding of the sector and its regulatory landscape, these professionals play a vital role in formulating strategic approaches, fostering key relationships, and navigating complex financial and investment scenarios, thereby enabling the sector to thrive.

## Skill Gaps

According to the BioTalent Labour Market Intelligence report of 2021, a significant number of employers (approximately two-thirds) face challenges in recruiting or retaining qualified personnel due to a scarcity of skilled and experienced talent.[136] Through our research and stakeholder consultations, the following skills gaps were identified:

| Skills Gaps | |
|---|---|
| **Analytical Skills**<br>• Problem solving<br>• Information Handling<br>• Data modeling and visualization<br><br>**Resource Management Skills**<br>• Business Development | **Interpersonal Skills**<br>• Communication Skills<br>• Collaboration<br><br>**Knowledge**<br>• Knowledge of relevant technology and knowledge advancement<br>• Regulatory knowledge |

## Future Skills

Through our research and stakeholder consultations, the following skills were identified as increasingly important in the future:

| Future Skills | |
|---|---|
| **Foundational Skills**<br>• Digital literacy<br>  – Proficiency in AI utilization<br><br>**Technical Skills**<br>• Researching and Investigating<br>• Infectious -disease research | **Knowledge**<br>• Physical Sciences<br>  – Cell and gene therapies<br>  – Genomics<br>  – Drug delivery<br>  – Pandemic Readiness<br>• Logistics, Design and Evaluation<br>• High-Tech manufacturing |

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[136] BioTalent Canada, Labour Market Intelligence, 2021

# Challenges and Barriers to Upskilling

## Key Employer Challenges

Employers in the biomanufacturing sector face several challenges regarding improving and maintaining their workforce. One significant challenge is the common misconception among job applicants that a bachelor's degree in health-related fields is a necessary requirement for biomanufacturing positions. In reality, the sector offers a wide range of roles where highly technical qualifications may not always be essential. To address this misconception, it is crucial to provide accurate guidance to potential candidates, highlighting the diverse skill sets and career opportunities available in the field.

Another challenge, highlighted by stakeholders, is the scarcity of candidates with practical or non-academic skills, leading to a limited pool of suitable applicants. This issue is further exacerbated by the tendency of candidates to gravitate towards larger, well-known organizations, diverting talent away from the biomanufacturing sector. The predominance of SMEs in the biomanufacturing sector adds to the complexity. SMEs often lack dedicated HR teams and require individuals with marketing and sales skills in addition to technical expertise. This mismatch in employer expectations and candidate skill sets further compounds the difficulty in recruiting and retaining qualified personnel.

## Key Employee Challenges

Employees in the biomanufacturing sector face various challenges when it comes to upskilling. One significant challenge is the underrepresentation of equity-deserving groups, which often discourages individuals from applying as they perceive that they may not fit into the culture of the sector. Stakeholders have emphasized the importance of creating a more inclusive environment where individuals can see representation from diverse backgrounds. It was emphasized during consultations that when employees see people who look like them in the sector, they are more likely to feel motivated and confident in pursuing career opportunities in that sector.

The fast-paced nature of biomanufacturing and the emphasis on innovation also pose challenges for employees. The sector's rapid pace and constant drive for innovation can be demanding, requiring individuals to adapt quickly and keep up with advancements. Many employees find it challenging to adjust to this fast-paced environment, which may affect their ability to upskill effectively and meet the evolving demands of the sector.[137]

Another challenge employees face in upskilling is limited worker mobility after graduation. While employers need to attract graduates from various regions to fill job vacancies, most students are not eager to move to other parts of the country once they complete their studies. This limited graduate mobility can benefit companies located near post-secondary institutions, but it presents hiring challenges for those situated in areas limited access to nearby graduates. Studies have

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[137] BioTalent Canada, Labour Market Intelligence, 2021

shown that the majority of Canadian university graduates remain and work in the region where they studied, except for Atlantic Canada, where a significant proportion of graduates move to other provinces or territories in search of higher salaries and career opportunities.[138]

## Challenges in Upskilling

As emphasized by stakeholders, the cost associated with participating in the biomanufacturing sector poses a significant challenge to implementing effective upskilling programs, particularly in regions like Atlantic Canada. Relocating for job opportunities can be financially burdensome for individuals, limiting their ability to actively engage in upskilling initiatives.

Another challenge relates to the inadequacy of practical training and experience provided by most academic programs in Canada. Many new graduates lack the necessary skills and readiness to work directly in the biomanufacturing sector, resulting in a gap between academic knowledge and sector demands. Stakeholders have emphasized the importance of practical training and experience as a foundation for upskilling programs. Without a strong foundation, employees may face difficulties in further developing their skills and competencies through upskilling initiatives. It is imperative for academic institutions to collaborate closely with industry partners to design curriculum and training programs that bridge the gap between theory and practical application. By aligning education with sector needs, graduates will be better prepared to engage in upskilling activities and contribute effectively to the sector.

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[138] BioTalent Canada, Labour Market Intelligence, 2021

# Implications to the Sector

The challenges faced by employers in the biomanufacturing sector have significant implications for their workforce development efforts. The misconception regarding educational requirements creates a barrier to attracting suitable candidates and limits the talent pool for employers. Addressing this misconception by providing accurate guidance and highlighting the diverse career paths available can help bridge the skills gap and attract qualified individuals to the sector. The mismatch between employer expectations and candidate skill sets, especially in SMEs, further complicates the recruitment process. Employers need to raise awareness about the value of marketing and sales skills in the biomanufacturing sector to attract candidates with a broader skill set. By addressing these challenges, employers can enhance their upskilling initiatives and ensure a skilled workforce capable of driving innovation and growth.

Employees in the biomanufacturing sector face challenges related to underrepresentation, adaptability to the fast-paced and innovative nature of the environment, and limited mobility after graduation. Creating a more inclusive environment and fostering representation from diverse backgrounds can encourage individuals to pursue careers in the sector. Additionally, supporting employees in adapting to the sector's fast-paced nature through targeted upskilling programs can help them stay current and meet sector demands. The limited mobility of graduates poses challenges for employers seeking talent outside of regions with fewer post-secondary institutions. Efforts should be made to encourage graduates to explore job opportunities in different regions and highlight the potential career prospects available.

The challenges in upskilling in the biomanufacturing sector have great implications on potential workforce development initiatives. The financial burden of relocating for job opportunities restricts individuals' participation in upskilling programs, particularly in certain regions. To address this, employers could consider offering financial assistance or exploring remote upskilling options. Furthermore, the inadequacy of practical training and experience provided by academic programs creates a gap between theoretical knowledge and sector requirements. Close collaboration between academic institutions and sector partners could help develop curriculum and training programs that provide practical skills and prepare graduates for the demands of the biomanufacturing sector. By overcoming these challenges in upskilling, employees can acquire the necessary competencies and contribute effectively to the sector's advancement.

# Opportunities

The biomanufacturing sector is presented with a range of opportunities that can shape its future and drive its success. By recognizing and capitalizing on these opportunities, the sector can position itself for growth, innovation, and long-term sustainability.

## Emerging Trends in the Sector Related to Skills and Occupations

### Emerging Technology

The emergence of new technologies presents a promising opportunity for the biomanufacturing sector. By focusing upskilling endeavors on precision medicines, such as cell and gene therapies, RNA and viral vectors, and monoclonal antibodies, the sector can drive health innovation. Leveraging technologies like AI allows for more precise disease targeting and the development of cutting-edge platforms. By investing in R&D, facilities, and supply chains, the sector can stay at the forefront of medical technology advancements and position itself as a global leader in the field.[139]

### Strengthening Domestic Production Capacity

The COVID-19 pandemic has highlighted the importance of pandemic preparedness and domestic production capacity. Investing in flexible vaccine platforms, such as synthetic mRNA and virus-like particles, offers an opportunity to rapidly respond to future pandemics.[140] By strengthening domestic production capacity for these platforms, the sector can reduce dependency on external sources, enhance national resilience, and contribute to Canada's economic objectives. This investment not only supports pandemic response but also creates job opportunities and stimulates economic growth.

## Upskilling Opportunities

### Enhancing Representation of Underrepresented Groups

Addressing the lack of representation of equity-deserving groups in the biomanufacturing sector presents a valuable opportunity to upskill and hire from underrepresented communities. Actively recruiting and upskilling individuals from demographic groups that are traditionally under-represented, such as Indigenous persons, newcomers to Canada, and persons with disabilities[141], the sector can tap into a diverse talent pool and unlock untapped potential. Recruiting individuals from underrepresented groups will not only address the talent shortage but also contribute to creating a more inclusive and diverse workforce. Stakeholders emphasized how the biomanufacturing sector would benefit from a wider range of perspectives, experiences, and innovative ideas.

### Collaboration between Academic Institutions and Industry

Collaboration between academic institutions and industry partners presents another opportunity to bridge the gap between education and sector needs. By working together, they can design curriculum and training programs that provide students with practical training and hands-on experience. This collaborative approach ensures that graduates are equipped with the skills required by the biomanufacturing sector, reducing the skills gap and facilitating a smooth transition into the workforce.

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[139] Government of Canada, Canada's biomanufacturing and Life Sciences Strategy, 2021
[140] Government of Canada, Canada's biomanufacturing and Life Sciences Strategy, 2021
[141] BioTalent Canada, Labour Market Intelligence, 2021

# Conclusion

The biomanufacturing sector plays a crucial role in securing future competitiveness, driving productivity growth, and promoting sustainability. However, the sector faces significant challenges if it does not prioritize upskilling and attracting a skilled workforce. These challenges hinder the sector's ability to expand operations and adapt to emerging technologies. Without an expansion in its workforce and the acquisition of key skills, the sector may struggle to achieve the targets set by the Government of Canada.

Insights from the research and stakeholder consultations emphasize the need for upskilling programs and workforce initiatives that align consistently with the demands of employers. Currently, the sector must address gaps in manufacturing and production, distribution and logistics, and management, finance and administration to ensure a robust workforce. To maintain competitiveness in the future, it is crucial for workers in the sector to adapt their skills to emerging and evolving technologies. By actively investing in the development of a skilled and adaptable workforce, the biomanufacturing sector can position itself for sustained growth and success.

# The Clean Technology Sector

> > >

# Executive Summary

Deloitte has been engaged to support Palette Skills' leadership role related to the Industry Upskilling Initiative funded by Innovation, Science and Economic Development Canada (ISED). The purpose of Upskill Canada is to connect employers to qualified talent and help high potential untapped talent move into fast growing careers. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills for high-demand roles in six key sectors (digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, biomanufacturing). In this chapter, we outline the challenges and catalysts associated with the development of the clean technology sector, with a focus in the sector's workforce. We define the clean technology sector as "any process, product, or service designed with the primary purpose of contributing to remediating or preventing negative environmental impacts through significant energy efficiency improvements, the sustainable use of resources, or environmental protection activities."[142]

The clean technology sector is an enabler of economic growth, diversification, decarbonization and employment opportunities. In 2021, the clean technology sector contributed over $61 billion to Canada's real GDP and an estimated 314 thousand jobs.[143] Ontario and Quebec make up most of the market with a 34% and 31% contribution, respectively, to Canada's clean technology sector real GDP.[144] The sector is dominated by men, who make-up 64% of environmental and clean technology jobs and own or manage 87% of companies.[145]

For the clean technology sector to reach its objectives and remain a global leader, it will need to overcome existing challenges such as raising capital, barriers in commercializing and scaling up, global competition, and finding and retaining talent. The sector will need to develop and commercialize new clean technology, upskill talent, and continue filling occupational shortages in all stages of production. Currently, companies are looking to hire applied and technical scientists as well as business, finance, and administrative professionals. Moreover, companies are looking to fill occupation gaps at a manufacturing level. The skills associated with these jobs were also identified as gaps in the sector.

The outcomes of the research and study are structured as follows: an overview of the sector, a summary of the labour and skills analysis, challenges, implications, and opportunities for the sector. To be of benefit to the broader training and workforce development ecosystem, the findings presented in this chapter reflect the wide-ranging needs of the sector. Some occupations listed or industry opportunities might be beyond Upskill Canada's scope. This might include skilled trades occupations and those requiring certification from a professional body. Eligibility for Upskill Canada funding will be dependent on identifying demand for jobs through direct employer engagement.

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[142] Definition obtained from ISED
[143] Statistics Canada
[144] Statistics Canada
[145] Statistics Canada, Environmental and Clean Technology Products Economic Account: Human Resource Module, 2020, 2022

# Overview of the Sector

## The Clean Technology Sector

In 2020, Canada announced its goal to achieve net-zero emissions by 2050.[146] Many provinces and cities have also made their own net-zero commitments including Toronto, Vancouver, Halifax, Quebec, and Newfoundland and Labrador.[147] To achieve net-zero emissions, the economy will need to increase sustainable production practices. The clean technology sector has the potential to diversify the economy, transform industries, and ultimately improve environmental outcomes.

Clean technology ("cleantech"), as defined by ISED, **"encompasses any process, product, or service designed with the primary purpose of contributing to remediating or preventing negative environmental impacts through significant energy efficiency improvements, the sustainable use of resources, or environmental protection activities".[148]** Please see Appendix A  for a complete list of the NAICS used to define cleantech in this report.

> ### What Constitutes the Cleantech Sector?
>
> As with many of the other sectors analyzed in this study there exists no standard definition of what constitutes the cleantech sector. Many organizations have developed their own standard. It can be argued that out of all the sectors analyzed in this study, the cleantech sector likely has the largest variability in terms of how the sector is defined (see Appendix B: Sector Definition – Alternative Definitions). In identifying the specific NAICS industries that would constitute the sector, the approach taken in this study is consistent with Statistics Canada's Environmental and Clean Technology Products Economic Account. The benefit of this approach is that while the data set produced may have certain deficiencies, it does have the benefit of providing certain level of detail relating to key economic variables such as GDP, employment, and wages at the industry and provincial level. It also has the advantage of providing data across time, allowing progress to be tracked and compared as needed.

If governments achieve their set objectives, the demand for clean technologies and workers in the sector will increase. For example, the International Energy Agency has projected that the value of clean energy technologies would triple, and related jobs would more than double by 2030.[149] The rapid growth of cleantech and its workforce will be critical in ensuring a sustainable future.

## Palette Skills' Activities in the Sector

In the past six years, Palette Skills has been developing an understanding of the needs of employers and how to best engage them in the talent development process. Palette Skills has established partnerships with sector leaders to continue to refine their understanding of the talent landscape across the cleantech sector.

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[146] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021
[147] Government of Canada, Net-Zero Emissions by 2050, 2023
[148] Definition obtained from ISED
[149] IEA, The world is entering a new age of clean technology manufacturing, and countries' industrial strategies will be key to success, 2023

## Current State of the Sector

Canada is emerging as a global cleantech leader. Canadian cleantech companies have proven their ability to build resource-efficient products. In 2019, Canada ranked fourth in the Global Cleantech Innovation Index for its ability to produce cleantech startups and commercialize innovations.[150] In 2022, 13 Canadian companies were recognized in the Global Cleantech 100 list, which identifies companies best positioned to help build a more digitalized, de-carbonized and resource-efficient future.[151] Most of the Canadian companies recognized in the Global Cleantech 100 list are in the energy and power sector (5 Canadian firms out of 14 global firms), and the resources and environment sector (6 Canadian firms out of 21 global firms).

With Canada positioning itself as a global leader, the cleantech sector is increasingly important to Canadian businesses. Approximately, one in ten businesses used cleantech goods and services from 2015 to 2017.[152] Industries such as pipeline transportation, utilities, rail and water transportation and oil and gas extraction were more likely to report high rates of cleantech utilization.[153] To reach net-zero and sustainability targets more companies will need to adopt to clean technologies.
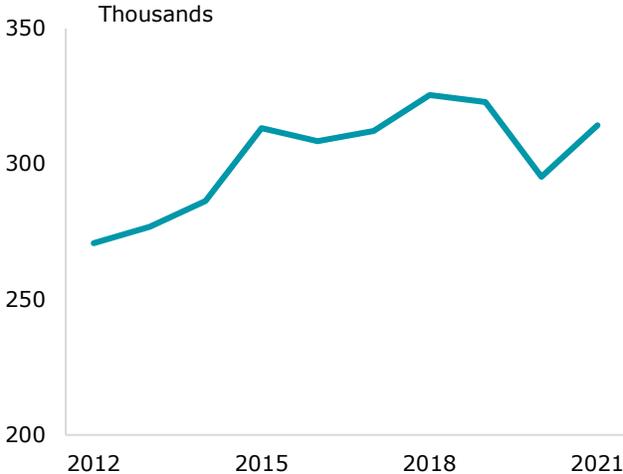
The contribution of the cleantech sector to Canada's GDP has been steadily increasing. As seen in Figure 22, in 2021, the cleantech sector contributed over $61 billion to Canada's GDP. In 2021, an estimated 314 thousand jobs were attributable to the sector.

*Figure 22: Cleantech Sector Real GDP*
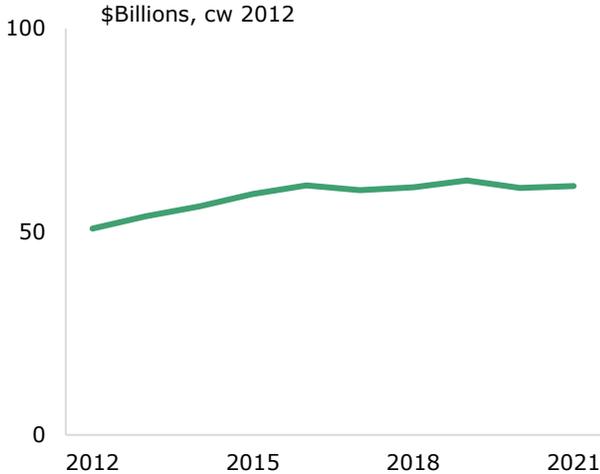


*Source: Statistics Canada*

*Figure 23: Cleantech Sector Employment*
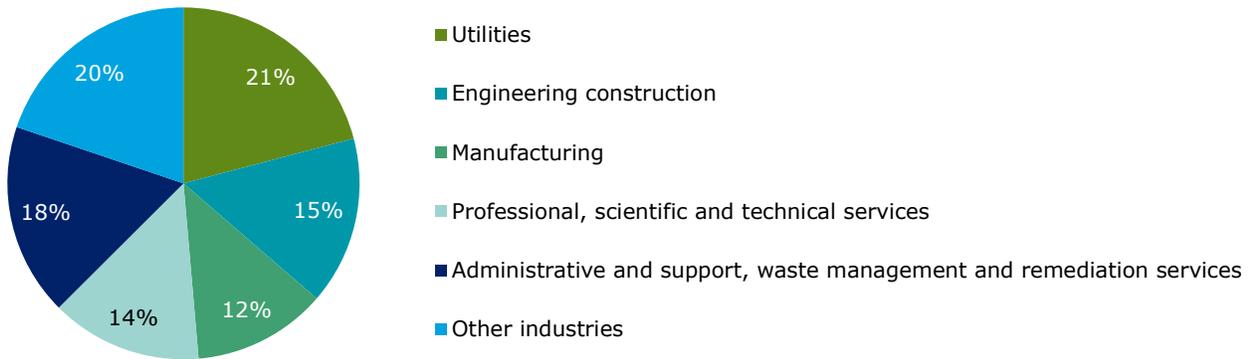


*Source: Statistics Canada*

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[150] Export Development Canada and MaRS, Women in Cleantech Closing the Gender Gap in Cleantech Innovation, 2020
[151] Export Development Canada, Exploring Canada's Cleantech Sector, 2022
[152] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[153] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020

*Figure 24: Employment Distribution by Industry of the Canadian Cleantech sector in 2021*



Legend:
- Utilities
- Engineering construction
- Manufacturing
- Professional, scientific and technical services
- Administrative and support, waste management and remediation services
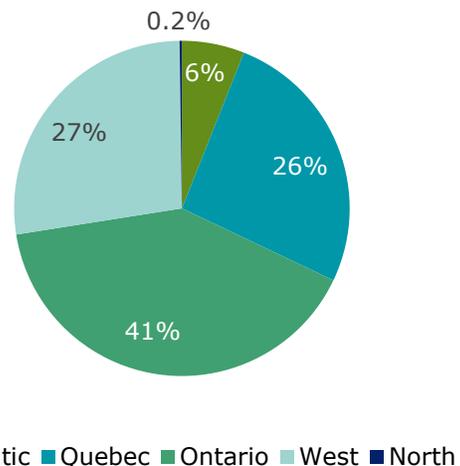- Other industries

*Source: Statistics Canada*

The cleantech sector is diverse, and unique both in terms of the various industries that it is comprised of, as well as at regional level. As seen in Figure 24, cleantech companies are distributed in a variety of industries. Most of the employees in cleantech companies serve utilities (21%) and engineering construction (15%) industries.[154] At a regional level, as seen in Figure 25 and Figure 26 Ontario and Quebec make up a majority of the market with a 34% and 32% contribution to Canada's cleantech sector real GDP in 2022, respectively. In regard to employment, these two provinces, contribute to an even larger share of 41% and 26% respectively in 2021.

*Figure 25: Cleantech Sector Real GDP by Region in 2022*



Legend: Atlantic  Quebec  Ontario  West  North
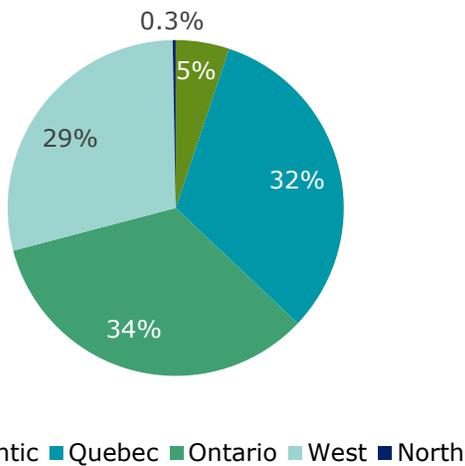
*Source: Statistics Canada*

*Figure 26: Cleantech Sector Employment by Region in 2021*



Legend: Atlantic  Quebec  Ontario  West  North

*Source: Statistics Canada*

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[154] Government of Canada, 2022 Cleantech Industry Survey Results, 2023

## Key Challenges

The cleantech sector has the potential to be a global leader, but it must overcome existing challenges. Some of the most pressing challenges include raising capital, finding and retaining talent, barriers to commercialization, global competition and trade barriers, building public perception and awareness, and disconnect between environmental policy targets and regulations.[155,156,157] The most cited challenges identified in our research and consultations were raising capital, barriers to commercializing and scaling up, and finding and retaining talent.

In the 2022 Cleantech Industry Survey by Natural Resources Canada, 36% of cleantech companies reported that raising capital was their greatest challenge.[158] Cleantech R&D often requires substantial upfront investments, and capital for commercialization and growth. Companies have low access to patient capital[159], scale-up investments, and grant funding suited to the risk and costs of the sector.[160] In 2020, the global cleantech sector experienced a decline in investment, partly due to the disruption of the COVID-19 pandemic. Currently, tight monetary policies are driving up interest rates, which tends to increase financial pressures. Given the economic environment and challenges in raising capital, companies benefit from experienced and skilled workers to successfully raise capital. Difficulty finding workers with financial expertise is increasing the challenge of raising capital. Low access to capital also has down-stream impacts on labour challenges by providing limited capacity to maintain competitive wages and salaries.

The second most cited challenge in the 2022 Cleantech Industry Survey was commercializing and scaling-up in Canada.[161] Insufficient funds for growth and lack of regulatory drivers to adoption are the most significant challenges to commercialization.[162]  The sector also faces challenges in finding early adopters and a small Canadian market.[163] Policy and regulatory ambiguity driven by changing regulations and uncertain government support can create uncertainty for investors and businesses. Moreover, challenges with integration of cleantech with existing infrastructure may also delay market adoption. Therefore, targeted regulations, awareness, and behavior changes are needed to encourage businesses and households to adapt to cleantech.

Finding and retaining talent was the third most cited challenge in the 2022 Cleantech Industry Survey. Companies identified the main hiring issues to be rising salaries and wage costs, lack of skills required for jobs in the market, insufficient resources to support training of new employees, and competition from other firms.[164] Additional information of the challenges employers and employees face can be found on page 90.

Hiring challenges are not isolated but vary across regions. A larger share of companies in Atlantic Provinces and British Columbia identified finding and retaining talent as their greatest challenge.[165]

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[155] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[156] Export Development Canada, Exploring Canada's Cleantech Sector, 2022
[157] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[158] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[159] As defined by the Business Development Bank of Canada patient capital refers to money a SME raises and refers to its lenient repayment terms.
[160] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[161] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[162] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[163] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[164] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[165] Government of Canada, 2022 Cleantech Industry Survey Results, 2023

Firms in Atlantic Canada and Manitoba struggle the most with finding resources to train employees compared to the rest of Canada.[166] Consequently, it is important to develop regional upskill programs to address these specific regional pressures.

Overall, the cleantech sector is predominantly composed of SMEs. Stakeholders highlighted that compared to larger companies, SMEs face more acute challenges in growing capital, obtaining market access, commercializing, and retaining talent. Therefore, the solutions needed to overcome labour and skills shortages will be different than in a more mature sector. For example, there may a greater focus on retention of workers and career development within firms.

## Policy Context

### Policies Supporting the Cleantech Labor Force

The broader policy context plays a crucial role in shaping the demographics, supply, and demand of the cleantech sector labor force. First, the Government of Canada is funding a series of initiatives to help underrepresented groups succeed in the sector. These funds include the Indigenous Climate Funding and the Women in Technology Venture Fund, ongoing programs that support entrepreneurs from equity-deserving groups.[167] By providing funding and making information more accessible, the government aims to increase diversity in the cleantech sector workforce.

Second, there is the possibility for the sector to tap into the international labour pool of skilled workers. Stakeholders highlighted the opportunity to bring in experienced workers from other countries. Internationally experienced workers could drive business development, while training less experienced domestic workers. In 2023, the Government of Canada targeted Science, Technology, Engineering, and Math (STEM) occupations in the category-based rounds of invitations for permanent residency.[168] Experienced STEM workers can support companies in various stages (R&D, export, service provider, etc.). The government could further revise immigration strategies to ensure Canada is attracting newcomers with the right skills and credentials needed for the cleantech sector.[169]

However, there are barriers to integrating new Canadians to the workforce. Stakeholders shared that the immigration process is challenging for both employers and employees. For example, highly qualified workers often struggle with multiple immigration requirements and costs associated with licenses while adapting to a new culture. The costs of licenses and number of compulsory regulated professions varies across provinces. For example, Quebec and Saskatchewan have the most compulsory regulated professions.[170] Additionally, workers, such as engineers, may be barred from registering in their profession without Canadian work experience. Some provinces are updating their requirements to ease the transition of new Canadian workers into the labour force. For example, PEO is the first regulated profession to remove the requirement of Canadian experience. This will enable international workers to join the labour force more quickly.[171]

[166] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[167] Government of Canada, Reconciliation, equity, diversity and inclusion, 2022
[168] Government of Canada, Express Entry rounds of invitations: Category-based selection, 2023
[169] Royal Bank of Canada, The skills revolution Canada needs to reach Net Zero, 2022
[170] The PLACE Centre and Smart Prosperity Institute, Ready for Green Jobs, 2023
[171] Government of Ontario, Ontario Removing Unfair Work Barriers for Skilled Newcomers, 2023

**Other Policies Supporting the Cleantech Sector**

The cleantech sector also receives government support through international trade policies, as well as public funding and subsidies. For example, the government established international trade agreements that account for clean technologies, products, and services.[172,173] For instance, the Canada-European Union (EU) Comprehensive Economic and Trade Agreement eliminates EU tariffs on Canadian cleantech products.[174] These trade agreements support cleantech companies by increasing their customer base, eliminating tariffs, and allowing Canadian companies to compete with international companies more fairly.

Additionally, cleantech companies can access the Clean Growth Hub government website for information, resources, and advice on federal supports available. These benefits can support businesses through different activities such as R&D, commercialization, adoption, and hiring of employees.[175] For example, the Sustainable Development Technology Canada (SDTC) program funds SMEs that are at a pre-commercial stage. As of 2022, the SDTC program allocated $1.53 billion to sustainable projects and created/sustained an estimated 20,942 total jobs (direct and indirect) to the Canadian economy.[176] Government funding provides companies with additional support to address their hiring issues and skills gaps.

Finally, government regulations will influence the rate and level of adoption of cleantech. More strict and targeted regulations will push the demand of sustainable technology. In parallel, this will increase the demand for workers at all stages of the cleantech production.

## Emerging Trends

Government regulations and advancement of emerging technologies will shape the rate and extent of cleantech adoption.[177] As the world increasingly acknowledges the climate crisis, there is a growing realization that adoption of cleantech is essential to achieving a sustainable future. Many countries and development banks have promoted "build back better" campaigns, focusing on expanding infrastructure with environment and energy needs.[178] Environmental campaigns, policies, and targets lead to a surge in investment, and commercialization efforts. For the sector to respond to increasing demand, it needs a growing skilled cleantech workforce.

Stakeholders have shared that companies are increasingly focusing on their environmental performance. A company's commitment to ESG requirements will influence demand in the supply chain. Consequently, companies across the economy will begin demanding workers that have experience and knowledge in cleantech.

Additionally, emerging technology can also accelerate the market adoption of cleantech. Enabling technologies like AI, automation, aerial imagery, and other technologies can offer new solutions for emissions reductions and de-carbonization.[179] The development of more cost-effective solutions allows for a broader adoption of cleantech. Consequently, emerging technology has the potential to accelerate the adoption of cleantech across the economy. Coupled with emerging technology, there will also be the need to protect digital asset and data. Like other sectors, there will be an increase in demand for cybersecurity skills.[180]

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[172] Export Development Canada, Exploring Canada's Cleantech Sector, 2022
[173] Government of Canada, Clean Canada: protecting the environment and growing our economy, 2019
[174] Government of Canada, Opportunities and Benefits of CETA for Canada's Clean-Tech Exporters, 2022
[175] Government of Canada, Funding and support opportunities, 2023
[176] Sustainable Development Technology Canada, Economic Benefits, 2023
[177] Deloitte, Scaling solutions: Accelerating the commercialization of made-in-Canada clean technology, 2023
[178] Export Development Canada, Exploring Canada's Cleantech Sector, 2022
[179] Deloitte, Scaling solutions: Accelerating the commercialization of made-in-Canada clean technology, 2023
[180] Export Development Canada, Exploring Canada's Cleantech Sector, 2022

From a supply side perspective, the reservoir of critical minerals will impact the value chains of the green economy.[181] Critical minerals are essential inputs for cleantech products such as advanced batteries, renewable energy, semiconductors, and more.[182] The steps taken to ensure sustainable use of critical minerals will impact the progress of the cleantech sector. A well-executed strategy for managing critical minerals presents an opportunity to foster sector growth and competitiveness, providing positive impacts for rural, remote, and Indigenous communities.[183]

## The Potential Future of the Sector

The cleantech sector is positioned to become a leading Canadian export industry. The federal government aims to double the 2020 export value of cleantech products by 2025.[184] If cleantech reaches an annual value of $20 billion in exports, it will become one of Canada's top five exporting industries.[185] In order to achieve these objectives, some of ISED's proposed strategies include driving cleantech adoption through government procurement, developing an agile regulatory system, and expanding skills development.[186]  As the value of exports grows, there will be a corresponding rise in the demand of skilled labour to support the growth of the sector.

Under the new federal government plan, clean energy jobs (a subset of clean tech) are expected to grow annually 4% between 2020 and 2030.[187] Clean energy jobs are expected to increase the most in Alberta (164%), followed by Saskatchewan (99%), and British Columbia (57%).[188] These gains are significant and outpace the employment losses in the fossil fuel sectors.

A successful cleantech sector will require upskilling of labour, opportunities for underrepresented communities, Indigenous prosperity and reconciliation. The workforce will need to be prepared not only for key occupations today but jobs that will exist into the future.[189]

## Implications to the Sector

Canada has the opportunity to become a global cleantech leader. Canada's potential is highlighted through its recognitions in the Global Cleantech Innovation Index and Global Cleantech 100 list. However, challenges in securing capital, commercialization, and obtaining skilled labour is leaving Canada behind. Currently, Canada is at risk of not meeting its 2030 emissions target and 2050 net-zero goals without accelerating commercialization and adoption of cleantech.[190] Companies will need both greater access to capital and skilled labour force to accelerate commercialization and adoption of cleantech. The sector, government, and academia will need to collaborate to address existing challenges and build a strong labour force for the cleantech sector.[191]

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[181] As defined by Blue Green Canada, a green economy is a low-carbon, resource efficient, and socially inclusive economy.
[182] Government of Canada, Canada's critical minerals strategy: Discussion Paper, 2022
[183] Government of Canada, Canada's critical minerals strategy: Discussion Paper, 2022
[184] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[185]Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[186]Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[187] Clean Energy Canada, The New Reality, 2021
[188] Clean Energy Canada, The New Reality, 2021
[189] Clean Energy Canada, The New Reality, 2021
[190] Deloitte, Scaling solutions: Accelerating the commercialization of made-in-Canada clean technology, 2023
[191] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020

# Sector Labour Market and Occupations/Skills Analysis

## Overview of Job Supply and Demand

The cleantech labour market is impacted by both supply and demand factors. Renumeration, competition from other firms, and underrepresentation of equity-deserving groups are key factors impacting the supply of labour.

Equity-deserving groups are underrepresented in the cleantech sector. In 2020, women held approximately 36% of environmental and cleantech jobs and earned on average 82% of men's salaries.[192] In 2020, Indigenous peoples represented 6% of the cleantech workforce.[193] Meanwhile, at the management level, women managed 13% of cleantech companies while Indigenous peoples managed only 2%.[194] These ratios have not significantly changed in the past decade. In 2009, women and Indigenous people represented 33% and 4% of the workforce respectively.[195] The underrepresentation of equity-deserving groups limits the size of the labour force and prevents companies from benefiting from a diverse workforce.

Additionally, challenges related to compensation are limiting recruiting and retention efforts. In the 2022 Cleantech Industry Survey by Natural Resources Canada, over half of the respondents highlighted rising salaries and wage costs as a barrier in recruiting and retaining employees.[196] Moreover, approximately one quarter of respondents identified competition from other firms to be a challenge.[197] Please see page 90 for more information.

Nevertheless, demand for workers will continue to increase as the government refines objectives, and companies adapt to ESG goals. There will be an increase in demand from traditional and cleantech companies for workers with skills and sustainability knowledge. The cleantech sector will drive changes in demand of occupations and skills in three ways:

1. **Increase in demand due to new economic activity:** Increase demand of workers in traditional occupations without significantly changing the skills and requirements for these jobs. This demand will be reflected in the occupation gaps of the sector. For example, electrical power-line installers and repair workers.[198]

2. **Alter the skills and requirements of existing occupations:** Changing knowledge requirements and associated skills needed to integrate with sustainable technology. This demand will be reflected in the skills gap of the sector. For example, increase demand for knowledge around energy-efficient materials.[199]

3. **New occupations:** Unique occupations and worker requirements due to new technology. This demand will be reflected both in occupation and skills gap but also in future occupation and skills. For example, wind turbine service technicians, and energy auditors.[200]

As identified in page 75, occupation and skills gaps are a significant challenge to the sector. The sector is facing a shortage of labour, and none of the sector's key occupations (as identified in the table below) were flagged to be oversupplied in the Canadian Occupational Projection System

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[192] Statistics Canada, Environmental and Clean Technology Products Economic Account: Human Resource Module, 2020, 2022
[193] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[194] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[195] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[196] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[197] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[198] Future Skills Centre, Upskilling the labour force for the clean technology, 2022
[199] Future Skills Centre, Upskilling the labour force for the clean technology, 2022
[200] Future Skills Centre, Upskilling the labour force for the clean technology, 2022

(COPS) dataset. Without intervention it is likely these gaps will continue to persist. In this sub-section, we look to identify the key occupations, occupation gaps, and future occupations in the cleantech sector. Similarly, we look to identify the key skills, skill gaps, and future skills that will be needed for the success of the cleantech sector.

## Occupations

### Key Occupations

For the cleantech sector, having skilled workers in diverse roles is essential for continuous growth. In the 2022 Cleantech Industry Survey, 69% of cleantech companies reported looking to hire applied and technical scientists (engineers, product designers, chemists) to scale their businesses.[201] Meanwhile, 45% of cleantech companies also reported looking for business, finance, and administration professionals to scale their business.[202] Applied and technical sciences, business, finance, and administration were the most sought out occupations for companies across different target industries.[203] Similarly in the 2020 Environmental Careers Organization (ECO) Canada Sector Study, STEM and business development occupations were outlined as critical to cleantech activities.[204] In this study (which included a survey), respondents highlighted the importance of workers at the production and services level such as trades, drivers, and machine operators.[205] The demand of these occupations varies across comprising industries. For example, trade and related occupations are important for companies in mining, renewable, and non-emitting energy supply industries.[206] Notably, trade and construction occupations are important to build the infrastructure that enables decarbonization. On the other hand, software and data occupations are key for the growth of energy efficiency firms.[207]

Through our research and stakeholder consultations, the following occupations were identified as being key to the sector's growth and competitiveness:[208,209,210,211,212]

| Key Occupations | Top Associated Skills[213, 214] |
|---|---|
| Architectural technologists and technicians | • Numeracy<br>• Coordinating<br>• Critical Thinking |
| Biochemists | • *Critical Thinking*<br>• *Digital Literacy*<br>• *Operation Monitoring of Machinery and Equipment* |

[201] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[202] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[203] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[204] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[205] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[206] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[207] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[208] The Information and Communications Technology Council, Canada's Growth Currency, 2019
[209] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021
[210] Lightcast, 2023
[211] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[212] Clean Resource Innovation Network, The Future of Work in Alberta: Talent Needs for a Transitioning Oil & Gas Industry, 2021
[213] The top associated skills are defined based on the top three skills related to the occupation in the Occupational and Skills Information System (OaSIS).
[214] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Key Occupations | Top Associated Skills[213, 214] |
|---|---|
| Bioengineer | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Biologists | • Critical Thinking<br>• Oral Communication: Oral Comprehension<br>• Oral Communication: Oral Expression |
| Blockchain developers | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Business, sales, and commercial development | • *Critical Thinking*<br>• *Decision Making*<br>• *Digital Literacy* |
| Chemical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Chemical technologists and technicians | • Equipment and Tool Selection<br>• Critical Thinking<br>• Evaluation |
| Chemists | • Critical Thinking<br>• Digital Literacy<br>• Operation Monitoring of Machinery and Equipment |
| Civil engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Civil engineering technologists and technicians | • Numeracy<br>• Coordinating<br>• Critical Thinking |
| Data analytics | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Drafting technologists and technicians | • Numeracy<br>• Critical Thinking<br>• Digital Literacy |
| Electric vehicle (EV) engineer | • *Critical Thinking*<br>• *Decision Making*<br>• *Evaluation* |
| Electrical and electronics technologists and technicians | • Equipment and Tool Selection<br>• Troubleshooting<br>• Evaluation |
| Environmental scientists | • *Monitoring*<br>• *Critical Thinking*<br>• *Decision Making* |
| Financial analysts | • Digital Literacy<br>• Numeracy |

| Key Occupations | Top Associated Skills[213, 214] |
|---|---|
| | • Critical Thinking |
| Geoscientists | • Digital Literacy<br>• Numeracy<br>• Oral Communication: Oral Comprehension |
| Mechanical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Mechanical technologists and technicians | • Equipment and Tool Selection<br>• Operation Monitoring of Machinery and Equipment<br>• Preventative Maintenance |
| Power engineer | • Operation Monitoring of Machinery and Equipment<br>• Troubleshooting<br>• Operation and Control |
| Software developers | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| Supervisors, inspectors, and auditors | • *Coordinating*<br>• *Instructing*<br>• *Management of Material Resources* |
| Trades, construction, and related occupations | • *Instructing*<br>• *Management of Financial Resources*<br>• *Management of Material Resources* |

**Industry Perspective**

Both research and stakeholder consultations highlight that it will be imperative for the sector to have a well-balanced mix of occupations with both technical and business-related skills to scale businesses. The key occupations for the sector will vary depending on regions and comprising industries. Therefore, the design of upskill programs need to have a regional and sectoral lens.

## Occupation Gaps

Our research has identified occupation gaps stemming from two key sources. First, companies struggle with finding skilled workers in various occupations such as STEM, trades, and business fields. Secondly, companies are challenged in retaining workers due to volatility of the market, company culture, and competition.[215] In our research, potential causal factors for hiring issues include rising salaries and wage costs, and competition from other sectors. These challenges are further explored in page 90.

The sector is facing occupation gaps both at a technical and business development level. Moreover, stakeholders shared that the sector is facing a gap in trades, construction, and audit occupations. Specifically, people who will build, service, and upkeep cleantech. For example, a mechanic serving

[215] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020

EVs or an electrician implementing cleantech. Along with the individuals building and upkeeping cleantech, there will also be a need for cleantech auditors to ensure standards are met. As cleantech is adopted by households, the need for cleantech workers will rise. The sector is currently not equipped to respond to this demand.

Through our research and stakeholder consultations, the following occupations gaps were identified:[216,217]

| Occupation Gaps | Top Associated Skills[218] |
|---|---|
| Business and commercial development specialists | • *Critical Thinking*<br>• *Decision Making*<br>• *Digital Literacy* |
| Construction | • Instructing<br>• Management of Financial Resources<br>• Management of Material Resources |
| Data analyst | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Designer | • *Product Design*<br>• *Digital Literacy*<br>• *Numeracy* |
| Digital occupations (e.g., software engineers, coders) | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Directors, managers, and project managers | • Time Management<br>• Coordinating<br>• Decision Making |
| Drivers | • *Operation and Control*<br>• *Equipment and Tool Selection*<br>• *Management of Material Resources* |
| Engineers | • *Critical Thinking*<br>• *Decision Making*<br>• *Evaluation* |
| ESG and sustainability specialists[219] | • *Communication, Interpersonal, Facilitation Skills*<br>• *Critical and Analytical Thinking*<br>• Organizational Skills |
| Mechanics | • *Operation Monitoring of Machinery and Equipment*<br>• *Preventative Maintenance*<br>• *Repair* |

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[216] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[217] The Transition Accelerator, Assessing the Workforce Required to Advance Canada's Hydrogen Economy, 2022
[218] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.
[219] The corresponding occupation and alternatives are not available in the in the Occupational and Skills Information System (OaSIS). We obtained the top skills from the Alberta Alis website.

| Occupation Gaps | Top Associated Skills[218] |
|---|---|
| Millwrights | • Preventative Maintenance<br>• Repairing<br>• Operation Monitoring of Machinery and Equipment |
| Plant, equipment, and machine operators | • *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment*<br>• *Preventative Maintenance* |
| Quality/assurance control[220] | • *Critical Thinking*<br>• *Teamwork*<br>• *Communication Skills* |
| Regulatory specialists | • Oral Communication: Active Listening<br>• Oral Communication: Oral Comprehension<br>• Reading Comprehension |
| Technicians | • *Equipment and Tool Selection*<br>• *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment* |
| Welders | • Equipment and Tool Selection<br>• Operation and Control<br>• Preventative Maintenance |

> **Clean Energy Spotlight**
>
> As identified by the Clean Energy and Pathways to Net-Zero: Jobs and Skills for Future Leader survey, participants highlighted the need for entry-level roles in construction, utilities, manufacturing, and skilled trades. At a mid to senior-level roles the roles identified were project managers, engineers, and skilled trades. Without filling the demand for these roles, the sector will struggle with mobilizing clean energy initiatives.[221]

**Future Occupations**

In our research and stakeholder consultation, it has been revealed that most of the occupations that are key for the sector today will continue to be critical for the sector in the future. For example, it is estimated by ECO Canada that applied sciences and related occupations will make up approximately 25% of environmental job openings to 2029.[222] The specific skills and day to day activities may change as technology evolves and priorities shift.

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[220] The corresponding occupation and alternatives are not available in the in the Occupational and Skills Information System (OaSIS). We obtained the top skills from the Alberta Alis website.
[221] ICTC, Clean Energy and Pathways to Net-Zero; Jobs and Skills for Future Leaders
[222] Government of Canada, 2022 Cleantech Industry Survey Results, 2023

Through our research and stakeholder consultations, the following occupations were identified as increasingly important in the future: [223,224,225]

| Future Occupations | Top Associated Skills [226] |
|---|---|
| Chemical engineers | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Civil engineers | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Cybersecurity | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Electrical engineers | • Critical Thinking<br>• Decision Making<br>• Numeracy |
| Electricians | • Repairing<br>• Setting Up<br>• Equipment and Tool Selection |
| Electrochemical engineers | • *Critical Thinking*<br>• *Decision Making*<br>• *Evaluation* |
| Electronics engineers | • Critical Thinking<br>• Decision Making<br>• Numeracy |
| Environmental technologists | • *Monitoring*<br>• *Critical Thinking*<br>• *Decision Making* |
| Geologists and geoscientists | • Digital Literacy<br>• Numeracy<br>• Oral Communication: Oral Comprehension |
| Heavy-duty technician | • Equipment and Tool Selection<br>• Preventative Maintenance<br>• Repairing |
| Mechanics | • *Operation Monitoring of Machinery and Equipment*<br>• *Preventative Maintenance*<br>• *Repair* |
| Millwrights | • Preventative Maintenance<br>• Repairing<br>• Operation Monitoring of Machinery and Equipment |

[223] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[224] The Transition Accelerator, Assessing the Workforce Required to Advance Canada's Hydrogen Economy, 2022
[225] We also conducted an analysis to identify whether key occupations in the advanced manufacturing sector will be in shortage in the future based on the Canadian Occupation Projection System database.
[226] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Future Occupations | Top Associated Skills[226] |
|---|---|
| Production and machine operators | • *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment*<br>• *Preventative Maintenance* |
| Programmers and automation related jobs | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Strategic jobs, directors, managers | • *Time Management*<br>• *Coordinating*<br>• *Decision Making* |
| Truck drivers | • Operation and Control<br>• Equipment and Tool Selection<br>• Management of Material Resources |
| Welders | • Equipment and Tool Selection<br>• Operation and Control<br>• Preventative Maintenance |

**Industry Perspective**

Similar to the case of key occupations and gaps, the future occupations needed in the sector will be specific to a region and comprising industry. For example, one stakeholder shared that chemical engineers will be increasingly important for the cleantech sector in Newfoundland and Labrador but not necessarily other regions. Therefore, when designing forward-looking upskill programs it will be key to collaborate with industry stakeholders to ensure that regional demand considerations are considered.

# Skills

## Key Skills

Similar to occupations, the skills needed in the cleantech sector varies across regions and comprising industry. Moreover, the key skills of the sector will evolve with emerging technology. Therefore, there is a need to continuously update the key skills needed.

While technical and specialized skills will be critical to the success of the sector, upskill programs cannot be limited only to these skills alone. Social-emotional skills such as teamwork, communication, and leadership were some of the most demanded skills in job postings during a two-and-a-half-year period from 2020 to 2022 snapshot.[227] This highlights the importance of non-technical and non-specialized skills in the cleantech sector.

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[227] Toronto Metropolitan University, Labour Market Insights on the Clean Technology (Cleantech) Sector, 2022

Through our research and stakeholder consultations, the following skills were identified as being key to the sector's growth and competitiveness: [228,229,230,231,232]

| Key Skills | |
|---|---|
| **Foundational Skills**<br>• Digital literacy<br>  – Digital modelling<br><br>**Analytical Skills**<br>• Data management and data analytics<br>• Skills in applied and technical sciences[233]<br><br>**Technical Skills**<br>• Digital production<br>  – Capacity to use digital tools/technologies such as:<br>    • Programming<br>    • Software development<br>    • Software systems (e.g., software for chemical reaction models, design, and drafting)<br>    • Automation<br>    • Dashboards<br>• Product development and design<br>• Skilled trades[234] | **Resource Management Skills**<br>• Organization<br><br>**Interpersonal Skills**<br>• Managing communication<br>• Customer relations and support<br><br>**Personal Attributes**<br>• Leadership<br>• Teamwork[235] |

**Industry Perspective**

On top of the identified skills, given the relative novelty of the cleantech sector it will be important for workers to have knowledge around relevant sustainability topics, government regulations, sales, and marketing.
These skills will allow for the sector to continue to build a presence in the overall economy.

### Skill Gaps

In the 2022 Cleantech Industry Survey, 38% of companies shared that the lack of skills required for a job to be a barrier in recruiting and retaining employees. The significance of this challenge varies based on the comprising industry and region. Companies in the waste and recycling, renewable and non-emitting energy supply, and energy efficiency industry tended to be most

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[228] The Information and Communications Technology Council, Canada's Growth Currency, 2019
[229] We also conducted an analysis of the key occupations identified, and the key skills identified in those occupations from the Lightcast database.
[230] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021
[231] Foresight Canada, Building Skills for a Clean Economy, 2022
[232] Toronto Metropolitan University, Labour Market Insights on the Clean Technology (Cleantech) Sector, 2022
[233] Skills in applied and technical sciences encompass a diverse skill set. It is not classified in OaSIS.
[234] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.
[235] Teamwork encompass a range of personal attributes. It is not classified in OaSIS.

impacted by the lack of available skills.[236] From a regional perspective, companies in British Columbia, Manitoba, Ontario, and Quebec tended to have the most significant barrier relating to the skills gap.[237]

Through our research and stakeholder consultations, the following skills gaps were identified:[238,239]

| Skills Gaps | |
| --- | --- |
| **Foundational Skills**<br>• Mathematics skills<br>• Science skills[240]<br>• Engineering skills[241]<br><br>**Analytical Skills**<br>• Data management and data analytics<br><br>**Technical Skills**<br>• Digital production<br>  – Capacity to use digital tools/ technologies such as:<br>    • Software<br>    • Knowledge of emerging technologies<br>• Energy modelling[242]<br>• Skilled trades[243] | **Resource Management Skills**<br>• Business development skills<br>• Project management<br><br>**Interpersonal Skills**<br>• Education and outreach |

**Industry Perspective**

The cleantech sector faces significant levels of regulatory hurdles and technical nuisances. As employees upskill in technical and soft skills it will be essential to also build their knowledge around key topics needed in the sector such as sales and marketing, government regulations, and sustainability topics (e.g., carbon tax, zero carbon concepts, economy of fuels and alternative transports). Stakeholders view building knowledge in these topics to be an easy win. An increase in the knowledge of sustainability topics will allow employees to identify opportunities more easily.

For example, approximately two-thirds of students interviewed by ICTC indicated that they were "not so confident" or "not at all confident" in their understanding of environment legislations and agreements, and knowledge of environmental business practices.[246] The gap in knowledge of current students highlights the opportunity to increase sustainability knowledge across the economy.

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236 Government of Canada, 2022 Cleantech Industry Survey Results, 2023
237 Government of Canada, 2022 Cleantech Industry Survey Results, 2023
238 ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
239 Government of Canada, 2022 Cleantech Industry Survey Results, 2023
240 Science skills encompass a diverse skill set. It is not classified in OaSIS.
241 Engineering skills encompass a diverse skill set. It is not classified in OaSIS.
242 Energy modelling encompass a diverse skill set. It is not classified in OaSIS.
243 Skilled trades encompass a diverse skill set. It is not classified in OaSIS.
244 ICTC, Clean Energy and Pathways to Net-Zero; Jobs and Skills for Future Leaders

## Future Skills

In order for the sector to become a global leader, it will be critical for the sector to be constant innovators and adopters of cleantech. Therefore, it is important to be forward-looking and consider skills that are needed for the future.

The future state of the cleantech sector will depend on how countries adapt to ESG requirements and emerging technology. Overall, the integration of different technologies will be key to continue to build the sector.

Through our research and stakeholder consultations, the following skills were identified as increasingly important in the future:[245]

| Future Skills[246] | |
| --- | --- |
| **Foundational Skills**<br>• Mathematics skills<br>• Science skills[247]<br>• Engineering skills[248]<br><br>**Analytical Skills**<br>• Data management and data analytics<br><br>**Technical Skills**<br>• Digital production<br>  – Capacity to use digital tools/<br>    technologies such as:<br>     • Software<br>     • Knowledge of emerging technologies<br>• Energy modelling<br>• Skilled trades[249] | **Resource Management Skills**<br>• Business development skills<br>• Project management<br><br>**Interpersonal Skills**<br>• Education and outreach<br><br>**Personal attributes**<br>• Creativity<br>• Entrepreneurship<br><br>**Knowledge**<br>• Sales and marketing |

[245] Export Development Canada, Canada's Cleantech Future, 2021
[246] Limited literature exists in the future skills needed in the sector. However, stakeholders discussed that current skill gaps also reflect skills that will be needed in the future.
[247] Science skills encompass a diverse skill set. It is not classified in OaSIS.
[248] Engineering skills encompass a diverse skill set. It is not classified in OaSIS.
[249] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.

# Challenges and Barriers to Upskilling

## Key Employer Challenges

Companies in the sector have struggled both in finding workers and retaining them. Stakeholders shared that hiring challenges are more acute since the COVID-19 pandemic.

These problems stem in part from the lack of financial capacity to compete with other sectors and train their workers. In the 2022 Cleantech Industry Survey, over half of companies selected rising salaries and wage costs (56%), insufficient resources to support training (28%), competition from other firms (25%), and difficulty attracting employees from senior positions (23%) as significant barriers in recruiting and retaining employees.[250]

As identified on page 75, access to capital is a main challenge faced by the sector. A lack of access to funds exacerbates other challenges such as rising renumeration costs and insufficient resources to support training. Although there may exist programs to support start-ups and SMEs in the sector, they often lack awareness of these programs.[251]

Companies in the cleantech sector also struggle with competition from other firms, especially when looking to hire a more senior talent. It is very hard to find people with experience in the cleantech sector, and so when looking to hire people with five to 10 years of experience companies struggle to compete with each other and outside sectors.[252] This expands the challenge of finding mid to senior talent in the cleantech sector.

Additionally, stakeholders shared that SMEs often struggle to build a supportive HR department that grows and retains talents within the firm. Therefore, companies are unable to retain talent and may contribute to a lack of senior employees. Given the sector is heavily composed of SMEs, to ensure success it will be important to consider how SMEs can build a more supportive culture that retain workers and encourages them to build a career within the sector.

**Industry Perspective**

As outlined by a stakeholder: "typically cleantech companies are small, pre-revenue and are competing against all dealerships for salary…it is definitely a challenge to compete on salary alone".

In addition, companies in the sector generally face challenges in finding skilled workers. As indicated in the 2022 Cleantech Industry Survey, companies identified lack of skills required for the job (38%) as a significant barrier in recruiting and retaining employees.[253] In some cases the lack of qualified candidates are so acute that some companies engaged recruiting experts to help fill an open lower-level position as they obtained few qualified responses. The challenges reflect the need to develop and upskill more workers in the cleantech sector.

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[250] Government of Canada, 2022 Cleantech Industry Survey Results, 2023
[251] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[252] ICTC, Clean Energy and Pathways to Net-Zero; Jobs and Skills for Future Leaders

[253] Government of Canada, 2022 Cleantech Industry Survey Results, 2023

## Key Employee Challenges

A main challenge for employees is understanding the nature of the sector and the opportunities that exist within. Stakeholders shared that often individuals do not understand what cleantech jobs entails and have a false perception of what constitutes the cleantech sector, or the variety of industries that it comprises. Consequently, employees may not position themselves for work opportunities within the sector which exacerbates employer's hiring challenges. Therefore, it is important to increase the availability of information on the labour market and skills that are relevant for the cleantech sector.[254]

Additionally, individuals often do not understand the career advancement opportunities within the sector. Stakeholders expressed employees need to have a clear connection between upskilling programs available and career pathways in the sector.

## Challenges in Upskilling

Stakeholders highlighted very few upskill programs exist targeting the specific skills needed in the cleantech sector. Stakeholders shared challenges in upskilling are two-fold. First, there is no broad base expertise of clean technologies in the market. Consequently, a significant level of training has to be done in-house which means programs are targeted towards a very specific technology or skillset. Consequently, this can create major inefficiencies as every cleantech will require slightly different skills and expertise.[255]

Second, stakeholders highlighted that some of the few upskilling programs available are not calibrated with marketplace and employer needs. In the Foresight Cleantech Accelerator Centre Skills project, more than half of employers surveyed ascribed skills gaps to inadequate skills training in universities and colleges.[256] Meanwhile, around a third of employers highlighted a lack of understanding among workers on how to apply skills.[257] Therefore, although some universities have started to offer modules on cleantech, they lack the hands-on experience and specificity needed in a work setting.

Since many aspects of cleantech sector are nascent, there is an increasing expectation of greater government involvement over time, especially as it relates to auditing and certifying the training programs. The government should ensure safety and standards in training. However, government regulations and needs for certification could delay technology adoption.

## Implications to the Sector

In order for the cleantech sector to meet Canada's export and net-zero targets, it needs to develop cost-efficient and market-ready clean technologies. In addition, the sector needs more SMEs to transition from R&D to commercialization of products or services. To do so, the sector will need both workers with entrepreneurship skills to grow SMEs and workers in the production line to produce the technologies.[258] Cleantech companies need well-rounded workers trained in technical, business, and soft skills. The cleantech sector will only be able to unlock its potential if it has the right skills and occupations in place.

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[254] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[255] Royal Bank of Canada, The skills revolution Canada needs to reach Net Zero, 2022
[256] Future Skills Centre, Skills for a Clean Economy, 2023
[257] Future Skills Centre, Skills for a Clean Economy, 2023
[258] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019

The sector also has the opportunity to diversify its workforce and encourage underrepresented groups to lead and manage cleantech companies. A more diversified workforce will bring unique and different perspectives to the sector to help tackle climate crisis issues.

The cleantech sector will continue to evolve based on evolving targets, and emerging technology. Canadian workers will need to be agile and adopt a growth mindset to respond to changing policies and technologies. Companies will need to be willing to hire workers that have core skills and train them with additional bespoke skills.[259] The government will have to work with the sector to minimize regulations and certifications needed to operate in the sector, and to minimize delays in technology adoption.[260]

There will be a continuous need to correctly define, measure, and track the cleantech sector. Reliable sectoral data will be needed to identify the most in demand occupations and skills in the sector. Likewise, dependable data will be important for cleantech companies to make informed hiring and business decisions.

# Opportunities

## Emerging Trends in the Sector Related to Skills and Occupations

### Emerging Technology

As outlined on page 77, emerging technology will continuously impact the key skills and occupations in the sector. The most impactful technologies in today's cleantech sector include big data, sensors, data management, robotics, and biotechnology.[261] Emerging technologies also include IoT, resource extraction, and technologies related to energy systems, transportation, advanced materials efficiencies, and big-data analytics.[262] The advancement of these technologies will increase the demand for digital and technical skills in the cleantech sector.

### Investment Trends

An increase in climate policies triggers interest of venture capital firms, governments, and other financial players. As seen in page 77, the Government of Canada has many funds in place to scale and prepare companies for international export markets. The increase in investment and available funds provides companies with more access to capital needed to hire employees, develop products, and scale-up.

The increase in public awareness of the cleantech sector may also increase the visibility of the sector to potential employees. With increased level of investments, the sector has the opportunity to position itself as a viable career option for both junior and senior employees.

### Changing Workforce

Across the economy, Canada is experiencing the effects of an aging population through increases in retirements. In 2012, the Canada worker-to-retiree ratio was 4.2 to one, and projections estimate that in 2036 the number will be closer to two to one.[263] The agriculture and forestry, manufacturing, and transportation sectors are expected to be the most impacted by 2030.[264] As

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[259] Royal Bank of Canada, The skills revolution Canada needs to reach Net Zero, 2022
[260] Royal Bank of Canada, The skills revolution Canada needs to reach Net Zero, 2022
[261] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[262] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020
[263] Government of Canada, Backgrounder: Growing Canada's Economic Future, 2017
[264] The PLACE Centre and Smart Prosperity Institute, Ready for Green Jobs, 2023

the occupations needed for the cleantech sector heavily overlaps with jobs in the sectors outlined, it will be key to attract new workers into the sector as new jobs are created and workers retire.

**Upskilling Opportunities**

### Delivery Opportunities

For students and recent graduates, an increase in work-integrated learning programs can help students obtain the skills needed to transition to the workforce fulltime.[265] Stakeholders highlighted the opportunity to develop co-op programs to create more opportunities for junior hires.

The sector can also look into working with educational institutions to co-develop curricula that supports a cleantech career path.[266] In order for these programs to be successful they need to target specific technologies or knowledgebase. Industry and institutions will need to work together to standardize training around commonly adopted technologies to the fullest extent possible.[267]

There is also the opportunity to use upskill programs and micro-credentials to support mid-career transitions.[268] As outlined on page 90, the sector is facing a shortage of senior workers. A greater support of mid-career transitions can bring more qualified senior workers into the cleantech workforce.

### Regional and Sectoral Lens

Stakeholders indicated the criticality of taking into account local considerations when launching upskill programs. Regions have different mix of comprising industries and so the occupations and skills demanded will vary. Stakeholders view that programs at a local level are often more effective than at a broader regional or national level due to cultural and demand differences.

For example, Saskatchewan has a larger proportion of pure play cleantech in the water and wastewater sector, while Alberta has a larger proportion of companies in the air, environment and remediation sector compared to other regions.[269] These regional differences highlight the importance of launching upskill programs with a local lens.

### Partnership Opportunities

The skills needed in the cleantech sector will be constantly changing. As a result, there is uncertainty around the skills needed by Canadian workers. Therefore, it will be essential for programs to be industry driven. It is key to involve to both companies deploying the technology and the end-users. By understanding the lifecycle of the products, programs can be tailored towards the skills needed for a successful adoption of technology.

To ensure the upskill programs are being tailored according to the sector's need and reaching the employees most in need there is an opportunity to partner with incubators and accelerators. Business accelerators and incubators help start-ups access the resources needed to grow their companies and could help identify most in need start-ups.[270]

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[265] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[266] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[267] Royal Bank of Canada, The skills revolution Canada needs to reach Net Zero, 2022
[268] Future Skills Centre, Skills for a Clean Economy, 2023
[269] Government of Canada, Cleantech companies, 2022
[270] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019

**Audience**

As identified on page 79, equity-deserving groups are underrepresented in the cleantech sector, and it is critical to ensure groups are not being left behind the sustainability change. In order to expand the cleantech workforce, it will be critical to increase the participation of equity-deserving groups in the sector at both senior and junior levels.[271] Additionally, a special focus should be paid to those whose livelihoods are most likely disrupted by climate change.[272] Programs need to be accessible to these groups and tailored to their specific needs and challenges.[273] Along with the increase in participation of equity-deserving groups, there is a need for a cultural shift to ensure individuals have the support they need to succeed in the sector. Increasing representation of equity-deserving groups will be important to bring diverse and unique perspective on ESG challenges and to help lead creative solutions.

There is also an opportunity to work with educational institutions to introduce cleantech careers pathways at an early age.[274] As outlined by stakeholders, the lack of knowledge about the cleantech sector and the career development opportunities is a barrier for recruitment for employers. By expanding the audience for career opportunities, the sector can build broader awareness.

**Skills**

As identified by research and validated by stakeholder engagements, some of the most achievable opportunities in the short term include trade occupations, upskilling of new technology, development of business development skills, and sectoral knowledge. Specifically, in the Foresight Cleantech Accelerator Centre Skills project, 77% of cleantech employers found value in upskill programs that puts a cleantech lens on traditional skills or shows employees how their skills can be applied to the cleantech sector.[275]

Workers in the cleantech sector do not need only technical skills or specialized scientific training. The sector also requires workers with soft skills and entrepreneurial skills which are essential for continuous growth.[276] The success of the cleantech sector will depend more on common transferrable workplace skills than on specific technical skills.[277]

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[271] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[272] Royal Bank of Canada, The skills revolution Canada needs to reach Net Zero, 2022
[273] Export Development Canada and MaRS, Women in Cleantech Closing the Gender Gap in Cleantech Innovation, 2020
[274] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[275] Future Skills Centre, Skills for a Clean Economy, 2023
[276] Innovation, Science and Economic Development Canada, Report from Canada's Economic Strategy Tables: Clean Technology, 2019
[277] Future Skills Centre, Skills for a Clean Economy, 2023

# Conclusion

While the cleantech sector in Canada has made significant progress, crucial challenges remain. Occupation and skills gap is one of the challenges that must be resolved to fully capture the economic potential of Canada's cleantech sector.

Research and stakeholder consultations highlight the importance of developing upskill programs that are sector driven. Programs need to be specific to regions, and the comprising industries they serve. Furthermore, as technology advances the specific skills needed in the sector and the upskill programs to train them will need to evolve.

Companies in the cleantech sector have limited funds and resources to invest in training. Therefore, it will be essential to build cost-effective upskill programs that are employer-driven, builds skills applicable across the sector, and strengthens the knowledge of cleantech and its regulatory hurdles. The sector needs well-rounded workers trained in technical, business, and soft skills to build continuous sectoral knowledge and experience. By continuously investing in the development of a skilled and adaptable workforce, the cleantech sector can position itself as a global cleantech leader.

# The Ag-tech Sector

> > >

# Executive Summary

Deloitte has been engaged to support Palette Skills' leadership role related to the Industry Upskilling Initiative funded by Innovation, Science and Economic Development Canada (ISED). The purpose of Upskill Canada is to connect employers to qualified talent and help high potential untapped talent move into fast growing careers. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills for high-demand roles in six key sectors (digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, biomanufacturing). In this chapter, we outline the challenges and catalysts associated with the development of the agricultural technology ("ag-tech") sector, with a focus on the sector's workforce. In this report, we define ag-tech, as "development and adoption of innovative technologies to create new products, enhance processes, and establish more efficient and cost-effective ways of working, including production activities that depend on information, automation, computation, robotics, software, sensing, and networking".[278]

The ag-tech sector is abundant with R&D activity and innovation to further support the continued evolution of the agriculture and food industries.[279] In 2021, the agricultural, and food and beverage manufacturing industries (users of the technology) collectively employed approximately 590 thousand people and generated over $70 billion of real GDP for Canada in 2022.

For the sector to become a global leader in innovation and exports, it will need to overcome existing challenges such as barriers to technological adoption, a lack of skilled domestic labour, and regulatory restrictions. The sector will need increased investment in new technology, upskilling workers to lead innovation, and recruiting domestic workers to fill the occupation shortages that exist throughout the value-chain. Currently, some of the occupations facing the biggest shortages include general labourers, specialized roles (e.g., horticulturist, precision agronomist, industrial butchers, veterinarians, and growers), skilled trades (e.g., plumbers, industrial electricians, heavy duty mechanics, and millwrights), engineers, transport truck drivers, and managers with technical and industry knowledge. The skills associated with these jobs were also identified as gaps in the sector, along with digital and soft skills.

The outcomes of the research and study are structured as follows: an overview of the sector, a summary of the labour and skills analysis, challenges, implications, and opportunities for the sector. To be of benefit to the broader training and workforce development ecosystem, the findings presented in this chapter reflect the wide-ranging needs of the sector. Some occupations listed or industry opportunities might be beyond Upskill Canada's scope. This might include skilled trades occupations and those requiring certification from a professional body. Eligibility for Upskill Canada funding will be dependent on identifying demand for jobs through direct employer engagement.

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[278] Definition obtained from ISED
[279] Invest in Canada, Ag-tech landing page, n.d.

# Overview of the Sector

## The Ag-tech Sector

The ag-tech sector in Canada encompasses a wide variety of industries, including primary agriculture, aquaculture, and food and beverage processing.[280] The dynamic sector leverages advanced technology and innovation to enhance productivity and efficiency across the agriculture value chain. With a focus on achieving goals such as food safety, environmental sustainability and, the development of novel food products, technology plays a pivotal role throughout various stages of food and beverage production processes.[281]

Defining the boundaries of the ag-tech sector presents a challenge due to the lack of a standard from an industry composition perspective. In this study, our approach is to concentrate on industries within the agri-food supply chain that harness advanced technology and technological innovation to enhance agricultural processes and production efficiency. This means that focus is not placed solely on technology producing firms in Information and Communications Technology (ICT) or advanced manufacturing, but rather on industries that utilize these technologies within the agri-food supply chain. As a result, our research specifically focuses on primary agriculture, as well as food and beverage manufacturing, while excluding food services, retail, and wholesale sectors. This approach acknowledges the unique technology and skill requirements of these industries, enabling us to gain insights into how advanced technology drives efficiency and innovation within the ag-tech sector. In this report, we define ag-tech, as **"development and adoption of innovative technologies to create new products, enhance processes, and establish more efficient and cost-effective ways of working, including production activities that depend on information, automation, computation, robotics, software, sensing, and networking".[282]**

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[280] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018
[281] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018
[282] Definition obtained from ISED

Figure 27: Agri-food Supply Chain

- Primary Agriculture
- Food and Beverage Manufacturing
- Food Retail and Wholesale
- Food Services

Supply Chain
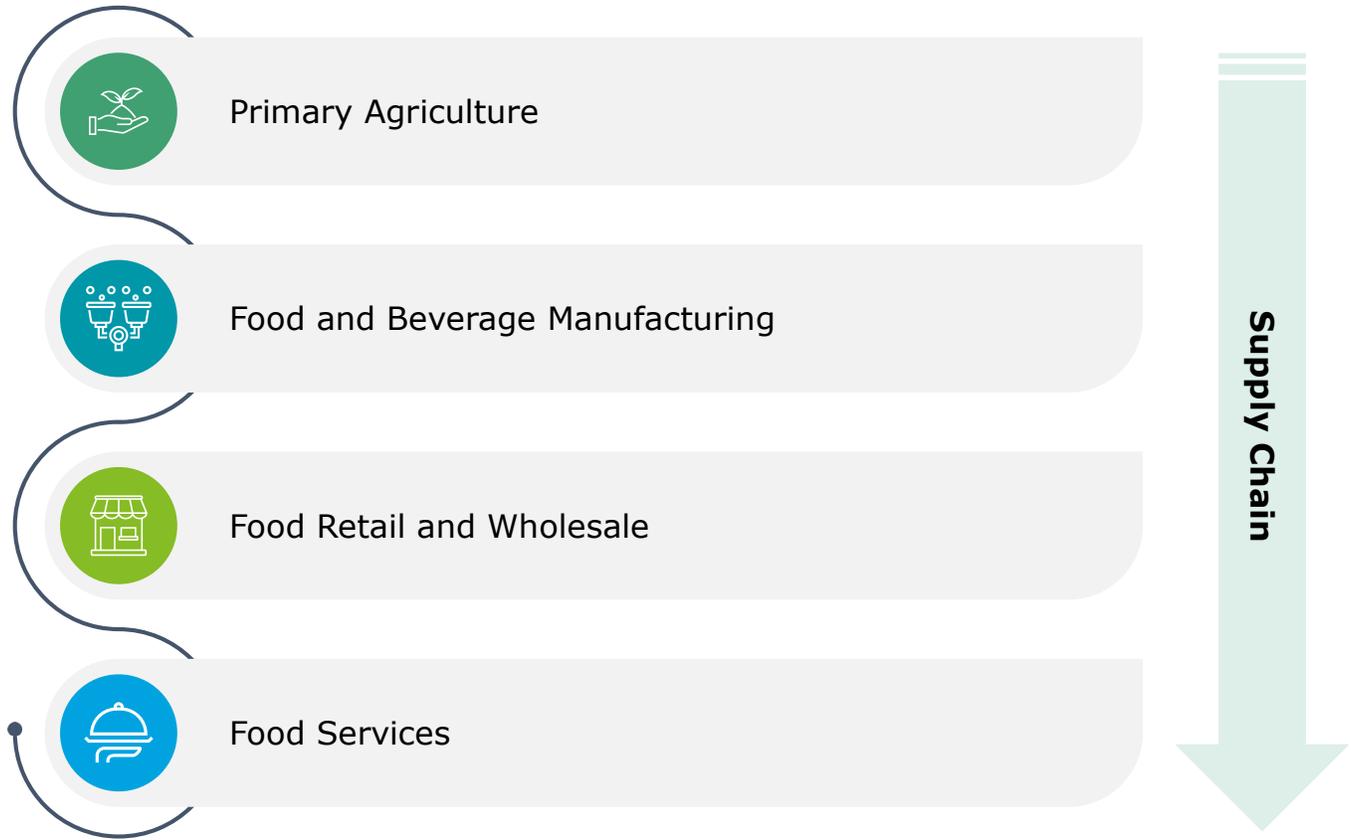
## Current State of the Sector

Economic activity as measured by real GDP within the sector has almost doubled in the last 25 years, rising from $38 billion in 1997 to approximately $70.2 billion in 2022. Employment on the other hand has slightly declined over the same period, from roughly 660 thousand employees in 1997 to approximately 589 thousand in 2021. The implication of a declining level of employment counterbalanced with a larger growth in real GDP indicates a rapid growth in productivity. In fact, productivity as measured as real GDP per worker, almost doubled in the sector since 1997.
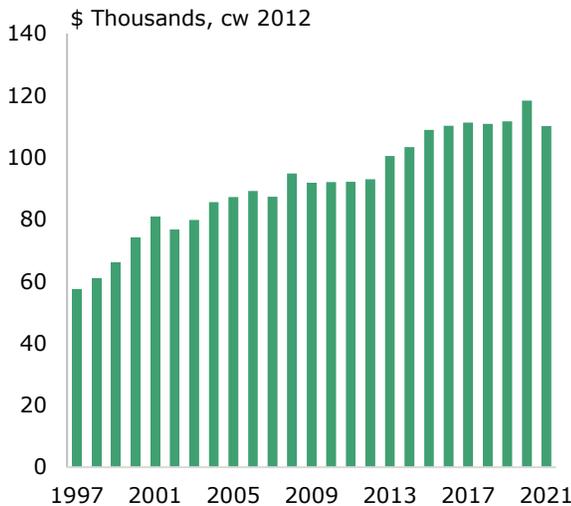
*Figure 28: Agri-food Sector Real GDP*

$Billions, cw 2012
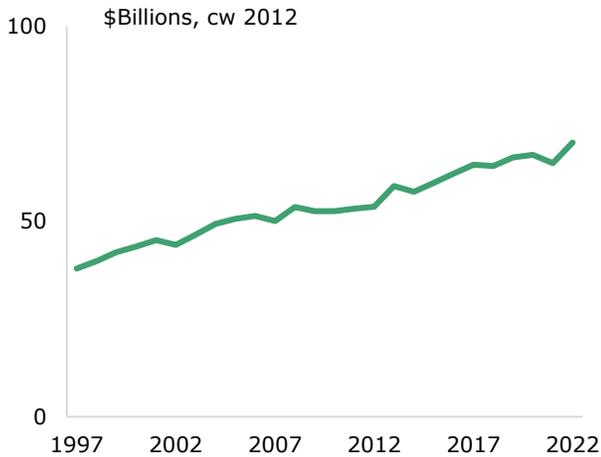


*Source: Statistics Canada*

*Figure 29: Agri-food Sector Employment*

Thousands
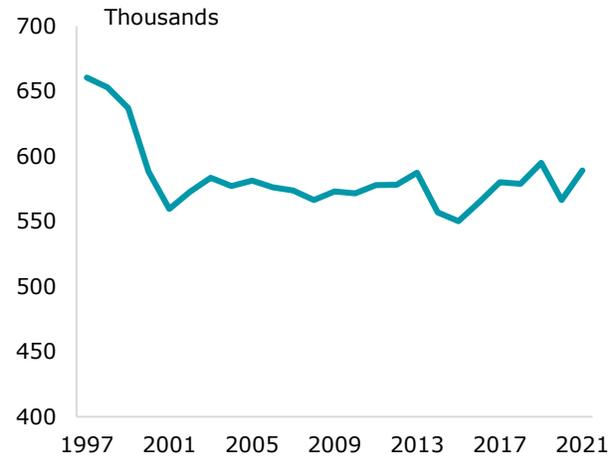


*Source: Statistics Canada*

*Figure 30: Agri-food Sector Productivity – GDP per employee*

$ Thousands, cw 2012



*Source: Statistics Canada*

*Figure 31: Agri-food Sector Employment Share by Region in 2021*



Atlantic ■ Quebec ■ Ontario ■ West ■ North
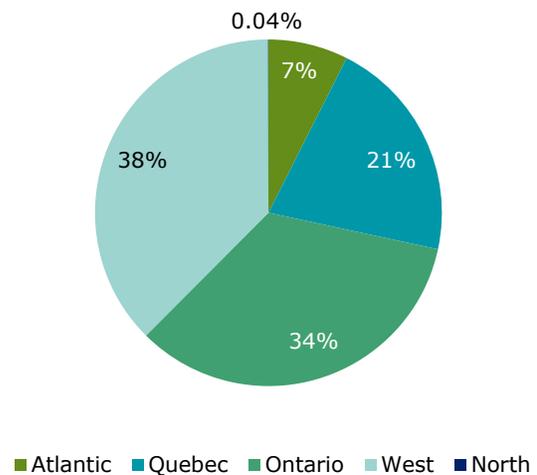
*Source: Statistics Canada*

## Palette Skills' Activities in the Sector[283]

In 2021, in partnership with the University of Saskatchewan and the Enterprise & Machine Learning Initiative (EMILI), Palette Skills received funding from Protein Industries Canada to launch an upskilling program to transition workers into roles in the agricultural technology sector in Saskatchewan. To develop the program, Palette Skills engaged 20 agriculture employers through interviews and roundtable discussions to better understand the talent needs of the sector and validate existing research and data. Palette Skills worked with EMILI to conduct a sector insights report that expanded on employer engagement through a survey.

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[283]Palette Skills, Automation and Digital Agriculture Specialist Program, n.d.

In 2022, Palette Skills launched their Automation and Digital Agriculture Specialist program, focused on automation and digitization technologies in agriculture production and processing for the residents of Saskatchewan. This program provides hands-on learning experience including education of emerging technologies such as geographic information systems (GIS), IoT, drones, AI, robotics, and big data from industry experts. This program aids in providing connections to innovative ag-tech businesses and start-ups in the region. Those that complete the program typically acquire or strengthen the following skills:

- Automation and digital agriculture
- Farming best practices and sustainability
- Soil management
- Precision agriculture

- Big data and IoT
- Agribusiness digital management tools
- Business management skills (e.g., project management, problem-solving, team building)

The program is divided into three streams: (1) agri-business and sales, (2) industrial technician, and (3) data analyst and programmer. Some noted career pathways after completion of this program include:

- Business development representative
- Precision agronomist
- Crop input sales representative
- Agribusiness development manager
- Precision agriculture specialist
- Control systems specialist

- Sensor remote sensing analyst
- Automation technologist
- Ag-tech software engineer
- Precision agriculture programmer
- Ag data analyst
- Agribusiness applications developer

Over an eight week stretch, the goal of this program is to educate workers to identify, manage, and implement technological solutions throughout the ag-tech value chain. So far, the program has upskilled over 80 participants from Saskatchewan and worked with over 80 employers.

## Key Challenges

Aging demographics, and rising retirements is a factor that is posing a particular acute challenge for this sector. The average age of Canadian farmers is rising, and it was reported that approximately 70% of farmers do not have succession plans.[284] Trends in the aging labour force, heightened by the COVID-19 pandemic, emphasized the sector's need for automation and robotics.[285] As labour supply associated with manual work may be limited, there are opportunities to use technology to fill this labour gap.[286] Although new technologies seems promising, stakeholders have reported the high cost of adoption as a barrier and have expressed concerns regarding the return on investment. As a result, a large challenge for the sector also includes barriers associated with technological adoption. Current expenses of firms in this space can be as high as 83 cents per dollar of sales, further impacting a firm's ability to invest in new technologies.[287] To ensure a positive return on investment for these new technologies, having the correct skillset and understanding of the respective technologies is essential. It should be noted that while technological adoption remains a challenge for the sector, technological adoption rates

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[284] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[285] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[286] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[287] Royal Bank of Canada, Farmer 4.0: How the coming skills revolution can transform agriculture, 2019

across regions in Canada are unequal. This is a result of the great diversity of the sector and how technological adoption is often directly related to the different set of products that are produced. For instance, in precision agriculture, typically concentrated in Western Canada, it is much easier to utilize machines to replace manual farm labour. However, fruit farms and greenhouses that are typically concentrated in southern Ontario tend to rely on low-skilled, physical human labour.[288] These regional and industry compositional differences will contribute to the disparity in technological adoption within the sector.

As the Canadian and global population continues to grow, there will be an increasing role for this sector to be a global supplier. This will pose great opportunities for Canada and the sector. These opportunities range from direct impacts to the sector through expansion, especially into new markets, to additional economic development benefits that can be provided for rural communities. Nevertheless, the expanding market will also pose some unique challenges. Firstly, some of these challenges will relate to the transitioning process of being a greater global supplier. To fully take advantage of the opportunity, by expanding into new markets and product offerings, greater business development and global links to the food value-chain will be required. In addition, greater levels of investments will be required, especially in new technologies, as mentioned above.

Population growth will also pose a challenge for the sector to ensure sustainable environmental practices and stewardship is adhered. With growing awareness of environmental issues, the sector will need to maximize its sustainable practices. Implementing agroecology, conservation agriculture, and regenerative farming methods can help mitigate environmental impacts, preserve natural resources while promoting biodiversity. Overall, this trend could provide a great opportunity for Canada. However, to harness these opportunities, it will require a proactive approach, investment in R&D, access to finance and technology, supportive policies, and enhanced farming capacity. By capitalizing on these opportunities, the sector can play a pivotal role in ensuring food security, sustainable development, and economic prosperity.

Employers within the sector also face numerous challenges when it comes to growing and improving their workforce. In short, labour shortage and skills gap is a key challenge for the sector. One of the largest challenges this sector faces is the lack of domestic labour participation, and its overreliance on foreign workers to rectify labour gaps. Some factors as to why this is the case include an aging workforce, difficulty reaching underrepresented equity-deserving groups, and a lack of new entrants from the younger demographic.[289] Younger individuals and new entrants to Canada often do not view the sector as viable career options.[290] This can be attributed, in part, to a lack of awareness about the diverse opportunities available within the field. There is a noticeable gap in education within schools as it relates to informing students on topics such as food production, farming, food processing, and career paths within the sector.[291] This limited exposure reduces learning opportunities for young individuals to gain insights and develop the necessary skillset for the sector. Furthermore, individuals who possess transferable technological skills often show little interest in pursuing a career in the sector.[292]

Employers within the sector also find it difficult to compete with other employers from other sectors for the same supply of talent. Due to lower margins, employers are unable to offer wages and salaries for certain key occupations that are comparable to those in other sectors such as digital technologies and manufacturing.[293] In certain circumstances, the lack of ability to provide competitive wages is contributing to the sectors labour shortage.

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[288] Royal Bank of Canada, Farmer 4.0: How the coming skills revolution can transform agriculture, 2019
[289] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[290] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[291] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[292] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[293] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021

General perceptions of the sector and structural implications of the job are another deterring factor for recruitment. Some occupations within the sector have high levels of seasonality, weekend and evening working hours, and involve manual labour, which are considered unfavourable.[294] The structural implications of some occupations have further added to a negative perception, dissuading them from seeking jobs within the sector.

## Policy Context

Canada has various immigration programs at both the federal and provincial levels with the goal of attracting global talent to Canada permanently or temporarily. Currently, the Government of Canada has category-based Express Entry rounds for top foreign candidates looking to work in Canada. This program looks for candidates who can help the country meet specific economic goals in select occupations, such as agriculture and agri-food occupations.[295]

Another immigration program includes the TFW program which prioritizes the immigration of highly skilled workers associated with in-demand occupations across provinces and territories, including occupations within the agriculture sector.[296] Despite the high use of the TFW program by the agricultural industry, it is still experiencing significant labour shortages. Sustained efforts to support the sector and close its labour gaps could unlock significant capacity and economic opportunities for Canada.

## Emerging Trends

The sector in Canada is experiencing the transformative impact of emerging technologies within the digital economy. Stakeholders have highlighted the emergence of AI as a driving force behind increased efficiency in various agricultural operations. With the potential to become a significant contributor in global food production, Canada can shift towards becoming a higher value-added producer. To achieve this, stakeholders have emphasized the importance of R&D in areas such as regenerative agriculture and genetic modification, with a strong focus on sustainability.

Additionally, there are efforts being made to expand broadband to rural areas. Currently, the lack of broadband is a bottleneck, restricting the implementation and adoption of newer technologies and digital tools to a large degree.[297] Increasing broadband to rural areas would enable further optimization of supply chains, increase crop yield, and expand e-commerce opportunities. This would be possible through big data analytics, more accurate data input, and greater adoption of Industry 4.0 technologies.[298] Overall, this may benefit multiple sectors in rural areas, and better connect the sector to surrounding regions and populations.

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[294] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[295] Government of Canada, Express Entry rounds of invitations: Category-based selection, 2023
[296] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[297] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018
[298] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018

## The Potential Future of the Sector

The Government of Canada recognized the sector to have potential to be a large driver of economic growth, setting a goal for the sector of $75 billion in exports by 2025.[299] The purpose of these growth objectives is to position Canada as a global industry leader and to seize future opportunities.

With the innovation of Industry 4.0 continuing to make headway, there is large focus on the importance of data, innovation, and cleantech within the sector. One thought leadership study by RBC provides an ambitious view that with the advent of Industry 4.0 the next generation of farmers will primarily be working in office buildings, data centers, and engineering labs.[300] This shift will be the result of utilizing machinery and robotics to transform our landscape into an efficient and sustainable food source for the planet.[301]

As the world's population is expected to reach 10 billion by 2050, Canada has an opportunity to be a sustainable global supplier, especially as the global market demand for protein accelerates in the same time period.[302] Creating awareness of the opportunities within the sector is crucial for Canada to capitalize on the sector's potential.[303] Innovation, a highly skilled workforce, appropriate infrastructure, and regulations will be key to successfully seizing these opportunities and meeting objectives.[304]

# Sector Labour Market and Occupations/Skills Analysis

### Overview of Job Supply and Demand

The sector's labour market is impacted by both supply and demand factors. Some key factors that limit the labour supply within the sector include the structural implications of the job, aging population, increased retirements, and non-competitive wages and salaries. This supply gap was further exacerbated by the COVID-19 pandemic as there was a restriction of foreign workers from entering and staying in the country.[305]

Overall, as identified on page 90, labour shortages are a significant challenge for the sector. The sector is facing a continued shortage of labour with a gap that if left unaddressed is at risk of widening. According to the Canadian Occupational Projection System (COPS) dataset, there are no key occupations within the sector that are flagged to be oversupplied now or in the future, yet the dataset reports significant occupations associated with the sector in shortage. This sub-section identifies the key occupations, occupation gaps, and future occupations in the sector. Similarly, it identifies the key skills, skill gaps, and future skills that will be needed for success now and in the future.

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[299] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018

[300] Royal Bank of Canada, Farmer 4.0: How the coming skills revolution can transform agriculture, 2019

[301] Royal Bank of Canada, Farmer 4.0: How the coming skills revolution can transform agriculture, 2019

[302] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018

[303] Royal Bank of Canada, The Next Green Revolution: How Canada can produce more food and fewer emissions, 2022

[304] Innovation, Science and Economic Development Canada, Report of Canada's Economic Strategy Tables: Agri-food, 2018

[305] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022

# Occupations

## Key Occupations

To promote the growth of the sector, it is important to raise awareness about the diverse range of roles available. Stakeholders had indicated that there is often a misconception associated with the sector and the nature of the work it entails. This misconception often leads to a lower pool of labour supply willing to participate. The primary stereotype is often associated with traditional farm-related positions, overlooking the increasing presence of the digital roles and the various technical and management roles it encompasses. To attract more domestic workers and contribute to the industry's expansion it will be essential to raise awareness about the diverse occupations beyond traditional farming.

Having a deep bench of highly skilled workers across various roles is vital for growth and advancement. For this sector to thrive, it is important to maintain individuals with technical skills. However, our research and stakeholder consultations have also indicated that occupations associated with lesser technical skills are also important in the production process. Furthermore, given the diverse nature of the sector, different regions of the country will have different areas of specialization and expertise, resulting in the production of different goods. Therefore, the specific key occupations for the sector may differ across Canada.

Through our research and stakeholder consultations, the following occupations were identified as being key to the sector's growth and competitiveness:[306,307,308,309,310,311]

| Key Occupations | Top Associated Skills[312] |
| --- | --- |
| Agronomists | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| AI Software Developer | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Chemical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Data analyst | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Equipment operator | • Operation and Control<br>• Equipment and Tool Selection<br>• Operation Monitoring of Machinery and Equipment |

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[306] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[307] CAHRC, National Workforce Strategic Plan for Agriculture and Food and Beverage Manufacturing, 2022
[308] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[309] CAHRC, Grow the Future, 2021
[310] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[311] EMILI, Upskilling for Digital Agriculture Insights Report for Palette Skills Pilot Project: Summary of Findings, 2022
[312] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Key Occupations | Top Associated Skills[312] |
|---|---|
| Equipment technicians/mechanics | • Setting Up<br>• Troubleshooting<br>• Equipment and Tool Selection |
| Feeder position | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Finance | • *Coordinating*<br>• *Instructing*<br>• *Management of Personnel Resources* |
| Food scientist | • *Equipment and Tool Selection*<br>• *Management of Material Resources*<br>• *Operation and Control* |
| General labourer | • *Setting Up*<br>• *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment* |
| Grower | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Herdsperson | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Horticulturist | • Management of Material Resources<br>• Coordinating<br>• Critical Thinking |
| Human resource development | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Industrial butcher | • Equipment and Tool Selection<br>• Management of Material Resources<br>• Operation and Control |
| Industrial electrician | • Preventative Maintenance<br>• Repairing<br>• Setting Up |
| Logistics and distribution managers | • *Management of Financial Resources*<br>• *Management of Material Resources*<br>• *Management of Personnel Resources* |
| Maintenance electrician | • *Preventative Maintenance*<br>• *Quality Control Testing*<br>• *Repairing* |
| Managers and supervisors (e.g., Farm supervisors) | • *Management of Financial Resources*<br>• *Management of Material Resources*<br>• *Management of Personnel Resources* |

| Key Occupations | Top Associated Skills[312] |
|---|---|
| Manufacturing engineer | • Decision Making<br>• Evaluation<br>• Monitoring |
| Marketing | • Coordinating<br>• Decision Making<br>• Negotiating |
| Mechanical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Millwright | • Preventative Maintenance<br>• Repairing<br>• Operation Monitoring of Machinery and Equipment |
| Plumber | • Repairing<br>• Setting Up<br>• Troubleshooting |
| Power Engineers | • Operation Monitoring of Machinery and Equipment<br>• Troubleshooting<br>• Operation and Control |
| Precision Agriculture – agronomists; heavy duty mechanics, production advisors | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Production Operators | • *Coordinating*<br>• *Management of Material Resources*<br>• *Monitoring* |
| QA/QC Specialists in Food Processing | • *Quality Control Testing*<br>• *Equipment and Tool Selection*<br>• *Management of Material Resources* |
| Registered Veterinary Technologists | • *Decision Making*<br>• *Instructing*<br>• *Learning and Teaching Strategies* |
| Salespeople | • *Management of Material Resources*<br>• *Negotiating*<br>• *Persuading* |
| Software developers | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| Transport truck drivers (e.g., Livestock transportation drivers) | • Operation and Control<br>• Management of Material Resources<br>• Operation Monitoring of Machinery and Equipment |
| Veterinarians | • Decision Making<br>• Instructing<br>• Learning and Teaching Strategies |

## Occupation Gaps

Occupation gaps have been a consistent challenge for the sector with little sign of abating. As of 2021, harvesting, aquaculture, and marine harvesting labourers experienced the largest demand-supply shortage of approximately 22%.[313]

Our research and stakeholder consultations found that general labourer is the most difficult position to fill within the sector. Some possible reasons for this include the seasonality of work, its manual nature, and the extended hours of work. This shortage has drastically increased the need for automation and robotics within the sector, and in some cases has been a driver for technological adoption.[314] These challenges are further explored on page 116.

Through our research and stakeholder consultations, the following occupations gaps were identified:[315,316,317,318,319,320]

| Occupation Gaps | Top Associated Skills[321] |
|---|---|
| Agriculture salespeople | • Coordinating<br>• Critical Thinking<br>• Decision Making |
| Engineer Mechanical | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Equipment operators<br>• AgTech machinery operators | • *Operation and Control*<br>• *Equipment and Tool Selection*<br>• *Operation Monitoring of Machinery and Equipment* |
| Feeder positions/Growers | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| General labourer | • *Setting Up*<br>• *Operation and Control*<br>• *Operation Monitoring of Machinery and Equipment* |
| Heavy duty mechanics | • Equipment and Tool Selection<br>• Preventative Maintenance<br>• Repairing |

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[313] Government of Canada, Canadian Occupational Projection System (COPS), 2022
[314] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[315] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[316] CAHRC, National Workforce Strategic Plan for Agriculture and Food and Beverage Manufacturing, 2022
[317] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[318] CAHRC, Grow the Future, 2021
[319] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[320] EMILI, Upskilling for Digital Agriculture Insights Report for Palette Skills Pilot Project: Summary of Findings, 2022
[321] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Occupation Gaps | Top Associated Skills[321] |
|---|---|
| Herdspersons | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Horticulturists | • Management of Material Resources<br>• Coordinating<br>• Critical Thinking |
| Industrial butchers | • Equipment and Tool Selection<br>• Management of Material Resources<br>• Operation and Control |
| Industrial electrician | • Preventative Maintenance<br>• Repairing<br>• Setting Up |
| Maintenance electrician | • *Preventative Maintenance*<br>• *Quality Control Testing*<br>• *Repairing* |
| Managers and supervisors<br>Farm supervisors | • *Management of Financial Resources*<br>• *Management of Material Resources*<br>• *Management of Personnel Resources* |
| Millwright | • Preventative Maintenance<br>• Repairing<br>• Operation Monitoring of Machinery and Equipment |
| Plumber | • Repairing<br>• Setting Up<br>• Troubleshooting |
| Precision Agriculture – agronomists | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Production advisors | • *Coordinating*<br>• *Management of Material Resources*<br>• *Monitoring* |
| Transport truck drivers | • Operation and Control<br>• Management of Material Resources<br>• Operation Monitoring of Machinery and Equipment |
| Veterinarian | • Decision Making<br>• Instructing<br>• Learning and Teaching Strategies |

**Industry Perspective**

Research and stakeholder consultations highlighted that a shortage of transport truck drivers is adversely affecting the sector, creating a bottleneck in the production flow of work. This shortage is exacerbated by the licensing requirements and regulations negatively impacting the supply and value chain within the agriculture industry.[323]

## Future Occupations

As there is a growing need for digital skills within the sector, the shift to more technologically focused roles is expected to continue. The sustained transformational effects of AI, data science, engineering, IoT, sensors, drones, and biotechnology are all becoming more critical to the development of the sector.[323]

Through our research and stakeholder consultations, the following occupations were identified as increasingly important in the future:[324,325,326,327,328]

| Future Occupations | Top Associated Skills[329] |
|---|---|
| Automation expert | • *Preventative Maintenance*<br>• *Repairing*<br>• *Troubleshooting* |
| Automation technician | • *Preventative Maintenance*<br>• *Repairing*<br>• *Troubleshooting* |
| Chemical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Data analyst | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Data scientist | • Digital Literacy<br>• Numeracy<br>• Systems Analysis |
| Farm managers | • *Management of Financial Resources*<br>• *Management of Material Resources* |

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[322] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[323] Royal Bank of Canada, The Next Green Revolution: How Canada can produce more food and fewer emissions, 2022
[324] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[325] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[326] Royal Bank of Canada, The Next Green Revolution: How Canada can produce more food and fewer emissions, 2022
[327] Royal Bank of Canada, Farmer 4.0: How the coming skills revolution can transform agriculture, 2019
[328] EMILI, Upskilling for Digital Agriculture Insights Report for Palette Skills Pilot Project: Summary of Findings, 2022
[329] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Future Occupations | Top Associated Skills[329] |
|---|---|
| | • *Management of Personnel Resources* |
| Farm technician | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Food safety inspector[330] | • *Communication*<br>• *Analytical skills*<br>• *Knowledge of government acts and regulations* |
| Food scientist | • *Equipment and Tool Selection*<br>• *Management of Material Resources*<br>• *Operation and Control* |
| Ground and equipment maintenance | • *Setting Up*<br>• *Troubleshooting*<br>• *Equipment and Tool Selection* |
| Horticulturists and associated services | • Management of Material Resources<br>• Coordinating<br>• Critical Thinking |
| IT support | • *Critical Thinking*<br>• *Decision Making*<br>• *Digital Literacy* |
| Maintenance support | • *Preventative Maintenance*<br>• *Quality Control Testing*<br>• *Repairing* |
| Manufacturing engineer | • Decision Making<br>• Evaluation<br>• Monitoring |
| Manufacturing managers | • Management of Financial Resources<br>• Management of Material Resources<br>• Time Management |
| Mechanical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Researcher | • *Critical Thinking*<br>• *Decision making*<br>• *Digital Literacy* |
| Service technician[331] | • *Operation/Monitoring of Machinery and Equipment*<br>• *Interpersonal skills*<br>• *Digital and mathematics skills* |

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[330] The corresponding occupation and alternatives are not available in the in the Occupational and Skills Information System (OaSIS). We obtained the top skills from the Alberta Alis website.
[331] The corresponding occupation and alternatives are not available in the in the Occupational and Skills Information System (OaSIS). We obtained the top skills from the Alberta Alis website.

| Future Occupations | Top Associated Skills[329] |
|---|---|
| Software developer | • Digital Literacy<br>• Digital Production<br>• Evaluation |

# Skills

## Key Skills

As is the case for occupations, the key skills demanded for the sector vary across regions in the country. This variation depends on the specific industry within the sector, and the nature of the business operating in the region.

Through our research and stakeholder consultations, the following skills were identified as being key to the sector's growth and competitiveness:[332,333,334,335,336,337,338]

| Key Skills | |
|---|---|
| **Foundational Skills**<br>• Numeracy<br>• Literacy<br>• Engineering skills<br><br>**Analytical Skills**<br>• Data management and analytics<br>• Critical thinking<br><br>**Technical Skills**<br>• Digital production<br>  – Capacity to use digital tools/technologies such as:<br>    • Software development<br>    • Programming<br>    • AI<br>• Skilled trades[339]<br>  – Plumbing<br>  – Electrician<br>  – Mechanic<br>  – Machinist | • Specialized skills such as technical skills related to:[340]<br>  – Growing plants<br>  – Animal handling<br>  – Precision agriculture<br>  – Food science<br><br>**Resource Management Skills**<br>• Human resource development skills<br><br>**Interpersonal Skills**<br>• Change management<br>• Managing communication<br><br>**Knowledge**<br>• Business skills in tandem with sector knowledge:<br>  – Sale and marketing<br>  – Finance |

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[332] Government of Canada, Canadian Occupational Projection System (COPS), 2022
[333] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[334] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[335] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[336] Future Skills Centre, Mapping the green jobs transition, 2022
[337] CAHRC, Grow the Future, 2021
[338] EMILI, Upskilling for Digital Agriculture Insights Report for Palette Skills Pilot Project: Summary of Findings, 2022
[339] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.
[340] Specialized skills encompass a diverse skill set. It is not classified in OaSIS.

**Industry Perspective**

Stakeholders in the sector emphasized the increasing importance of digital skills such as information management. Currently, there are many vacancies for these positions, and employers will likely continue to be challenged to hire for this skillset over the next 10 years.[342]

## Skill Gaps

The sector is facing a persistent shortage of domestic and foreign skilled workers. This is expected to lead to an increasing skills gap across various aspects of the sector. This shortage poses significant challenges to meeting its evolving demands and hampers its objectives and overall growth.

Through our research and stakeholder consultations, the following skills gaps were identified:[342,343,344,345,346,347,348]

| Skills Gaps |
| --- |

**Foundational Skills**
- Numeracy
- Literacy
- Engineering skills

**Analytical Skills**
- Data management and analytics
- Critical thinking
- Problem solving in digital environments

**Technical Skills**
- Digital production
  - Capacity to use digital tools/technologies such as:
    - Software development
    - Programming
    - AI
- Skilled trades[349]

- Specialized skills such as technical skills related to:[350]
  - Growing plants
  - Animal handling
  - Food science
  - Genetics
  - Precision agriculture

**Resource Management Skills**
- Human resource development skills

**Interpersonal Skills**
- Change management

**Knowledge**
- Business skills in tandem with sector knowledge:
  - Sale and marketing

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[341] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[342] Government of Canada, Canadian Occupational Projection System (COPS), 2022
[343] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[344] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[345] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[346] Future Skills Centre, Mapping the green jobs transition, 2022
[347] CAHRC, Grow the Future, 2021
[348] EMILI, Upskilling for Digital Agriculture Insights Report for Palette Skills Pilot Project: Summary of Findings, 2022
[349] Skilled trades encompass a diverse skill set. It is not classified in OaSIS.
[350] Specialized skills encompass a diverse skill set. It is not classified in OaSIS.

| Skills Gaps | |
|---|---|
| – Plumbing<br>– Electrician<br>– Mechanic<br>– Machinist | – Finance |

## Future Skills

Digital skills will be essential for the sector's success and evolution.[351] Insufficient awareness of the potential careers within the sector has contributed to a bottleneck in attracting individuals with essential technical skills, such as coding, AI, and data science. These skills are crucial for driving the sector's evolution and addressing the growing demands of the industry.[352] However, attracting individuals with digital skills to the sector remains a key challenge as individuals interested in technology, are typically not interested in operations of this sector. This is discussed further on page 116.

**Industry Perspective**

Stakeholders in the sector have highlighted that while technical skills are important for the sector to thrive, just as important are the business, leadership, and people management skills, which will be in great demand in the future.

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[351] Royal Bank of Canada, The Next Green Revolution: How Canada can produce more food and fewer emissions, 2022
[352] Royal Bank of Canada, The Next Green Revolution: How Canada can produce more food and fewer emissions, 2022

Through our research and stakeholder consultations, the following skills were identified as increasingly important in the future:[353,354,355,356,357,358,359,360]

## Future Skills

### Foundational Skills
- Engineering skills[361]
  - Mechanical and chemical engineering skills
- Digital Literacy
  - Agriculture knowledge coupled with application programming interface skills
  - Skills in emerging technologies such as:
    - Plant propagation and nutrient management
    - Farm robotics
    - Biotechnology

### Analytical Skills
- Critical thinking
- Problem solving
- Decision making

### Technical Skills
- Digital production
  - Capacity to use digital tools/technologies such as:
    - Software development
    - User interface management
    - Coding and programming
    - Data management and analytics
    - AI and automation knowledge
    - Blockchain
    - Sensing
- Regenerative agriculture techniques

### Resource Management Skills
- Human resource development skills

### Interpersonal Skills
- Managing communication
- Customer relations and support

### Knowledge
- Business skills in tandem with sector knowledge:
  - Finance
- Exposure to environmental studies

### Personal Attributes
- Leadership
- Collaboration
- Administration and collaboration

[353] Government of Canada, Canadian Occupational Projection System (COPS), 2022
[354] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[355] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[356] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[357] Future Skills Centre, Mapping the green jobs transition, 2022
[358] CAHRC, Grow the Future, 2021
[359] Royal Bank of Canada, Farmer 4.0: How the coming skills revolution can transform agriculture, 2019
[360] Royal Bank of Canada, The Next Green Revolution: How Canada can produce more food and fewer emissions, 2022
[361] Engineering skills encompass a diverse skill set. It is not classified in OaSIS.

# Challenges and Barriers to Upskilling

## Key Employer Challenges

A key employer challenge in developing their firm's skills and talents remains the strategic choice of determining the prerequisite skills required for work in the sector and those that can be developed through upskilling. Idiosyncratic knowledge and industry familiarity is a premium within this sector. However, technical skills are also in high demand. In large measure, those who do have strong technical skills are not necessarily familiar with the sector, while individuals with robust industry knowledge might not be steeped with strong technical skills. Thus, in hiring, many employers will need to make a choice in trading-off one over the other. Stakeholders had indicated that for the most part, it is more seamless to prioritize technical skills as a pre-requisite in hiring and to upskill individuals on the idiosyncratic nature of the industry. In other words, it is more seamless to hire people with the aligned skill sets but who lack industry knowledge, than to hire someone with advanced industry knowledge, but lacks alignment on the necessary skills, as industry knowledge is more easily transferable. Stakeholders have echoed the importance of this strategic choice given the perception challenges that the sector faces.

Employers within the sector face numerous challenges as it pertains to growing and improving their workforce. The over reliance on foreign workers within the sector is a key concern of employers. The sector has heavily relied on TFW programs to facilitate its labour strategy.[362] During the COVID-19 pandemic, the sector witnessed a large disruption to this strategy and labour gaps were exacerbated by the travel restrictions in place creating an extensive impact on the food supply-chain. Additionally, the sector continually faces challenges with policies related to TFW as the application processes are complex.[363] This overreliance presents a major risk not only to the sector but to the broader Canadian economy as well. In certain circumstances, inexpensive foreign workers may pose a disincentive for investment in productivity enhancing machinery and equipment, and with it reduce the need and demand for upskilling.

Additionally, while stakeholders reported that a background in the sector is not necessarily mandatory, others have faced challenges integrating new hires from diverse professional backgrounds into the workforce culture. Stakeholders suggested that one way to overcome this challenge is through mentorship opportunities. Leveraging the expertise of experienced professionals within the industry to educate and mentor individuals can play a vital role in integrating newcomers and helping them feel like valued members of the community. Additionally, a mentorship approach may be vital to bringing in and closing the gap among underrepresented groups in the sector. For example, Statistics Canada reported that the employment loss for women in the sector was 2% higher when compared to men. It was also reported that the job recovery rate was continuing to lag for women, particularly for young women. [364]

Upskilling is also another solution to overcome this challenge. By developing programs that teach how to apply high-demand technical skills within the context of the agricultural sector, job seekers can enter new roles with the knowledge and skills needed to succeed.

This is also an opportunity for employers to shift their mindset from emphasizing culture fit to understanding the benefits that diverse experience can bring to their company. Employers should continue to mindfully recruit and retain talent from diverse talent pipelines, including from equity-deserving groups. As the labour market continues to tighten, and labour becomes more scarce,

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[362] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[363] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[364] Government of Canada, Empowering women leadership in the agriculture and agri-food sector, 2020

adopting these approaches to talent will become vitally important for those companies that wish to continue to grow.

## Challenges in Upskilling

It has been affirmed by stakeholders that there is a lack of awareness of the availability of jobs and opportunities that exist within the sector. Younger Canadians typically do not think of pursuing this sector as a career pathway. However, if they do, they likely will not broaden their search past farming.[365] To rectify this obstacle, it may be beneficial to incorporate more sector related topics into school curricula, including the sectors' role in the economy, and current issues surrounding food security and sustainability.[366]

Another challenge to upskilling is the lack of infrastructure available. The location for some sector related and food processing facilities tend to be in rural areas and not always easily accessible by current transportation options.[367] This lack of infrastructure can be a limiting factor in obtaining full access to the labour and talent pools available.[368]

# Implications to the Sector

If the sector does not properly address the labour and skills shortages, the implications are numerous. The lack of available labour may constrain farm growth, reduce productivity, and cause production delays leading to reduced sales and revenue.[369] Additionally, unfilled vacant positions result in producer's having to delay expansion plans due to lack of resources.[370] Lack of labour resources also creates negative knock-on effects by placing the work burden on a smaller pool of workers which can result into higher rates of burnout and increased turnover.[371,372] This would further enhance the current labour shortage and continue to hinder the sector's growth and innovation.

By not addressing the labour shortage, Canada also misses out on potentially becoming a leader in the global demand for food staples. Specifically, our potential leadership role ranging from protein products to field crops, food processing, and red meat industries may be constrained.[373]

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[365] CAHRC, National Workforce Strategic Plan for Agriculture and Food and Beverage Manufacturing, 2022
[366] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[367] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[368] Brock University, Systemic Barriers and Drivers to Technology Adoption in Canada: Lessons for Agri-Innovation in Ontario from Stakeholders of Canada's Global Innovation Clusters, 2022
[369] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[370] CAHRC, How Labour Challenges Will Shape the Future of Agriculture: Agriculture Forecast to 2029, 2019
[371] CAHRC, How Labour Challenges Will Shape the Future of Agriculture: Agriculture Forecast to 2029, 2019
[372] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[373] CAHRC, How Labour Challenges Will Shape the Future of Agriculture in Canada, 2021

# Opportunities

## Emerging Trends in the Sector Related to Skills and Occupations

This sector in Canada is experiencing several emerging trends, with changes that reflect consumer preferences, technological advancements, environmental concerns, and global market dynamics.

### Sustainable Agriculture

In recent years, there has been a growing trend towards sustainable agriculture practices and organic farming methods. Consumers are increasingly demanding environmentally friendly and ethically produced food. As a result, farmers and food producers in Canada are obliged to provide evidence of reduced chemical inputs, organic certifications as well as embracing regenerative agriculture to meet consumer expectations. The Government of Canada is proposing to develop a Sustainable Agriculture Strategy to further support this growing trend.[374] This strategy is aimed at providing an innovative and coordinated approach to improving this sector's environmental performance and supporting its long-term vitality. To further support this trend, there is also a five-year agreement (April 1, 2023 to March 31, 2028) between the federal, provincial and territorial governments of Canada to strengthen the competitiveness, innovation, and resiliency of the agriculture, agri-food and agri-based products sector: the Sustainable Canadian Agriculture Partnership (Sustainable CAP).[375] The Sustainable CAP is a new $3.5 billion agreement which includes $1 billion in federal programs and activities and $2.5 billion in cost-shared programs and activities funded by federal, provincial and territorial governments.[376]

This rise in sustainable agriculture has also led to a rise in popularity of plant-based diet and alternative forms of protein. The demand for alternative protein sources is transforming this sector. Total protein demand is expected to double to 943.5 million metric tons by 2054.[377] The market for alternative proteins is expected to grow at 14% annually by 2024.[378] Canadian companies are investing in R&D of plant-based protein products, such as meat substitutes and dairy alternatives. In Canada, sales of plant-based protein grew to $1.5 billion in the 2016/2017 fiscal year.[379] This trend presents opportunities for innovation, diversification, and the creation of new value-added products.

To add to this, pivoting towards sustainable agriculture, there is also a promotion of circular economy and reduced food waste in the sector. Efforts are being made to minimize post-harvest losses, improve supply chain efficiency, and divert food waste from landfills through innovative solutions. Initiatives such as surplus food redistribution, composting, and anaerobic digestion are gaining momentum to create a more sustainable and efficient food system.

### Food Transparency

With the population having greater concerns over the origin, sustainability, and safety of their food, there is a rising demand for transparency within this sector. To support these concerns, Health Canada has introduced a voluntary Transparency Initiative (TI) process for gene-edited plants developed for food use.[380] Further, there is also the Canadian Food Inspection Agency (CIFA). The CIFA works to protect Canadians from preventable health risks related to foods. To keep up with the digital technologies of the economy, CIFA continued to highlight digitization efforts to by

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[374] Government of Canada, Sustainable Agriculture Strategy: Discussion Document, 2023

[375] Government of Canada, Sustainable Canadian Agricultural Partnership, 2023

[376] Government of Canada, Sustainable Canadian Agricultural Partnership, 2023

[377] National Research Council Canada, Plant-based protein market: global and Canadian market analysis, 2022

[378] National Research Council Canada, Plant-based protein market: global and Canadian market analysis, 2022

[379] National Research Council Canada, Plant-based protein market: global and Canadian market analysis, 2022

[380] Government of Canada, Novel foods: Transparency initiative, 2022

increasing IT capacity and providing employees with the required skills and resources to adapt to a digital way of working. Technologies such as blockchain, QR codes, and digital platforms are being used to provide accurate and accessible information about the food supply chain.

### Digital technologies

The sector in Canada is witnessing a surge in innovation. Startups and established companies are developing technologies and solutions for smart farming, vertical farming, aquaculture, hydroponics, robotics, and AI applications in agriculture. New advancements in technology are proving to be transformative tools that are facilitating innovative industries within the sector. Some of these transformative technologies include:[381]

- AI

- Robotics

- Additive manufacturing

- Nanotechnology sensors

- Unmanned aerial vehicles

- Blockchain

- Big data analytics

- Controlled-environment agriculture

These new technologies are cultivating new techniques in the field. For example, within the field of food science, newly developed technology in cellular agriculture and genetics may enable the sector to create new protein products.[382] Digital technologies and precision agriculture are transforming farming practices in Canada. Farmers are adopting sensor-based monitoring systems, satellite imagery, drones, and data analytics to optimize resource use, improve crop yields, and reduce environmental impacts. Additionally, precision agriculture includes drones, global positioning systems and irrigation technologies. These technologies enable real-time decision-making, precision application of inputs, and efficient farm management. These innovations enhance productivity, resource efficiency, and sustainability while addressing the challenges of a growing population and changing climatic conditions.

## Upskilling Opportunities

### Delivery Opportunities

According to stakeholders, providing more hands-on opportunities may help to overcome barriers to skill development and drive interest in the sector.[383] Stakeholders have voiced implementing an apprenticeship model in high schools and post-secondary institutions. Doing so may aid in helping individuals with a transferrable skillset smoothly transitioning into the sector. Another recommendation that was proposed was bringing a case-study model to post-secondary institutions that would intentionally gather people from different backgrounds to solve a problem related to the sector. The goal of this would be to ignite interest in the field and demonstrate the different occupations and career pathways available within the sector.

### Partnership Opportunities

To help rectify gaps subsidy programs may prove helpful. The government has supported a program called the *Women Entrepreneur Program* to address this issue.[384] This program equips women with access to capital that is needed to help launch or grow their business, such as tools,

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[381] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[382] FACETS, A scoping review of the digital agricultural revolution and ecosystem services: implications for Canadian policy and research agendas, 2021
[383] CAHRC, Ontario Agriculture and Food Processing Skills and Occupation Gaps, 2021
[384] Government of Canada, Empowering women leadership in the agriculture and agri-food sector, 2020

resources, and mentorship.[385] In Canada, there are more than 75,000 women farm operators which represent approximately 28.7% of all farm operators nationally.[386] By fueling the entrepreneurial spirit of women in Canada's agriculture sector, the program is expected to increase this percentage. Using subsidies such as this for other underrepresented groups may further help to close labour gaps.

# Conclusion

The sector is vital to the Canadian economy. Yet critical challenges if left unaddressed will hamper the growth of the sector. Insights from our research and stakeholder consultations have emphasized the need for more upskilling and mentorship programs, increasing awareness of the intricacies of the sector, and hands-on learning opportunities, to help close occupation and skills gap. Currently, the sector must address gaps in key general occupations such as general labourer and transport truck drivers, as well as more specialized roles such as skilled trades, engineers, horticulturist, precision agronomist, industrial butchers, and veterinarians. In addition, business-oriented roles in management and leadership will also require attention to meet the growing demands of the future.

As the world population continues to grow, and along with it a growing demand for food, Canada has a unique opportunity to be a global leader in this area. Before the sector can reach its full potential, however, it must solve challenges relating to attracting and retaining domestic talent, barriers to technological adoption, insufficient infrastructure, and regulatory challenges. Closing the occupation and skills gap will be critical to addressing the rest of the barriers this sector faces and ensuring future success.

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[385] Government of Canada, Empowering women leadership in the agriculture and agri-food sector, 2020
[386] Government of Canada, Empowering women leadership in the agriculture and agri-food sector, 2020

# The Digital Sector

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CHAPTER 5

# Executive Summary

Deloitte has been engaged to support Palette Skills' leadership role related to the Industry Upskilling Initiative funded by Innovation, Science and Economic Development Canada (ISED). The purpose of Upskill Canada is to connect employers to qualified talent and help high potential untapped talent move into fast growing careers. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills for high-demand roles in six key sectors (digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, biomanufacturing). In this chapter we outline the challenges and catalysts associated with the development of the digital sector, with a focus in the sector's workforce. In this report, we define the digital sector, as the aggregation of the Information, Communication, and Technology (ICT) sector and digital occupations within other sectors. Per ISED's definition the digital sector refers to the production of goods or services, or supplying technologies, used to process, transmit and/or display data or information and create applications for vertical markets such as healthcare, education, finance, defence, the creative industries, and more. Digital technologies are electronic tools, systems, devices and resources that generate, store or process data (e.g., social media, online games, multimedia and mobile phones).[387] In terms determining the specific industries and occupations that comprise this sector, the analysis is based on the NAICS industries included by Statistics Canada in determining the ICT sector, plus a core set of digital occupations that are found in other industries in the economy apart from the ICT sector itself.

The ICT sector itself is a major contributor to the Canadian economy, creating pivotal economic growth and employment impacts. In 2022, the sector's real GDP was over $113 billion, and has been responsible for 14.9% of national GDP growth from 2016 to 2022. Employment growth within the sector has been continuously surpassing the overall economy for numerous years, employing more than 743 thousand individuals in 2021, and accounting for approximately 3.8% of total employment in Canada. The positive economic and employment contributions of the ICT sector impacts other sectors in Canada as well. In 2021, the Government of Canada estimated that for each direct job in the ICT sector, an additional 1.3 jobs were supported within the economy.[388] Additionally, for each $1 million of direct GDP that stemmed from the ICT sector, an additional $862,000 in GDP was produced for the overall Canadian economy.[389] As employment growth in the ICT sector continues to outpace that of the overall economy, there are still groups that are underrepresented within the sector such as women, and skilled new Canadians.

For the ICT sector to become more competitive and retain its advanced talent, it will need to overcome challenges such as rising foreign competition, rising salary pressures stemming from foreign competition, rapidly emerging technologies, and high monetary costs to learning. The sector will need to efficiently adapt and upskill as new technologies emerge, in order to lead the development, maintenance, and implementation throughout the economy. Additionally, the sector will need to retain highly skilled individuals to facilitate new developments and keep up with maintenance. Currently, some of the occupations facing the biggest shortages include data roles (e.g., data scientists, database analysts and administrators), computer programmers, information systems analysts, software and industrial engineers, user support technicians, UX/UI designers, and managers with technical and industry knowledge. The skills associated with these jobs are also identified as gaps within the sector. A further gap is the ever-growing need for business acumen and soft skills, which will need to work in tandem with existing technical knowledge to maximize the commercial potential of the sector.

The outcomes of our research and study are structured as follows: an overview of the sector, a summary of the labour and skills analysis, challenges, implications, and opportunities for the

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[387] Definition obtained from ISED
[388] Government of Canada, Canadian ICT Sector Profile 2021, 2022
[389] Government of Canada, Canadian ICT Sector Profile 2021, 2022

sector. To be of benefit to the broader training and workforce development ecosystem, the findings presented in this chapter reflect the wide-ranging needs of the sector. Some occupations listed or industry opportunities might be beyond Upskill Canada's scope. This might include skilled trades occupations and those requiring certification from a professional body. Eligibility for Upskill Canada funding will be dependent on identifying demand for jobs through direct employer engagement.

# Overview of the Sector

## The Digital Sector

The digital economy spans a variety of industries. Digital occupations can be found in diverse sectors such as advanced manufacturing, biomanufacturing, and cybersecurity. However, as seen in Figure 35, the core segment of the digital economy is the ICT sector. Due to the broad nature of the ICT sector, the Government of Canada has divided ICT into four subsectors: ICT manufacturing, software and computer services, communication services, and ICT wholesaling. Given Palette Skills' interest in upskilling for Canada's economy, it has directed Deloitte to focus analysis on the digital sector as a broad category, referring to the ICT sector as well as digital occupations ranging a variety of other sectors and industries. In this report, we define the digital sector, as the Digital, Information, Communication, and Technology (ICT) sector - **the production of goods or services, or supplying technologies, used to process, transmit and/or display data or information and create applications for vertical markets such as healthcare, education, finance, defence, the creative industries, and more. Digital technologies are electronic tools, systems, devices and resources that generate, store or process data (e.g., social media, online games, multimedia and mobile phones).[390]**

The ICT sector has remained a major contributor to the Canadian economy. In 2022, the sector's real GDP was over $113 billion, and has been responsible for 14.9% of national GDP growth from 2016 to 2022. Employment growth within the sector has been continuously surpassing the overall economy for numerous years, employing more than 743 thousand individuals in 2021, and accounting for approximately 3.8% of total employment in Canada. Overall, the GDP and employment contribution from the ICT sector in Canada has remained on an upward trajectory. In terms of the regional breakdown of employment, Ontario dominates the employment landscape, accounting for 47% of all ICT jobs in 2022. Quebec and the West maintained 23% and 26% of ICT jobs in 2022, respectively (See Figure 34).

This growth remained even during the COVID-19 pandemic and resulting recession. Unlike other industries, employment in the ICT sector accelerated during the COVID-19 pandemic. This can likely be attributed to two key factors. Firstly, the nature of the work, which for many of the occupations within the ICT sector can generally be considered 'low-contact' resulting in limited impact from pandemic measures. Secondly, the work from home environments placed an increasing demand on the ICT sector itself. Demand for online goods and services increased drastically. Further, this demand has continued even after pandemic measures were loosened and eventually removed.

The greatest dynamic component of the ICT sector is witnessed within software and computer systems industry, with a majority of companies being start-ups.[391] Ontario has the largest ICT start-up hub and entrepreneurial opportunities within the country.[392]

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[390] Definition obtained from ISED
[391] ISED, Canadian ICT Sector Profile 2021, 2021
[392] Conference Board of Canada, Innovation Report Card 2021, 2021

*Figure 32: ICT Sector Real GDP*

$Billions, cw 2012
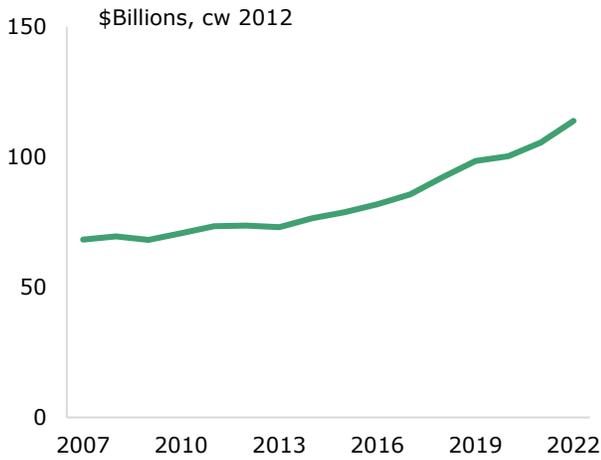


Source: Statistics Canada

*Figure 33: ICT Sector Employment*

Thousands
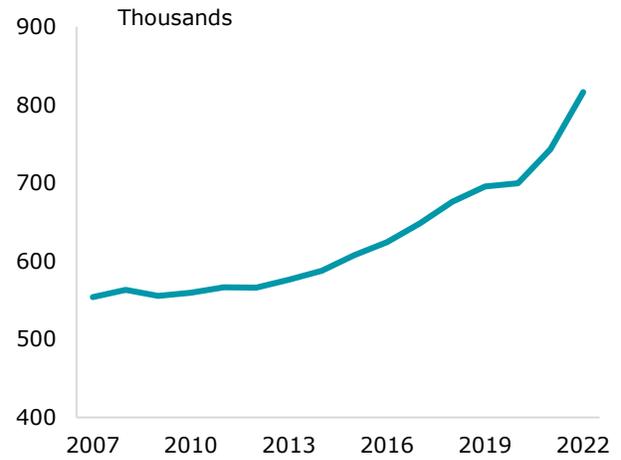


Source: Statistics Canada

*Figure 34: ICT Employment by Region in 2022*



■Atlantic ■Quebec ■Ontario ■West ■North
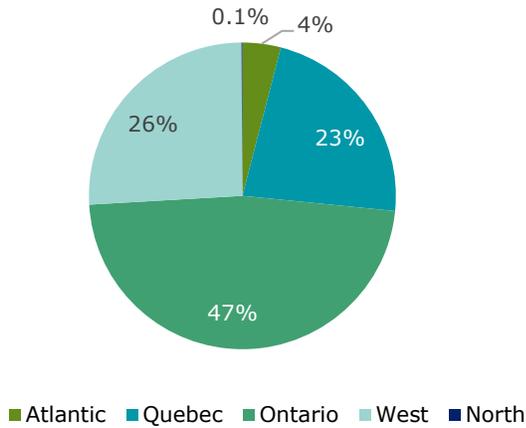
Source: Statistics Canada

*Figure 35: Employment in the Digital Economy in 2022*



■ICT Sector Employment
■Core ICT Occupations Outside ICT Sector
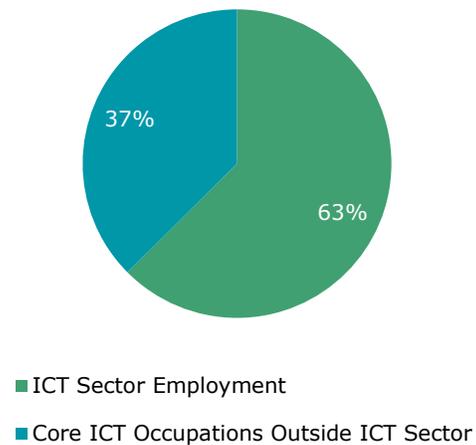
Source: Statistics Canada

## What Constitutes the Digital Sector?

The digitization of the Canadian economy has been on ongoing trend for several decades. While general observation can affirm this trend, measuring the actual size of the digital economy can prove difficult as there is no set categorization or standard for identifying the industries or occupations that would constitute the digital sector.

The approach taken in this study is to utilize Statistics Canada's definition of the ICT sector as the standard for the core set of industries within the digital economy. These industries reflect those firms whose primary products or services sold are digital in nature. Beyond this, a core set

of digital occupations are then identified (e.g., software engineers and designers, software developers and programmers, etc.) and are used to assess the level of digital employment across other sectors and industries of the economy outside of Statistics Canada's ICT sector. The occupations reflect the digital function maintained by industries outside the ICT sector. (See **Appendix A** for a complete list of industries within the ICT sector, and the list of core digital occupations within other industries of the economy outside the ICT sector).[393]

Hence, the digital economy includes the overall ICT sector as well as digital occupations within other industries. While there are firms whose primary functions fall into the ICT sector, there are a variety of digital occupations and roles dispersed throughout the economy (aiding in the makeup of the digital economy). As such, measuring the digital economy requires an assessment of both the ICT sector as well as all the digital jobs within various industries.

While the ICT sector is a large component of the digital economy – in 2022 63% share of the employment – a large portion of employment within the digital economy occurred outside the scope of the ICT sector (See Figure 35). The degree to which these other industries have adopted a digital workforce does indeed vary. For instance, industries employing the fewest ICT professionals were agriculture, forestry, fishing & hunting; management of companies and enterprises; and accommodation & food services. These industries collectively employed less than 1% of ICT professionals in Canada.

An outstanding question remains as to whether the large employment increase in the ICT sector and digital economy experienced during the pandemic is likely to persist as part of a new normal, or simply a temporary phenomenon. There is some evidence that some degree of labour hoarding did occur during the pandemic, especially with many ICT firms in Silicon Valley engaging in a hiring spree during this period. As recent labour market conditions in this area have returned to normal, it has consequently led to some employment restructuring in some of these firms. Nevertheless, stakeholder consultations indicated that despite recent labour restructuring efforts at these firms, the outlook for the digital sector within Canada remains strong, with its upward trend expected to continue in the near and long-term future.

## Palette Skills' Activities in the Sector

Palette Skills has been working with the digital sector since 2017. When Canada's technology sales sector was facing a talent shortage, Palette Skills used this opportunity to test the approach to upskilling. Palette Skills partnered with employers seeking new employees and developed unique, industry-led, short-burst upskilling programs that helped move talent from hospitality and retail, into lucrative jobs with high-growth firms. Palette Skills started by researching the sales talent challenge in tech, hosting roundtables with fast-growing, innovation-focused startups and scale-ups to understand their talent needs and how they address them.

Palette Skills launched their Business-to-Business (B2B) Tech Sales program, aimed at those looking to break into the tech industry. First launched in 2019 as an experiment, over the past four years, Palette Skills has delivered 33 cohorts in both Ontario and BC, engaging nearly 200 employers and upskilling over 500 job seekers. The program highlights the future career opportunities that can be built through strengthening transferable skills such as research abilities, communication, and collaboration skills, while gaining background knowledge of the ICT sector.[394]

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[393] Various organizations have established their own standard for what should constitute the digital or ICT sector. In some cases, the alternative standard can provide a broader and larger estimate of the sector. The approach taken in this report is to align with Statistics Canada's standard, so as to help facilitate the tracking and monitoring of sector progress over time.
[394] Palette Skills, SalesCamp: B2B Tech Sales Training, n.d.

This is done through exposure to the industry and soft skill development with a focus on relationship building.

This model of upskilling is applicable across sectors. For example, in Canada today, many traditional industries are digitizing, meaning many workers are having to learn new skills related to cloud computing, data analysis, and digital automation in order to move into a new job.

## Key Challenges

Although the ICT sector was not adversely affected by the COVID-19 global pandemic[395], the sector and digital economy face different challenges stemming from foreign competition and competitive market environments. The rapid development of emerging technologies, high monetary costs to learning, rising salary pressures from foreign competition, and a lack of diversity contribute to barriers in growth and upskilling within the Canadian digital economy.

**Industry Perspective**

In recent years, businesses have witnessed a remarkable increase in their dependency on digital solutions. The rapid advancements in technology, coupled with the ever-growing digital landscape, have created a compelling need for businesses to embrace and leverage digital solutions across various aspects of their operations. Digital solutions enable businesses to reach wider audiences, expand their market reach, and remain competitive in today's fast-paced, digitally driven economy. As a result, businesses across industries are increasingly investing in and relying on digital solutions to streamline their operations, deliver innovative products and services, and stay ahead in a rapidly evolving business landscape.
This digitalization of the industrial landscape is having a broader upskilling impact in various sectors as companies are looking to streamline roles and processes to find the most efficient way to utilize emerging technologies, such as AI.

## Policy Context

The Canadian policy context regarding the digital economy is shaped by various programs and funding initiatives to support the growth and sustained success of this sector. This includes investments in R&D of emerging technologies as well as attracting and retaining skills and talent. Additionally, Canada has made numerous efforts to enhance its digital infrastructure to aid in bridging the digital divide across the country. One major investment is in improved broadband connectivity across the country. The government has set targets to improve connectivity in rural and remote areas across the country, aiding and improving the infrastructure for the digital economy.

With improved and increased reliance on technology, there has been a recognition of the importance of digital skills for both businesses as well as individuals. This has resulted in various skill-based programs, including digital literacy and trainings, being implemented in workplaces as well as in more traditional educational institutions. Additionally, promoting digital skills in the workplace has also resulted in Canada trying to attract global talent to aid in improving the digital economy. Canada has various immigration programs at both the federal and provincial levels with the goal of attracting global talent both permanently and temporarily to Canada. An example of such is the TFW program that prioritizes the immigration of highly skilled workers in in-demand

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[395] The Information and Communications Technology Council, Onwards and Upwards – Digital Talent Outlook 2025, 2021

occupations across the country.[396] At the provincial level in particular, Ontario, Alberta, and British Columbia had introduced pilot immigration programs that focused on tech professionals to meet their digital skills needs.[397]

A C.D. Howe Institute study has indicated though that there is still opportunity for Canada to further increase the supply of new Canadians to close labour gaps that the domestic supply has been unable to fill.[398] Barriers surrounding the recognition of foreign credentials and experience may need to be addressed to ensure a smoother transition into the labour market for new Canadians with skills in-demand industries.

Additionally, Canada has been actively engaged in international trade agreements, aimed at promoting digital trade and protecting intellectual property (IP) rights. An example is the Canada-United States-Mexico Agreement, which includes specific digital trade as well as IP chapter provisions in the agreement.[399]

Policies such as these aim at supporting initiatives that foster a thriving digital economy and positioning Canada as a leader in the digital era. Sustained efforts to improve and grow the digital economy could unlock significant economic opportunities for Canada. However, there will need to be a focus on upskilling and retaining the required talent to adequately address labour gaps, including underrepresented groups, incentivizing upskilling, and establishing career development pathways.

## Emerging Trends

The emergence of Industry 4.0 brings new technologies to the market, such as AI, machine learning, cloud computing, big data and analytics, and the IoT. These technologies have transformed the way multiple sectors operate. There has been an especially large focus on how AI will transform occupations – whether by displacing individuals, changing the duties of certain roles, or creating new occupations. A study by the World Economic Forum predicts that AI will result in a net increase of 58 million jobs globally.[400] According to our research and stakeholder consultations, AI may be more additive rather than a means of replacement for roles, as we may see some occupations affected by AI shift towards more human-centric duties.

## The Potential Future of the Sector

The COVID-19 pandemic caused a permanent and expedited digital shift. ICT sector employment is now forecasted to grow at an annual rate of 2.22% compared to 1.97% of the general economy from 2021 to 2025.[401] However, we have yet to see the full impacts of this digital shift and the influence of emerging technologies along with the new challenges to be solved with them. It is important to build systems that are adaptable to the changing environment within the industry. For example, the rise of prompt engineering and ethical AI are increasingly essential as AI is being integrated into more sectors and occupations. Prompt engineering "involves selecting the right words, phrases, symbols, and formats that guide the model in generating high-quality and relevant texts".[402] Given the fast-paced nature of innovation within this sphere, stakeholders have highlighted the importance of having open lines of communication across the sector as well as with educational institutions and training programs to keep informed as to what skills are needed on an ongoing basis and to ensure individuals are ready for the future.

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[396] Government of Canada, Temporary Foreign Worker, 2023
[397] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[398] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[399] Government of Canada, The CUSMA agreement and related texts, 2022
[400] World Economic Forum, Here's why robots are actually going to increase human employment, 2021
[401] The Information and Communications Technology Council, Onwards and Upwards – Digital Talent Outlook 2025, 2021
[402] Microsoft, What are Prompts?, 2023

## Implications to the Sector

Retaining digitally skilled individuals within the Canadian ICT sector as well as attracting digital skills to other sectors of the Canadian economy remains a key challenge. Attractiveness of other leading ICT jurisdictions (e.g., Silicon Valley) has resulted in a brain drain, which is impacting more than just the ICT sector. This in turn has caused a shortage of skilled ICT talent in the domestic technology sector presenting a major issue hampering the growth of innovative companies in Canada.[403,404,405] These implications will continue to grow as emerging technology is introduced at an accelerated pace and foreign competition remains fierce.

# Sector Labour Market and Occupations/Skills Analysis

### Overview of Job Supply and Demand

The digital economy, including the ICT sector, is largely impacted by the supply and demand of skilled workers. In a survey undertaken by Information and Communications Technology Council (ICTC), more than 53% of organizations cited attracting and retaining skilled employees as one of their top human capital challenges.[406] Some key supply factors impacting labour shortage include competitive market challenges such as rising salary pressures from foreign competition as well as the rapid growth of emerging technologies resulting in a new advanced skillset required to keep up in this everchanging digital economy. A survey by KPMG, found that approximately 70% of small and medium sized business owners are finding it difficult to hire workers with the advanced digital skills that their companies need to grow.[407]

With the growth of Industry 4.0 coupled with the accelerating competition for talent, an aging population and increasing retirements, there exists significant demand for employment in the digital economy, including the ICT sector.[408] This has resulted in rising competition between the Canadian digital sector and with foreign competitors for domestic talent. A survey, based on Canadian LinkedIn profiles of STEM graduates, from 2015 and 2016 who attended Universities of Toronto, Waterloo, and British Columbia, found that many graduates working in the ICT sector have left for the US after graduation.[409] Additionally, a report done by Lindzon and Bergen has found that the ability to work remotely, adopted during the COVID-19 pandemic, has enabled foreign employers to recruit and hire Canadian talent more seamlessly without them having to relocate.[410] This is further exacerbated by the very competitive salaries offered by ICT firms in the US. These challenges have resulted in a brain drain in the digital economy in Canada.

Without adequate policy intervention to aid with foreign competition for employees, the overall labour shortage gap will likely continue to increase. According to the Canadian Occupational Projection System (COPS) dataset, the only key occupations within the ICT sector that are oversupplied are Data Entry Clerks and related occupations. This speaks to the rise of various AI software that may slowly phase out manual entry jobs. The section below identifies the key occupations, occupation gaps, and future occupations in the digital economy, including the ICT

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[403] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[404] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[405] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[406] Information and Communications Technology Council, Road to 2020 and Beyond, 2016
[407] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[408] Information and Communications Technology Council, Road to 2020 and Beyond, 2016
[409] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[410] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022

sector. Similarly, we look to identify the key skills, skill gaps, and future skills that will be needed for the success of the ICT sector as well as the Canadian digital economy.

## Occupations

### Key Occupations

For the ICT sector and the overall digital economy, key roles range from basic administrative roles to advanced roles such as software engineer, data scientist, and product manager. The rapid evolution of technology coupled with retirements and other labour exits will affect some occupations more than others. The occupations impacted will include information systems analysts, computer and network operators, computer programmers, software engineers, and database analysts and administrators.[411] The demand for digitally intensive middle-skilled jobs is also increasing.[412,413] This signals a shift towards a higher digital skillset required amongst middle-skilled jobs. Overall, the demand for these key occupations are fairly consistent across all regions of Canada.

Through our research and stakeholder consultations, the following occupations were identified as being key to the sector's growth and competitiveness:[414,415,416,417]

| Key Occupations | Top Associated Skills[418] |
|---|---|
| Aerospace engineer | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Back-end developer | • *Digital Literacy*<br>• *Digital Production*<br>• *Critical Thinking* |
| Computer and information systems manager | • Decision Making<br>• Evaluation<br>• Management of Material Resources |
| Computer and network operators | • Preventative Maintenance<br>• Troubleshooting<br>• Equipment and Tool Selection |
| Computer programmer | • Digital Literacy<br>• Digital Production<br>• Troubleshooting |

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[411] Information and Communications Technology Council, Road to 2020 and Beyond, 2016

[412] Jobs requiring more than secondary school but less than a bachelor's degree.

[413] Information and Communications Technology Council, Skills in the Digital Economy: Where Canada Stands and the Way Forward, 2016

[414] Future Skills Centre, Bridging the Digital Skills Gap, 2020

[415] The Information and Communications Technology Council, Road to 2020 and Beyond, 2016

[416] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022

[417] The Information and Communications Technology Council, Onwards and Upwards – Digital Talent Outlook 2025, 2021

[418] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Key Occupations | Top Associated Skills[418] |
|---|---|
| Data engineer | • Digital Literacy<br>• Numeracy<br>• Systems Analysis |
| Data scientist | • Digital Literacy<br>• Numeracy<br>• Systems Analysis |
| Database analysts and administrators | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| DevOps engineer | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Front-end developer | • *Digital Literacy*<br>• *Digital Production*<br>• *Critical Thinking* |
| Full-stack developer | • *Digital Literacy*<br>• *Digital Production*<br>• *Critical Thinking* |
| Industrial engineer | • Decision Making<br>• Evaluation<br>• Monitoring |
| Information systems analyst | • Evaluation<br>• Troubleshooting<br>• Critical Thinking |
| Managers and supervisors with technical and business knowledge | • *Decision Making*<br>• *Evaluation*<br>• *Management of Material Resources* |
| Mechanical engineer | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Product manager | • *Coordinating*<br>• *Critical Thinking*<br>• *Decision Making* |
| Prompt engineer | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Revenue operations manager/director | • *Evaluation*<br>• *Management of Financial Resources*<br>• *Management of Personnel Resources* |

| Key Occupations | Top Associated Skills[418] |
|---|---|
| Software engineer | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| Technical producer[419] | • *Creativity*<br>• *Adaptability and Perseverance*<br>• *Critical Thinking* |
| User support technicians | • Oral Communication: Active Listening<br>• Repairing<br>• Troubleshooting |
| UX/UI designer | • *Digital Literacy*<br>• *Evaluation*<br>• *Learning and Teaching Strategies* |
| Web designers | • Digital Literacy<br>• Evaluation<br>• Learning and Teaching Strategies |
| Web developer | • Digital Literacy<br>• Digital Production<br>• Critical Thinking |

## Occupation Gaps

Occupation gaps are a growing challenge in the ICT sector as well as in the digital economy as a whole. Although the COVID-19 pandemic has rapidly increased the demand for digital occupations and skills, those that possess them tend to stay within the ICT sector, creating a gap in other sectors requiring advanced digital skills.

Through our research, potential causal factors identified for the occupational shortage include a lack of representation of women and skilled new Canadians, increases in retirement, rapid technological advancement, rising salary pressures from domestic and foreign competition, and high monetary costs to learning limiting potential graduates that could be entering the labour force.

Through our research and stakeholder consultations, the following occupations gaps were identified: [420,421,422,423,424,425]

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[419] The corresponding occupation and alternatives are not available in the in the Occupational and Skills Information System (OaSIS). We obtained the top skills from the Alberta Alis website.
[420] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[421] The Information and Communications Technology Council, Road to 2020 and Beyond, 2016
[422] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[423] The Information and Communications Technology Council, Onwards and Upwards – Digital Talent Outlook 2025, 2021
[424] Lightcast, 2023
[425] Sudbury and Manitoulin – Workforce Planning, An Occupation Overview of the Digital Economy: The Information, Communications Technology (ICT) Workforce, 2018

| Occupation Gaps | Top Associated Skills[426] |
| --- | --- |
| Computer and information systems manager | • Decision Making<br>• Evaluation<br>• Management of Material Resources |
| Computer programmer | • Digital Literacy<br>• Digital Production<br>• Troubleshooting |
| Data scientist | • Digital Literacy<br>• Numeracy<br>• Systems Analysis |
| Database analysts and administrators | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Industrial engineer | • Decision Making<br>• Evaluation<br>• Monitoring |
| Information systems analyst | • Evaluation<br>• Troubleshooting<br>• Critical Thinking |
| Managers and supervisors with technical and business knowledge | • *Decision Making*<br>• *Evaluation*<br>• *Management of Material Resources* |
| Software engineer | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| User support technicians | • Oral Communication: Active Listening<br>• Repairing<br>• Troubleshooting |
| UX/UI designer | • *Digital Literacy*<br>• *Evaluation*<br>• *Learning and Teaching Strategies* |

### Future Occupations

It is important to not only address current occupation gaps but also to accurately identify future occupations that come with Industry 4.0. As emerging technologies are rapidly evolving, it is difficult to pinpoint exactly what occupations will exist. However, we can infer those digital skills, such as cognitive computing, general IT, and computer science, will continue to be in demand in the future, and may be the most pressing skills shortages over the next few years.[427]

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[426] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.
[427] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022

Through our research and stakeholder consultations, the following occupations were identified as increasingly important in the future:[428,429,430,431,432,433]

| Future Occupation | Top Associated Skills[434] |
|---|---|
| Aerospace engineer | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Application tester | • *Quality Control Testing*<br>• *Evaluation*<br>• *Numeracy* |
| Application testing technician | • *Quality Control Testing*<br>• *Evaluation*<br>• *Numeracy* |
| Computer programmers | • Digital Literacy<br>• Digital Production<br>• Troubleshooting |
| Data analyst | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Data engineer | • *Digital Literacy*<br>• *Numeracy*<br>• *Systems Analysis* |
| Data scientist | • Digital Literacy<br>• Numeracy<br>• Systems Analysis |
| DevOps engineer | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Industrial engineer | • Decision Making<br>• Evaluation<br>• Monitoring |

[428] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[429] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[430] The Information and Communications Technology Council, Road to 2020 and Beyond, 2016
[431] The Information and Communications Technology Council, Onwards and Upwards – Digital Talent Outlook 2025, 2021
[432] Lightcast, 2023
[433] Deloitte Future of Canada Centre, Catalyst: Canada at 2030, 2020
[434] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Future Occupation | Top Associated Skills[434] |
|---|---|
| Information systems testing technician | • Evaluation<br>• Troubleshooting<br>• Critical Thinking |
| IT support | • *Critical Thinking*<br>• *Decision Making*<br>• *Digital Literacy* |
| Maintenance support | • *Preventative Maintenance*<br>• *Quality Control Testing*<br>• *Repairing* |
| Managers and supervisors with technical and business knowledge | • *Decision Making*<br>• *Evaluation*<br>• *Management of Material Resources* |
| Software publisher | • *Digital Literacy*<br>• *Digital Production*<br>• *Evaluation* |
| Software test coordinator | • *Evaluation*<br>• *Troubleshooting*<br>• *Critical Thinking* |
| Software testing technician | • *Evaluation*<br>• *Troubleshooting*<br>• *Critical Thinking* |
| Systems tester | • *Evaluation*<br>• *Troubleshooting*<br>• *Critical Thinking* |
| User acceptance tester | • *Oral Communication: Active Listening*<br>• *Repairing*<br>• *Troubleshooting* |

# Skills

## Key Skills

In the same light as key occupations the demand for key skills in the ICT sector and digital economy seem to be fairly consistent across regions in Canada. As the digital economy is rapidly evolving, employers are less focused on specific occupations and more focused on skills and competencies required.[435] This is important to note as employers in various sectors are looking for a blend of digital and non-digital skills to be able to adapt to the growth of innovative companies in Canada.[436]

Through our research and stakeholder consultations, the following skills were identified as being key to the sector's growth and competitiveness:[437,438,439,440,441,442,443]

| Key Skills | |
| --- | --- |
| **Technical Skills**<br>• Digital Production<br>  – Cloud-based skills<br>  – Solution design<br>  – Machine Learning<br>  – AI<br>  – IT security<br>  – Database administration<br>  – Software engineering<br>  – Coding and programming<br>    • Proficiency with tools such as:  Java; JavaScript; Python; SQL; C++; HTML; React.js; Microsoft Azure; Git; R; Tableau; Kubernetes; Android; Linux<br>  – Blockchain<br><br>**Analytical Skills**<br>• Data modeling and visualization | **Foundational Skills**<br>• Email<br>• Word processing<br>• Spreadsheets<br>• Numeracy<br>• Literacy<br><br>**Resource Management Skills**<br>• Sales skills<br>• Finance skills<br>• Marketing skills<br>• Human resource development skills<br><br>**Abilities**<br>• Decision making<br>• Critical thinking<br>• Adaptability and change management<br>• Communication<br><br>**Personal Attributes**<br>• Interpersonal skills |

## Skill Gaps

Although there are many who work in advanced technology occupations, they often lack the skills needed to transfer their expertise to other in-demand positions. For example, a study by Patacsil and Tablatin found that soft skills such as teamwork and communication are very important for IT employers and students. While hard skills were perceived by the industry as somewhat

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[435] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[436] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[437] The Information and Communications Technology Council, Digital Economy Annual Review 2020, 2020
[438] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[439] ICTC, Skills in the Digital Economy: Where Canada Stands and the Way Forward, 2016
[440] ICTC, Digital Talent: Road to 2020 and Beyond, 2016
[441] ICTC, Onwards and Upwards – Digital Talent Outlook 2025, 2021
[442] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[443] Technation, Career Finder Landing Page, n.d.

important.[444] This highlights the lost opportunity of solely focusing on advanced technology skills while overlooking essential non-digital skills. In terms of industry demand for digital skills across the economy, skills gaps are reported by major sectors of the economy including manufacturing, health care, professional, scientific, technical services, and financial industries.[445] As collaboration continues to increase between the ICT sector and other digital areas within the economy, the ability to work effectively with converging skillsets will be critical for success.[446]

**Industry Perspective**

Stakeholders highlighted the importance of business and soft skills now and in the future. It is not enough to just have strong technical skills. They voiced how finding high quality individuals that know how to problem-solve and develop solutions, and commercialize products are essential to the success and growth of their businesses. It was emphasized that these skills are missing and will be critical when hiring.

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[444]F. Patacsil, C. Tablatin, Exploring the Importance of Soft and Hard Skills as Perceived by IT Internship Students and Industry: A Gap Analysis, 2017
[445] The Information and Communications Technology Council, Skills in the Digital Economy, 2016
[446] Future Skills Centre, Bridging the Digital Skills Gap, 2020

Through our research and stakeholder consultations, the following skills gaps were identified:[447,448,449,450,451,452,453,454]

| Skill Gaps | |
|---|---|
| **Technical Skills**<br>• Digital Production<br>  – Cloud Technology<br>  – Machine Learning<br>  – AI<br>  – Automation<br>  – IT security<br>  – Database administration<br>  – Software engineering<br>  – Data warehousing<br>  – Data analysis<br>  – Coding and programming<br>    • Proficiency with tools such as: Java; JavaScript; Python; SQL; C++; HTML; React.js; Microsoft Azure; Git; R; Tableau; Kubernetes; Android; Linux<br>  – Blockchain<br><br>**Analytical Skills**<br>• Data modeling and visualization<br><br>**Foundational Skills**<br>• Email<br>• Word processing<br>• Spreadsheets<br>• Numeracy<br>• Literacy | **Resource Management Skills**<br>• HR development skills<br>• Sales skills<br>• Finance skills<br>• Marketing skills<br><br>**Abilities**<br>• Critical thinking<br>• Adaptability and change management<br>• Communication<br>• Problem solving in digital environments<br><br>**Personal Attributes**<br>• Interpersonal skills<br><br>**Knowledge**<br>• Product management<br>• Project management<br>• Agile methodology |

## Future Skills

As technologies continue to evolve worldwide, digital skills are going to be increasingly essential. A survey conducted by the Canadian Council of Chief Executives found that engineering, IT, general business and skilled trades are in demand occupations in which finding skilled talent is difficult and is expected to become increasingly more so over time.[455]

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[447] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[448] ICTC, Skills in the Digital Economy: Where Canada Stands and the Way Forward, 2016
[449] ICTC, Digital Talent: Road to 2020 and Beyond, 2016
[450] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[451] Deloitte Canada, Catalyst - Future of Canada Centre, 2020
[452] ICTC, Onwards and Upwards – Digital Talent Outlook 2025, 2021
[453] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[454] Technation, Career Finder Landing Page, n.d.
[455] The Information and Communications Technology Council, Skills in the Digital Economy, 2016

Through our research and stakeholder consultations, the following skills were identified as increasingly important in the future: [456,457,458,459,460,461]

| Future Skills | |
| --- | --- |
| **Technical Skills**<br>• Digital Production<br>  – Cloud-based skills<br>  – Solution design<br>  – Machine learning<br>  – AI<br>  – Cognitive computing<br>  – Computer science<br>  – Software engineering<br>  – Coding and programming<br>    • Proficiency with tools such as: Java; JavaScript; Python; SQL; C++; HTML; React.js; Microsoft Azure; Git; R; Tableau; Kubernetes; Android; Linux<br>  – Blockchain | **Resource Management Skills**<br>• Finance skills<br>• Marketing skills<br>• Human resource development skills<br>• Customer service skills<br><br>**Interpersonal Skills**<br>• Leadership skills<br><br>**Knowledge**<br>• Administration skills<br><br>**Abilities**<br>• Decision making<br>• Judgement<br>• Communication |

**Industry Perspective**

Stakeholders have highlighted the growing skillset needed for immersive reality. Immersive reality will likely be adopted across various industries in the future. Currently, it is a tool used for training purposes, such as for airplane pilot training.[464] However, as this tool becomes more commonly integrated, its use cases will expand.

[456] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[457] ICTC, Skills in the Digital Economy: Where Canada Stands and the Way Forward, 2016
[458] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[459] Deloitte Canada, Catalyst - Future of Canada Centre, 2020
[460] ICTC, Onwards and Upwards – Digital Talent Outlook 2025, 2021
[461] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[462] Oh, Chang-Geun, Pros and Cons of A VR-based Flight Training Simulator; Empirical Evaluations by Student and Instructor Pilots. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 2020

# Challenges and Barriers to Upskilling

## Key Employer Challenges

Employers in the digital economy face several challenges around upskilling and retaining their workforce. Competitive market challenges and foreign competition have largely increased the demand for digital skills across sectors and economies, creating increased competition for talent. To remain competitive and retain talent that possess the requisite skills, employers will need to offer higher wages to attract workers.[465] However, this is not possible for every sector or ICT employer in the country, resulting in varied salaries and a brain drain.[466,467,468] This is discussed further on page 141.

In addition to the challenges of offering a very competitive salary, stakeholders have echoed concerns regarding how to maintain a positive work culture experience. As there has been a shift to a remote working environment as well as regulations that enable individuals to work cross-border, there is concern about how to cultivate an enjoyable employee experience. This is important as a positive work culture may be an enabling factor to retaining highly skilled individuals and further facilitating collaboration.

## Key Employee Challenges

Through our research and stakeholder consultations it has been identified that emerging technologies such as blockchain, AI, and the cloud are rapidly evolving the workforce and are bringing the need for new in tandem skills. This fast-paced innovation poses a challenge to employees to remain knowledgeable and quickly adapt to the advancements in technology. Stakeholders have reported that although employees have credentials, they need to consistently be re-educating and upskilling themselves on skills such as:

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[463] Microsoft, What are Prompts?, 2023
[464] Harvard Business Review, A Practical Guide to Building Ethical AI, 2020
[465] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[466] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[467] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[468] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022

- Knowledge skills: coding, design, or analytics skills;

- Soft skills: collaboration, communicate, emotional intelligence; and

- Industrial context skills: an understanding as to how industry specific skills and knowledge is important.

Despite this demand for internal upskilling, it is difficult to identify the specific digital skills that are required for each distinct role to remain competitive and knowledgeable for the future.[469] Adaptability and transferability in skills will be necessary to keep up with emerging technological trends.

Additionally, our research and stakeholder consultations have found that high-monetary costs to learning may be another barrier for employees when it comes to upskilling. As socioeconomic status can limit access to educational infrastructure, a certain percentile of the population may be at a disadvantage to upskilling opportunities despite the capabilities and potential they may possess.[470] Due to challenges and implications such as this, stakeholders have echoed the desire to move away from requiring credentials and instead focusing on capabilities and transferable skills, as it may also facilitate further career pathways for individuals in the sector.

Another challenge that employees face is the underrepresentation of equity-deserving groups within the digital economy, particularly the ICT sector. In September of 2021, approximately 28% of ICT workers were women. This is concerningly low as women make up approximately 48% of the overall labour force in Canada.[471] Additionally, women in STEM tend to be paid less than men. As such, the ICT sector falls short in its ability to attract and retain highly qualified women.[472] More than 52% of women leave STEM related jobs, with the highest number of exits occurring in the ICT sector at 56%.[473] They are also less likely to return to a STEM field compared to women in other sectors.[474]

Further exacerbating employee challenges is the difficulty of skilled new Canadians in finding adequate jobs. Highly skilled new Canadians are often unable to pivot from low paying jobs partially because foreign credentials and job experience are not adequately valued in Canada.[475,476] The underemployment of equity-deserving groups signals an inefficiency in recruitment and retention of the industry. As these barriers persist, the labour and skills gap shortage will likely continue to compound.

## Challenges in Upskilling

Stakeholders have emphasized the transition from the classroom to being on the job as a challenge faced in upskilling. Within the ICT sector, firms tend to work with legacy code or build their own. This differs from the traditional coding programs learned in school. Stakeholders highlighted that throughout this transition of school to workplace, it is important to have the right transferrable skills, as well as a passionate mindset to continue to learn in the everchanging environment.

Additionally, a challenge that has been communicated is that skills of recent graduates may be mismatched to meet the legacy technology that some Canadian firms still presently use.[477] As long as these firms are continuing to depend on this legacy technology, the further they risk falling

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[469] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[470] UNESCO, Socioeconomic inequalities and learning, 2021
[471] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[472] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[473] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[474] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[475] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[476] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[477] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022

behind in the overall growth and innovation opportunities within the sector.[478] To rectify this challenge, focus is needed on modernizing technology rather than teaching new workers how to operate old technology.[479]

A large barrier that individuals in the digital economy, particularly the ICT sector, experience is the need for five or more years of work experience regardless of skill level. As emerging technologies continue to disrupt and evolve current processes, stakeholders have voiced the desire to move away from a four-year degree program requirement during hiring and instead focus on capabilities related to the work. Doing so may introduce a more diverse pool of talent for business to choose.

# Implications to the Sector

By not addressing the current challenges, the sector will continue to be affected by the "brain drain".[480,481,482] Research from the C.D. Howe Institute has found that there is an outflow of both Canadian-born and foreign-born Canadian residents to other countries, particularly the US, seeking better employment opportunities which would include higher salaries, greater firm reputation, and preferred scope of work.[483,484] This may result in loss of top talent, and increases the risk of skills shortages in certain sectors, including ICT.[485]

There is also a cost of not having the skillset to properly utilize technology to its full potential. Stakeholders have stated that not having a sufficient skillset may lead to a reduced return on investment on technological adoption. Additionally, the shortage of skilled digital workers is a large barrier that hinders the growth and innovation of Canadian firms and sectors.[486] Traditional industries such as manufacturing, health care, professional, scientific, and technical services, and financial industries are most impacted as there is a large demand for digital skills in these sectors.[487] A prime example echoed by stakeholders was the gaming industry. As this industry continues to grow rapidly, there is an increased demand for highly trained software engineers and programmers. Digital skills shortages have impeded the growth of this industry.[488] Overall, digital skills shortages may lead to Canada falling behind on the global stage in some sectors as they do not have the advanced skills needed to succeed.

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[478] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[479] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[480] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[481] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[482] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022
[483] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[484] Brock University, Reversing the Brain Drain: Where is Canadian STEM Talent Going?, 2018
[485] Brock University, Reversing the Brain Drain: Where is Canadian STEM Talent Going?, 2018
[486] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[487] Future Skills Centre, Bridging the Digital Skills Gap, 2020
[488] The Conference Board of Canada, Digital Skills for Today and Tomorrow, 2022

# Opportunities

## Emerging Trends in the Sector Related to Skills and Occupations

The digital economy is constantly evolving, with various new trends and emerging technologies. These changes are impacting and shifting business and consumer behaviours. For companies to stay competitive in the digital landscape, they need to be aware and adaptable to new technologies.

### E-Commerce

A change that became prevalent during the COVID-19 pandemic was the over reliance on e-commerce and online marketplaces. In 2022, there were over 27 million e-commerce users in Canada, accounting for approximately 75% of the Canadian population.[489] E-commerce sales have been at a record high since the COVID-19 pandemic, reaching United States Dollar (USD) $2.34 billion sales in March of 2022.[490] This number is expected to reach USD $40.3 billion by 2025.[491] In an effort to stay competitive and reach consumers dispersed across Canada, and at times the world, retailers are having to invest in digital platforms. This trend gives rise to tech-savvy skills that majority of companies now need. This includes setting up a digital interface and e-commerce site, as well as the continued maintenance of it. Additionally, digital marketing and social media skills are also required to keep up with rising internet penetration rates. Businesses are needing to spend more on digital promotion than ever before.

### Cybersecurity

With the rise of e-commerce, online payments have also become the norm. This taps into the ever-emerging trend of cybersecurity and data privacy. As digital transactions and data collection increase so does the importance of data privacy and cybersecurity. Emerging trends include stricter regulations, enhanced encryption, biometric authentication, and privacy-focused technologies. Additionally, cyberattacks have increased drastically in the past few years, with most companies at risk and needing proactive protection measures. This will require a workforce transformation in each company's "IT" department. Safeguarding against attacks is at the forefront of digital protection.

### AI and Machine Learning

The development of AI and machine learning has been a new development affecting the global labour force. Despite concerns of AI displacing individuals from their jobs, studies and industry stakeholders predict that this may not entirely be the case. Industry stakeholders have suggested that AI may be used as an additive tool rather than a means to displace people from their roles and that the risk of automation is not consistent across all occupations.[492] Nonetheless, this has placed an ever-growing importance on upskilling in order to properly utilize the new technology and prepare for the new occupations that it may create. For example, human-centric qualities and skills may become increasingly important. When analyzing the effect of ATMs on bank tellers, it has been found that the automation changed the role of the occupation. The bank teller's role saw a shift

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[489] International Trade Administration, Canada – Country Commercial Guide, 2022
[490] International Trade Administration, Canada – Country Commercial Guide, 2022
[491] International Trade Administration, Canada – Country Commercial Guide, 2022
[492] Mavers, Scott & Baker, Rose, A Look at an Automation Adoption Through a Human Performance Technology Lens: A Case Study of Bank Tellers and Automated Teller Machines. Performance Improvement, 2021

that increased the importance of client relationship management in the day-to-day operations.[493] This example highlights the importance of having a human present to provide guidance and ensure that AI can aid in meeting the organization's core objectives.

### Sustainable Technology and Green Initiatives

The digital economy is increasingly focused on sustainability, with a push for green technology solutions, energy efficiency and reducing electronic waste. A major source of energy use and carbon emissions is IT equipment and data centers. While these systems can be improved for efficiency, this can be quite difficult and expensive. A new, environmentally friendly, solution is a cloud-based software-as-a-service model. Cloud operators can run servers more efficiently, allocated resources dynamically to service specified workloads and use less energy for cooling and power distribution.

## Upskilling Opportunities

### Delivery Methods

There is an opportunity to utilize hands-on learning experience to upskill and provide pathways to career progression. Stakeholders have emphasized the importance of facilitating relationships with employers, schools, and other training partners to further promote gaining hands-on, real-world experience. They highlighted the need for individuals to be trained on real industry problems and properly articulate solutions in a team setting.

Hands-on experience can also be approached through formal internships and apprenticeship programs. Some stakeholders have been facilitating these programs in-house. However, establishing these programs seem to be most impactful when partnering with educational institutions and leading industry technology providers. Unfortunately, the lack of available time and financial costs can be a significant barrier for some businesses, especially for SMEs, who may find it difficult to send employees away for training.[494] A possible solution could be found using subsidies. By using subsidies, employers would have the opportunity to engage in training without having incur significant financial burdens.

Stakeholders have noted key aspects to keep in mind while developing upskilling programs:

- **Establish ideal training times**: Four to 16 weeks or eight to 12 weeks. The purpose of this is to provide employees with short windows to reinforce or keep up with the evolving skills of the industry in between projects and business cycles.

- **Transparency in the day-to-day of jobs**: Focus on providing more clarity regarding job opportunities, allowing individuals to better understand roles and responsibilities through clear expectations setting.

- **Keep the human element in mind**: As people are learning in a variety of modalities, it is important to have innovative programs beyond traditional pathways and recognize other avenues of learning. Exploring other avenues such as collaborative workshops may also foster teambuilding and inclusivity for individuals, instead of watching a video independently.

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[493] Mavers, Scott & Baker, Rose, A Look at an Automation Adoption Through a Human Performance Technology Lens: A Case Study of Bank Tellers and Automated Teller Machines. Performance Improvement, 2021

[494] Information and Communications Technology Council, Skills in the Digital Economy: Where Canada Stands and the Way Forward, 2016

- **Support programs with scale**: It is important to build programs that are adaptable to the everchanging landscape in the sector as well as for the diverse needs of employers and employees within the industry.

Considering these recommendations may be important to developing effective and efficient upskilling programs.

## Partnership & Mentorship Opportunities

Stakeholders highlighted the opportunity for partnerships in upskilling. Companies may be able to collaborate with educators, such as schools and community groups, to further develop programs and avenues into the sector. This would provide support to those wanting to transition into the diverse areas within ICT or the overall digital economy, as well as establishing relationships with young talent and underrepresented communities. For example, a report found that to address the growing skills gap and attract and retain talent, establishing a strong pipeline direct from education is essential.[495] Participation in an apprenticeship or co-operative education program can help to develop this talent pipeline.[496]

## Targeted Audience

As the digital economy continues to grow, the need for a variety of skills is increasing. This coupled with Canada's aging population may pose a challenge for future employers. As such, many stakeholders have recommended targeting certain demographics for upskilling opportunities. One group, specifically mentioned, was individuals who were in the early stages of their careers, such as in entry level positions. The purpose of this is to help facilitate career development and to enable those with skills, such as project management, to grow into senior and leadership roles earlier in their careers. Targeting this demographic may also provide more opportunities for exposure. Employers need to provide more clarity as to what opportunities exist within different sectors of the digital economy and what the day-to-day aspects of certain occupations may look like. Overall, targeting this group may be a large enabler in gaining sector exposure and carving out career development paths.

Stakeholders have also recommended targeting underrepresented and underutilized population groups. For example, when highly skilled new Canadians arrive in Canada, their international qualifications are typically devalued.[497] Stakeholders have recommended a program to potentially provide credibility in the Canadian marketplace without the extensive monetary and time costs of traditional educational institutions. Additionally, stakeholders suggested leveraging accessible technology and infrastructure to ensure people with disabilities such as those who are blind or deaf can be upskilled as well.

## Policy as an Enabler

As there is a continued digital evolution in the economy, this shift may further widen inequalities in the labour market and increase the importance of addressing the labour gap.[498] Stakeholders have highlighted the importance that policy and regulations may play in addressing these gaps. For example, there could be policies put in place to address structural factors that influence women's' decision to leave STEM, such as through teaching methods, mentorship programs, addressing inhospitable learning or work environments, and focusing on STEM related bias and discrimination.[499] There is an opportunity to use policy and subsidies to incentivize upskilling. For example, utilizing subsidies and grants may encourage companies to invest in and offer more

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[495] University of Waterloo, How Co-op Can Boost Your Bottom Line, n.d.
[496] University of Waterloo, How Co-op Can Boost Your Bottom Line, n.d.
[497] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[498] C.D. Howe Institute, The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills, 2022
[499] Minnesota State University, Innovations and Critical Issues in Teaching and Learning, 2021

programs for employees to attend workshops and conferences for learning without having to utilize vacation days.

## Conclusion

To summarize, a skilled workforce is essential to ensuring competitiveness, economic growth, sustainability, and innovation in the digital sector. This is especially important given the impact this sector has on multiple sectors of the Canadian economy. If the sector is unable to upskill and retain talent, and close occupation gaps in underrepresented groups, it will continue to face barriers from rapidly emerging technologies, and rising salary pressures from foreign competition.

For Canada's ICT sector to be a leader on the global stage and remain competitive, it will be fundamental to continue to upskill employees, carve out career pathways, close occupation gaps, and provide further avenues for education. It will remain important for upskilling programs to maintain an open line of communication with the demand of employers as the environment continues to rapidly evolve. Currently, the sector must ensure it fills gaps in roles such as data, computer programming and engineering, information systems, user support technicians, and managerial roles, to ensure it remains competitive and prepares for the future of the digital economy.

# The Cyber Sector

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# Executive Summary

Deloitte has been engaged to support Palette Skills' leadership role related to the Industry Upskilling Initiative funded by Innovation, Science and Economic Development Canada (ISED). The purpose of Upskill Canada is to connect employers to qualified talent and help high potential untapped talent move into fast growing careers. Through Upskill Canada, partners will receive support and funding to develop short-cycle programs that develop a combination of technical, general business, and interpersonal skills for high-demand roles in six key sectors (digital technology, cybersecurity, agricultural technology, advanced manufacturing, clean technology, biomanufacturing). In this report, the cybersecurity ("cyber") sector is defined as the application of technologies, processes, and controls to protect systems, networks, programs, devices and data from cyber-attacks. It encompasses the protection of digital information and the underlying infrastructure on which it resides.

The cyber sector is a key driver of the Canadian economy, playing a substantial role in enhancing its resilience, global competitiveness, and overall security. As this sector is a relatively new sector in the industrial landscape, data can be limited and sparce. With limited data, the approach taken in this study is to track the cybersecurity specialists occupation within the National Occupation Classification (NOC) system over time as a measure of the core role within the sector. In addition, to supplement the measure of this core role, alternative sources and studies are used to provide a possible employment range for the sector.

The role of cybersecurity specialists has grown dramatically over the last two decades. This growth has proven to be even more robust during the pandemic period, as cybersecurity increased in critical importance for both business and governments. As of 2022 it is estimated that there were over 14,300 cybersecurity specialists employed in Canada. With respect to the regional distribution of cybersecurity specialists, similar to the ICT sector, Ontario dominates the employment landscape with 49% of employment in 2022. Quebec and the Western provinces maintain a similar share of employment with 22% and 24% respectively. Atlantic provinces collectively maintain about 5% employment. (ISC)² have estimated that as of 2022, total employment in the cybersecurity sector across Canada is close to 139,000, representing a 12.2% increase from the previous year.

To establish itself as a global leader and improve its competitiveness, the cyber sector must overcome a range of existing challenges. One prominent obstacle is a scarcity of investment due to the misconception of cybersecurity as a cost center rather than a strategic enabler thus hampering proper risk management. There is also a shortage of skilled professionals, with a mismatch between workforce skills and industry requirements, exacerbated by attrition rates and a gender imbalance.

The outcomes of our research and study are structured as follows: an overview of the sector, a summary of the labour and skills analysis, challenges, implications, and opportunities for the sector. To be of benefit to the broader training and workforce development ecosystem, the findings presented in this chapter reflect the wide-ranging needs of the sector. Some occupations listed or industry opportunities might be beyond Upskill Canada's scope. This might include skilled trades occupations and those requiring certification from a professional body. Eligibility for Upskill Canada funding will be dependent on identifying demand for jobs through direct employer engagement.

# Overview of the Sector

## The Cyber Sector

Cybersecurity ("cyber"), as defined by ISED, **is the application of technologies, processes, and controls to protect systems, networks, programs, devices and data from cyber-attacks. It encompasses the protection of digital information and the underlying infrastructure on which it resides. In today's increasingly digital world, cybersecurity is no longer limited to technical experts, but it requires the participation of individuals and collective efforts to ensure the security of digital assets.[500]**

The selection of the cybersecurity sector as an area of upskilling is driven by the need for securing the nation's digital assets, its significance to the regional, national, and global economy, its potential for innovation, and its impact on job creation. In the digital age, cybersecurity plays a paramount role in protecting sensitive information, critical infrastructure, and IP from cyber threats.[501] With the increasing frequency and sophistication of cyber-attacks, the demand for skilled cybersecurity professionals has surged. Investing in cybersecurity talent and infrastructure not only safeguards businesses and organizations but also contributes to a stable and secure digital economy. Moreover, the dynamic nature of cyber threats necessitates continuous innovation, driving the need for skilled professionals to develop cutting-edge technologies and proactive strategies. By prioritizing cybersecurity, Canadian businesses are embracing a sector that offers significant economic and innovative potential, while also creating job opportunities for individuals in an increasingly critical field.[502]

## Palette Skills' Activities in the Sector

Palette Skills has actively engaged in the cybersecurity sector through various initiatives, partnerships, and research projects. A notable endeavor is the Accelerated Cybersecurity Training Program, designed to facilitate the transition of graduates with quantitative degrees, professionals with advanced computing work experience, and to respond to the transition of working from home and the associated cybersecurity risks. Palette Skills partnered with the Fields Institute for Research in Mathematical Science to launch an 8-week accelerated Cybersecurity Training Program. Collaborating with an advisory board comprised of cybersecurity leaders from organizations such as KPMG, Scotiabank, WiCys, and the University of Toronto, Palette Skills has developed a robust training curriculum aligned with sector needs. As a result, the program boasts an impressive job offer rate of 90%, emphasizing its effectiveness in meeting the demands of the rapidly growing cybersecurity job market.[503] In total Palette Skills has worked with 38 employers and upskilled 49 participants, helping almost all of them secure new roles in cybersecurity.

## Current State of the Sector

As cyber is a relatively new sector in the industrial landscape, data can be limited and sparce. As such, measuring the size of the sector with any degree of accuracy will be difficult. Other organizations and studies have attempted to estimate the size of the sector, with results varying by wide margins.

There currently does not exist any industry category within the NAICS industry classification system pertaining to a cybersecurity sector. However, the recently updated NOC system has incorporated a cybersecurity specialist occupation within the classification system. While not much

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[500] Definition obtained from ISED
[501] ICTC, cybersecurity Talent Development, Protecting Canada's Digital Economy, 2022
[502] Technation, Canadian cybersecurity Skills Framework
[503] Palette Skills, Accelerated Cybersecurity Training Program

to go by, this can provide a glimpse of the progress of the sector and the rising importance that it will have in the Canadian economy. While this single occupation may be regarded as a core occupation within the sector, utilizing this single category as a measure will likely underestimate the size of the sector. This is because maintaining cybersecurity capabilities within a firm will require more than just cybersecurity specialists. Nevertheless, with limited data, the approach taken in this study is to track the cybersecurity specialist's occupation over time as a measure of the core role within the sector. In addition, to supplement the measure of this core role, alternative sources and studies are used to provide a possible employment range for the sector.

The data indicates that the role of cybersecurity specialists have grown dramatically over the last two decades. This growth has proven to be even more robust during the pandemic period, as cybersecurity increased in critical importance for both business and governments. As of 2022, it is estimated that there were over 16,700 cybersecurity specialists employed in Canada. With respect to the regional distribution of cybersecurity specialists, similar to the ICT sector, Ontario dominates the employment landscape with 49% of employment in 2022. Quebec and the Western provinces maintain a similar share of employment with 22% and 24% respectively. Atlantic provinces collectively maintain about 5% employment.

*Figure 36: Employment of Cybersecurity Specialist in Canada*
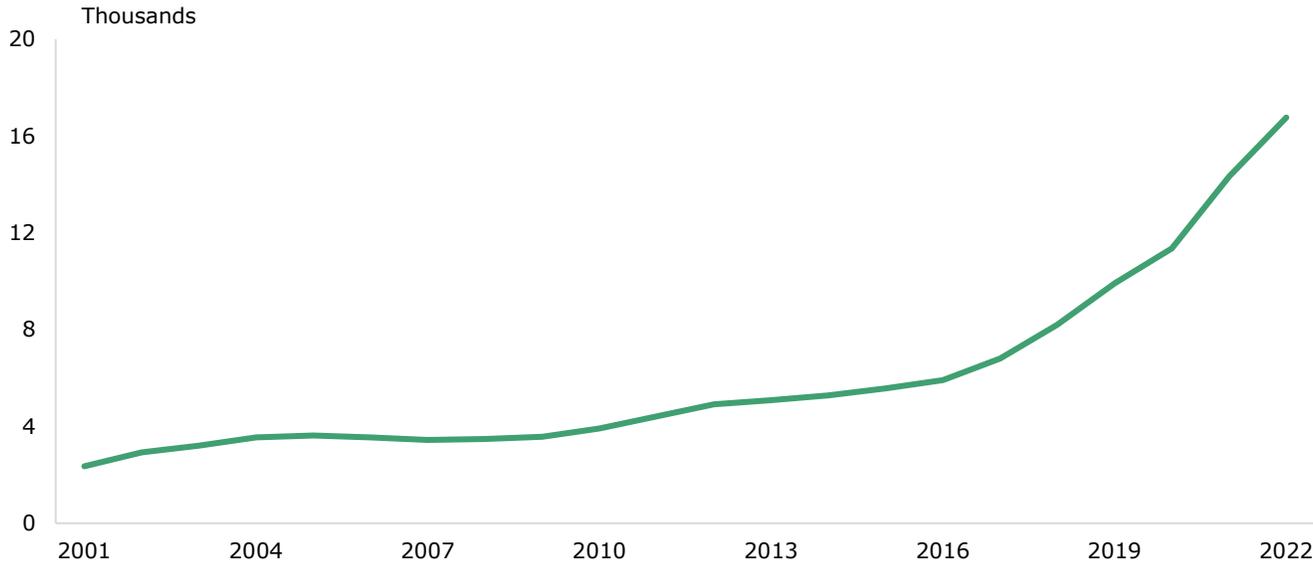


*Source: Lightcast*

*Figure 37: Regional Distribution of Cybersecurity
Specialist Occupations in 2022*



Legend: ■ Atlantic ■ Quebec ■ Ontario ■ West
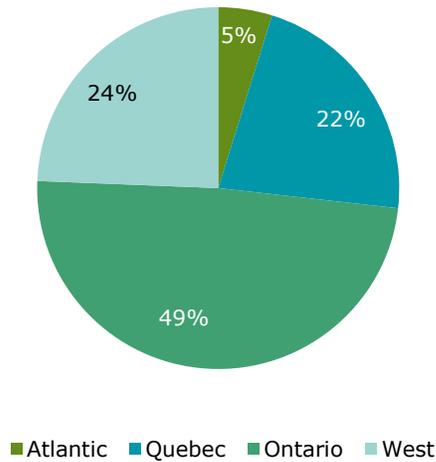
*Source: Lightcast*

Naturally, the cybersecurity sector employs more than just these specialists. Despite the difficulty in accurately measuring employment size, estimates have often been made by various organizations. For instance, (ISC)² estimated that as of 2022, total employment in the cybersecurity sector across Canada is close to 139,000, representing a 12.2% increase from the previous year.

The cyber sector has been a key economic driver, especially over the last few years. By various measure, when compared to the robust growth of the general ICT sector, the cybersecurity sector has maintained a more vigorous growth rate. Given the growing importance of cybersecurity in ensuring the integrity of digital assets for businesses and governments, the pace of growth for this sector is not expected to diminish in the near term.

*Figure 38: Performance of Key Variables, Canadian Cybersecurity Industry vs. Broader ICT Sector,
% Change, 2018 – 2022*



Legend: ■ Cybersecurity Sector ■ ICT Sector
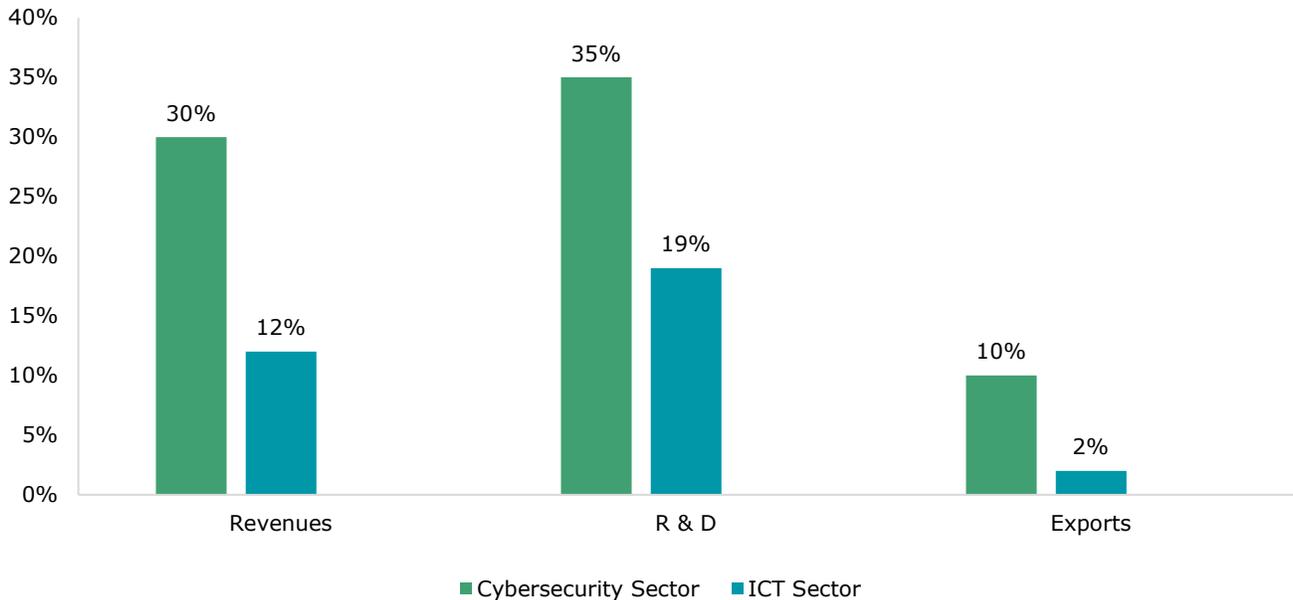
*Source: ISED, State of Canada's cybersecurity Industry, Fall 2022*

# Key Challenges

The cybersecurity sector faces unique challenges compared to other industries. One of the key challenges underscored by stakeholders during the cybersecurity roundtable sessions was the scarcity of investment, primarily driven by the prevailing misconception that cybersecurity is a mere cost center rather than a facilitator or a risk management endeavor aimed at securing economic advantages. To mitigate this challenge, stakeholders urged a paradigm shift wherein security is reconceptualized as trust, thereby dispelling the notion of security being solely cost-driven.

The effects stemming from this misconception can lead to determinantal results. Proper risk management arrangements relating to cybersecurity are generally underutilized in Canada, especially as it relates to smaller sized enterprises. Without proper cybersecurity risk management practices, Canadian institutions, be they businesses, governments or not-for-profits, are heavily exposed.

The following table outlines the percentage of risk management arrangements utilized by various sized Canadian enterprises.

*Table 1: Use of Risk Management Arrangements by Industry and Size of Enterprise in 2021*

| Risk management arrangements | Size of enterprise | Share |
|---|---|---|
| A written policy in place to manage internal cyber security risks | Total, all enterprises | 18.3% |
| | Small enterprises | 14.2% |
| | Medium-sized enterprises | 33.1% |
| | Large enterprises | 62.7% |
| A written policy in place to manage cyber security risks associated with supply chain partners | Total, all enterprises | 7.0% |
| | Small enterprises | 5.1% |
| | Medium-sized enterprises | 13.5% |
| | Large enterprises | 29.9% |
| A written policy in place to report cyber security incidents | Total, all enterprises | 12.7% |
| | Small enterprises | 9.5% |
| | Medium-sized enterprises | 23.6% |
| | Large enterprises | 53.8% |
| Other type of written policy related to cyber security | Total, all enterprises | 9.5% |
| | Small enterprises | 7.1% |
| | Medium-sized enterprises | 17.5% |

| Risk management arrangements | Size of enterprise | Share |
|---|---|---|
| A Business Continuity Plan (BCP) with processes to manage cyber security threats, vulnerabilities and risks | Large enterprises | 40.6% |
| | Total, all enterprises | 11.0% |
| | Small enterprises | 7.7% |
| | Medium-sized enterprises | 22.8% |
| | Large enterprises | 50.4% |
| Employees with responsibility for overseeing cyber security risks and threats | Total, all enterprises | 60.6% |
| | Small enterprises | 58.7% |
| | Medium-sized enterprises | 66.6% |
| | Large enterprises | 86.0% |
| Members of senior management with responsibility for overseeing cyber security risks and threats | Total, all enterprises | 25.3% |
| | Small enterprises | 22.5% |
| | Medium-sized enterprises | 35.3% |
| | Large enterprises | 56.7% |
| A consultant or contractor to manage cyber security risks and threats | Total, all enterprises | 38.0% |
| | Small enterprises | 35.2% |
| | Medium-sized enterprises | 51.5% |
| | Large enterprises | 46.4% |
| Monthly or more frequent patching or updating of operating systems for security reasons | Total, all enterprises | 29.3% |
| | Small enterprises | 25.0% |
| | Medium-sized enterprises | 45.2% |
| | Large enterprises | 75.5% |
| Monthly or more frequent patching or updating of software for security reasons | Total, all enterprises | 27.5% |
| | Small enterprises | 23.9% |
| | Medium-sized enterprises | 40.6% |
| | Large enterprises | 67.9% |

| Risk management arrangements | Size of enterprise | Share |
|---|---|---|
| Cyber risk insurance | Total, all enterprises | 16.1% |
| | Small enterprises | 13.7% |
| | Medium-sized enterprises | 24.4% |
| | Large enterprises | 46.5% |
| Business does not have any risk management arrangements for cyber security | Total, all enterprises | 18.8% |
| | Small enterprises | 21.3% |
| | Medium-sized enterprises | 8.1% |
| | Large enterprises | 1.8% |

*Source: Statistics Canada, Table 22-10-0130-01*

The cybersecurity sector struggles with underrepresentation of women, racialized peoples, and other marginalized groups. A 2021 report by (ISC)² indicated that women and racialized peoples are underrepresented in the field, and a lack of mentorship and opportunities for skill development limits the diversity of the workforce, especially for those who face barriers to traditional university education.[504]

Another key challenge is the ongoing shortage of skilled professionals. According to a global information security systems survey, many organizations believe that the skills shortage significantly impacts their operations.[505] Retaining cybersecurity talent in Canada is a significant challenge due to the competition from other provinces and the US. The sector faces a shortage of highly skilled and experienced professionals, while also having an excess of junior-level talent. This mismatch between the skills of the workforce and the cybersecurity requirements of organizations further compounds the challenges faced by the sector.[506]

Attrition rates in cybersecurity programs exacerbate the talent gap in the sector, with a noticeable gender imbalance as more women tend to drop out. Various reasons contribute to this attrition, including the allure of better opportunities outside the field, the perception of cybersecurity as overly technical, or simply losing interest. Different student cohorts, such as engineers or business majors, have their own specific reasons for leaving, such as seeking better opportunities or finding the field too technical.[507]

## Policy Context

Globally recognized credentials offer significant opportunities for international workers to enter the cybersecurity workforce. These credentials have played a vital role in shaping the labour force of the sector by enabling individuals with diverse educational backgrounds to contribute their skills and expertise. They have also facilitated international talent acquisition, granting organizations access to a global pool of cybersecurity professionals. Various certifications, such as those provided by CertNexus, Cisco Systems, CompTIA, and other reputable organizations, enjoy worldwide recognition. This recognition allows individuals possessing these certifications, regardless of their

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[504] (ISC)2, Cybersecurity Workforce Study, 2021
[505] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[506] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[507] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

country of origin, to be considered for job opportunities within the cybersecurity sector. Furthermore, in Canada these certifications can be obtained through local training providers, and exams can be taken at local testing centers or online. This aspect further facilitates the participation of individuals from different regions.[508]

## Emerging Trends

Digitalization is reshaping the global economy, and its rapid advancement has been further propelled by the COVID-19 pandemic. As businesses increasingly rely on digital infrastructure, the incidence of cybercrime has witnessed a corresponding surge in sophistication, frequency, and impact. IP, a critical asset for companies, represents approximately 80% of the value of Fortune 500 organizations, primarily stored in digital formats. Protecting this valuable IP has become a paramount concern.[509] In a survey conducted by the World Economic Forum in 2021, global leaders expressed alarm over cybersecurity failures. Specifically, 39% of respondents identified such failures as a clear and present threat.[510] This acknowledgment underscores the growing recognition of the significant risks posed by cyber threats to businesses and economies worldwide.

A prominent trend highlighted by stakeholders within the cybersecurity sector is the growing significance of AI and next generation technologies in combating cybersecurity challenges. These advancements are said to be playing a crucial role in enhancing security measures and mitigating potential risks. However, stakeholders also shed light on the evolving landscape and the ever-increasing importance of aligning recruitment and training strategies with the dynamic nature of technological advancements.

Furthermore, stakeholders have underscored the necessity for employers to reevaluate their hiring practices to ensure greater diversity. They advocate for a shift away from traditional approaches that often perpetuate homogeneity, such as relying on personal networks for recruitment. Instead, stakeholders suggest adopting more inclusive hiring strategies to attract and retain a diverse range of talent.

In terms of skills development, stakeholders have identified the potential benefits of implementing apprenticeship-style models in the cybersecurity field. This approach would provide aspiring professionals with practical experience while equipping them with the necessary knowledge and skills.

## The Potential Future of the Sector

The future of the cybersecurity sector holds great importance for Canadian innovation and prosperity. It is widely recognized that strong cybersecurity is a fundamental element in ensuring the confidence and reliability of the digital systems that support individuals, governments, and businesses in their daily activities.[511] The Government of Canada is committed to fostering a future where all Canadians actively contribute to shaping and maintaining the nation's cyber resilience.

To achieve its vision, the Government of Canada and its partners will focus on three key themes. Firstly, they will enhance cybersecurity awareness and education, promoting a culture of cybersecurity and equipping individuals with the necessary skills to navigate the digital landscape securely.

Secondly, there will be a strong emphasis on fostering innovation in cybersecurity technologies. This involves staying ahead of emerging threats, protecting critical infrastructure and sensitive

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[508] Canadian Centre for cybersecurity, Certifications in the Field of cybersecurity, 2022
[509] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[510] World Economic Forum, The Global Risks Report 2021, 2021
[511] Public Safety Canada, National cybersecurity Strategy, 2022

data, and supporting research, development, and collaboration among industry, academia, and government.

Lastly, the government aims to strengthen partnerships and cooperation among various stakeholders. By fostering collaboration, sharing information, and developing joint strategies, Canada can enhance its cybersecurity posture and contribute to global cybersecurity efforts.

## Implications to the Sector

The cybersecurity sector is confronted with unique challenges that have significant implications for its growth and effectiveness. Firstly, the ongoing shortage of skilled professionals poses a considerable challenge to organizations. With limited availability of qualified individuals, existing staff members experience an increased workload, leading to lower job satisfaction and potential burnout. [512] Moreover, organizations are compelled to invest more resources in recruitment efforts to address the skill gap, adding to their operational costs.

Secondly, the underrepresentation of women, racialized peoples, and other marginalized groups in the cybersecurity workforce has far-reaching consequences. The lack of diversity limits the talent pool and hampers innovation and problem-solving capabilities within the sector. A broader range of perspectives and experiences is essential in effectively addressing the evolving cyber threats. By fostering an inclusive and diverse workforce, the sector can benefit from a variety of insights and approaches, ultimately enhancing its ability to tackle cybersecurity challenges more comprehensively. [513]

Additionally, the increasing significance of AI and next-generation technologies in combating cybersecurity challenges presents both opportunities and implications for the sector. While these advancements offer enhanced security measures, they also necessitate a continual alignment of recruitment and training strategies with the evolving technological landscape. Staying up to date with emerging technologies and equipping professionals with the appropriate skills becomes crucial to effectively leverage these advancements and mitigate potential risks.

# Sector Labour Market and Occupations/Skills Analysis

### Overview of Job Supply and Demand

The cybersecurity sector operates within a complex ecosystem influenced by various supply and demand factors. These factors have a significant impact on the availability of skilled professionals, the demand for cybersecurity services, and the overall dynamics of the sector.

On the supply side, the sector faces challenges related to the shortage of skilled cybersecurity professionals. [514] This shortage can be attributed to various factors, including the rapid growth of the digital economy, the evolving nature of cyber threats, and the scarcity of specialized educational programs that adequately prepare individuals for cybersecurity roles. This scarcity of talent poses significant challenges for organizations seeking to build robust cybersecurity teams and effectively address the increasing sophistication and frequency of cyber threats.

Additionally, the recruitment and retention of cybersecurity professionals present ongoing challenges. The diverse range of responsibilities, educational backgrounds, skills, experience levels, and certifications required in the cybersecurity field make it difficult for employers to find

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[512] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[513] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[514] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

professionals with the ideal combination of technical, analytical, and soft skills, such as team work, communication and critical thinking skills.[515] Retention challenges are further compounded in the public sector, where lower pay scales, inadequate funding, bureaucratic obstacles, and the demanding nature of the work contribute to high attrition rates.[516]

On the demand side, the incidence of cybercrime and the growing recognition of the risks posed by cyber threats have heightened the demand for cybersecurity services. Businesses across industries increasingly rely on digital infrastructure, making them vulnerable to cyberattacks. IP represents a critical asset for companies, accounting for a significant portion of their value. Protecting this valuable IP has become a paramount concern, further driving the demand for cybersecurity solutions and expertise. [517]

Moreover, the evolving regulatory landscape plays a crucial role in shaping the demand for cybersecurity services. Governments and regulatory bodies are implementing stricter data protection and privacy regulations such as the Consumer Privacy Protection Act (CPPA)[518] , which require organizations to enhance their cybersecurity measures. Regulations such as the CPPA create a heightened demand for cybersecurity professionals and solutions to ensure data security and regulatory compliance.

## Occupations

### Key Occupations

In the cybersecurity sector, the presence of a diverse range of skilled professionals is crucial for driving sector progress. It is essential to have individuals who possess not only technical expertise but also excel in soft skills such as critical thinking, management, and troubleshooting.

Through our research and stakeholder consultations, the following occupations were identified as being key to the sector's growth and competitiveness:[519,520,521]

| Key Occupations | Top Associated Skills[522] |
|---|---|
| Communication and information systems managers | • Decision Making<br>• Evaluation<br>• Management of Material Resources |
| Computer engineers | • Decision Making<br>• Digital Literacy<br>• Digital Production |
| Computer network technicians | • Preventative Maintenance<br>• Troubleshooting<br>• Equipment and Tool Selection |

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[515] Deloitte, The changing faces of cybersecurity, 2018

[516] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

[517] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

[518] Government of Canada, New laws to strengthen Canadians' privacy protection and trust in the digital economy, 2022

[519] ICTC, cybersecurity Talent Development, Protecting Canada's Digital Economy, 2022

[520] Technation, Canadian cybersecurity Skills Framework

[521] The top associated skills are defined based on the top three skills related to the occupation in the Occupational and Skills Information System (OaSIS).

[522] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Key Occupations | Top Associated Skills[522] |
|---|---|
| Computer programmers and interactive media developers | • Digital Literacy<br>• Digital Production<br>• Troubleshooting |
| Electrical and electronics engineering technologists and technicians | • Equipment and Tool Selection<br>• Troubleshooting<br>• Evaluation |
| Electrical and electronics engineers | • Critical Thinking<br>• Decision Making<br>• Numeracy |
| Information systems analysts and consultants | • Evaluation<br>• Troubleshooting<br>• Critical Thinking |
| Mathematicians, statisticians and actuaries | • Critical Thinking<br>• Digital Literacy<br>• Learning and Teaching Strategies |
| Policy and program researchers, consultants and officers (context dependent) | • *Critical Thinking*<br>• *Decision Making*<br>• *Evaluation* |
| Senior government managers and officials | • Coordinating<br>• Critical Thinking<br>• Decision Making |
| Senior managers - financial, communications, business services | • Coordinating<br>• Critical Thinking<br>• Decision Making |
| Software engineers/designers | • Digital Literacy<br>• Digital Production<br>• Evaluation |
| User support technicians | • Oral Communication: Active Listening<br>• Repairing<br>• Troubleshooting |

## Occupation Gaps

Within the cybersecurity sector, the occupation gap challenge is an ongoing concern.

Through our research and stakeholder consultations, the following occupations gaps were identified:

| Occupation Gaps | Top Associated Skills[523] |
|---|---|
| Computer and information systems managers | • Decision Making<br>• Evaluation<br>• Management of Material Resources |
| Data administrators | • Critical Thinking<br>• Decision Making<br>• Evaluation |
| Database analysts | • Critical Thinking<br>• Decision Making<br>• Digital Literacy |
| Information systems analysts and consultants | • Evaluation<br>• Troubleshooting<br>• Critical Thinking |

## Future Occupations

In addition to addressing existing gaps, it is imperative for the sector to proactively acknowledge the emerging roles that will play a vital role in the future. It is crucial to recognize that as new technologies continue to evolve, so will the professions and the essential skills associated with them. It is conceivable that the daily duties, requisite skill sets, or even the nature of occupations may undergo substantial transformations.

Through our research and stakeholder consultations, the following occupations were identified as increasingly important in the future:

| Future Occupations | Top Associated Skills[524] |
|---|---|
| Computer and information systems managers | • Decision Making<br>• Evaluation<br>• Management of Material Resources |
| Computer programmers and interactive media developers | • Digital Literacy<br>• Digital Production<br>• Troubleshooting |
| Data administrators | • Critical Thinking<br>• Decision Making<br>• Evaluation |

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[523] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.
[524] For the italicized skills, the corresponding occupation is not available in the Occupational and Skills Information System (OaSIS). Therefore, skills in a similar alternative occupation are used as a substitute.

| Future Occupations | Top Associated Skills[524] |
|---|---|
| Information systems analysts and consultants | • Evaluation<br>• Troubleshooting<br>• Critical Thinking |

## Skills

### Key Skills

Through our research and stakeholder consultations, the following skills were identified as being key to the sector's growth and competitiveness:

| Key Skills | |
|---|---|
| **Technical Skills**<br>• Digital Production<br>   – cybersecurity strategy<br>   – IT security operations<br>   – Security management | **Resource Management Skills**<br>• Risk analysis<br>• Risk management |

### Skill Gaps

Based on findings from a global information security systems survey "Cyber Security Skills in Crisis" conducted by Information Systems Security Association (ISSA), a substantial number of organizations acknowledge that the skills shortage has a profound impact on their operational capabilities.[525]

Through our research and stakeholder consultations, the following skills gaps were identified:

| Skills Gaps |
|---|
| **Technical Skills**<br>• Digital Production<br>   – Cloud security<br>   – Incident response<br>   – Digital forensics<br>   – Networks<br>   – Internet protocols<br>   – Operating systems |

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[525] ISSA, Cyber Security Skills in Crisis: 3rd Annual Global Survey by ISSA and ESG Open Today, 2018

**Industry Perspective**

Stakeholders have highlighted that the cybersecurity sector is facing a significant skills gap, particularly in the areas of data science, automation, and scaling. As the sector rapidly evolves and integrates advanced technologies including Large Language Model (LLMs) such as ChatGPT and other innovative software solutions, traditional forms of education and post-secondary institutes are often hesitant to adapt their curriculum to meet the changing demands of the field. To address this challenge, closer collaboration between industry stakeholders, educational institutions, and training providers is necessary to ensure that educational programs and training initiatives are updated to equip professionals with the skills required to navigate the evolving cybersecurity landscape effectively.

## Future Skills

Through our research and stakeholder consultations, the following skills were identified as increasingly important in the future:

| Future Skills | |
|---|---|
| **Technical Skills**<br>• Digital Production<br>   – IT Operations Management | **Abilities**<br>• Accuracy<br><br>**Knowledge**<br>• Business Performance Management |

**Industry Perspective**

Stakeholders within the cybersecurity sector emphasize the importance of considering the duration of upskilling programs. While Work-Integrated Learning (WIL) and apprenticeship programs offer valuable hands-on experience and skills development, there is a delicate balance to strike. If the program duration is too short, individuals may not acquire all the necessary knowledge and practical exposure. Conversely, if the program duration is too long, participants may receive job offers before completing the program. Finding the optimal duration that ensures comprehensive training without hindering employment opportunities remains a challenge that requires further refinement and alignment with sector needs.

# Challenges and Barriers to Upskilling

## Key Employer Challenges

Recruiting cybersecurity staff presents a significant challenge to employers due to the diverse range of responsibilities, educational backgrounds, skills, experience levels, and certifications that professionals in this field possess. According to a 2018 study conducted by Deloitte on the cybersecurity ecosystem in Canada, a substantial majority (76%) of Chief Information Security Officers identified the difficulty in finding the ideal combination of technical, analytical, and soft skills as a major hurdle in the recruitment process for cybersecurity personnel.[526] This highlights the complexity and intricacy involved in assembling a qualified and well-rounded cybersecurity workforce.

Furthermore, employers in the cybersecurity sector face challenges when it comes to retaining professionals in the public sector. Despite being prime targets for cyberattacks, government organizations struggle with lower levels of retention among cybersecurity professionals. This can be attributed to various factors, including comparatively lower pay scales in the public sector compared to the private sector, inadequate funding, bureaucratic obstacles, lengthy and cumbersome hiring processes, extensive background checks, and the prevalence of burnout. These challenges create obstacles for employers in the cybersecurity sector, impeding their ability to attract and retain skilled professionals within the public sector.[527]

Stakeholders within the sector highlighted the need to prioritize practical knowledge and expertise over formal educational qualifications. The perception that a bachelor's degree holds less importance compared to practical understanding and knowledge of cybersecurity roles was identified as being a challenge to employers as many potentially successful cybersecurity professionals do not pursue this career path due to the misconception of a bachelor's degree in specific fields being necessary.

## Key Employee Challenges

One of the key challenges identified by stakeholders in the cybersecurity sector is the conventional practice among employers to heavily rely on a narrow selection of specific target schools and programs when recruiting talent. This approach restricts the potential pool of qualified candidates and hinders diversity in the sector. To address this challenge, stakeholders advocated for a more inclusive recruitment process that opens up opportunities to non-traditional talent. This includes individuals with different educational pathways or those transitioning from other sectors.

Another challenge to employees in the sector as emphasized by stakeholders is the timing of work, as cybersecurity demands 24/7 attention, which may pose difficulties for individuals with personal responsibilities such as childcare. The format of roles in the sector needs to be considered, as entry-level positions can be overly demanding and may require individuals to take on significant responsibilities affecting their day-to-day routines.

## Challenges in Upskilling

Designing effective cybersecurity learning programs presents its own set of challenges. While flexible programs that offer alternatives to traditional approaches may attract more students, their long-term impact might be less advantageous. The field demands a significant time commitment, technical certification, and often subjects workers to high levels of stress. While such programs

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[526] Deloitte, The changing faces of cybersecurity, 2018
[527] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

could delay the departure of unsuitable workers, they may not fully eliminate the underlying challenge.[528]

A rather significant challenge faced by the cybersecurity sector is the lack of communication between post-secondary institutions and cybersecurity job employers. The ICTC National Advisory Committee on Cybersecurity Training (INACCT) has emphasized this issue, citing limited time and project resources as contributing factors. As a result, there are noticeable disparities between student self-assessments and employer assessments when it comes to technical and soft skills. This discrepancy becomes particularly problematic when distinguishing between "must-have pre-hiring" skills and skills that can be developed on the job.[529]

The absence of effective communication channels between post-secondary institutions and employers hinders students' ability to adequately develop and evaluate these critical pre-hire skills before entering the cybersecurity workforce. To tackle this challenge, further research is necessary to gain a comprehensive understanding of how essential pre-hire skills, both technical and soft, can be nurtured. Bridging the gap between students' perceived skills and employers' expectations requires fostering better communication and collaboration between post-secondary institutions and cybersecurity job employers.

A high degree of attrition in cybersecurity programs is a major challenge facing the cybersecurity sector, as it delays the closure of the talent gap. Attrition is also gender-imbalanced, meaning that even if more women become interested in the field, ultimate gains in the workforce may be limited. ICTC's student survey found that over 50% of women who began a career in cybersecurity dropped out of the field, compared to 30% of men.[530]

# Implications to the sector

The current state of the cybersecurity sector has significant implications for its development, competitiveness, and sustainability. The sector's growth potential is hampered by occupational and skill shortages, presenting challenges for employers in recruiting and retaining cybersecurity professionals. The recruitment process itself is hindered by the scarcity of individuals possessing the ideal combination of technical, analytical, and soft skills. Moreover, a prevailing misconception that prioritizes formal educational qualifications over practical knowledge and expertise creates a barrier for promising individuals who may overlook the cybersecurity career path based on perceived requirements.

Retention challenges in the public sector pose further obstacles, jeopardizing national security. Factors such as lower compensation, limited funding, bureaucratic hurdles in hiring processes, and the risk of burnout contribute to difficulties in maintaining a stable and competent cybersecurity workforce within government organizations.[531]

Upskilling challenges impact both employers and employees in the cybersecurity sector. Employers often rely on a narrow selection of schools and programs, limiting the pool of qualified candidates and hindering diversity. This practice disregards individuals with the necessary skills and knowledge acquired through alternative pathways or practical experience. Consequently, talented individuals may face barriers in career advancement and professional growth due to a reliance on formal educational qualifications.

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[528] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[529] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[530] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[531] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

Designing effective cybersecurity learning programs is also a complex task. While flexible programs may attract more students, their long-term impact might be limited. The demanding nature of the field, including time commitments, technical certifications, and high levels of stress, pose challenges to successful upskilling initiatives. Improved communication and collaboration between post-secondary institutions and cybersecurity job employers are crucial for bridging the gap between perceived skills and employer expectations.

Furthermore, the high attrition rate, particularly among women, within cybersecurity programs delays progress in closing the talent gap. Despite increased interest from women, the gender imbalance in attrition hinders workforce growth. To address this, targeted efforts are necessary to foster an inclusive and supportive environment for underrepresented groups in the cybersecurity sector.[532]

The emergence of digitalization and the rise in cybercrime have significant implications for the cybersecurity sector. Protecting IP stored in digital formats has become a paramount concern for businesses. Global leaders acknowledge the clear and present threat of cybersecurity failures, emphasizing the need for robust security measures. The growing significance of AI and next-generation technologies highlights the importance of aligning recruitment and training strategies with technological advancements. Organizations must adapt their hiring practices to promote diversity and inclusivity, attracting a diverse range of talent. Implementing apprenticeship-style models can provide practical experience and bridge the skills gap, ensuring a skilled workforce ready to tackle evolving cybersecurity challenges.[533]

# Opportunities

## Emerging Trends in the Sector Related to Skills and Occupations

### Emerging Technology

The cybersecurity sector is poised for growth, innovation, and long-term sustainability, presenting a multitude of opportunities to shape its future trajectory. Emerging technologies offer significant prospects for focusing upskilling efforts on the digital side. With the rapid advancement of technologies like AI and automation, organizations have a chance to enhance their capabilities by developing the necessary skills and expertise in these areas. By investing in targeted upskilling programs that cater to novel digital technologies, organizations can equip their workforce with the knowledge and proficiency required to effectively leverage these tools for threat detection, incident response, and overall cybersecurity resilience.

### Shifting Emphasis to Practical Skills and Expertise

Within the sector, there is an opportunity to reevaluate the emphasis placed on formal educational qualifications and prioritize practical knowledge and expertise. Stakeholders have highlighted the detrimental impact of the prevailing misconception that bachelor's degrees are essential for cybersecurity roles, hindering the sector's ability to attract and retain top talent. To seize this opportunity, there is value in organizations shifting their mindset and recognize the inherent value of practical skills and experience in cybersecurity. By embracing this paradigm shift, employers can tap into a broader pool of qualified candidates who possess the necessary practical knowledge and expertise to excel in the field. This approach not only expands the talent pool but also fosters inclusivity and diversity, ensuring a dynamic workforce capable of addressing the sector's evolving challenges and driving innovation. Furthermore, stakeholders within the cybersecurity sector recognize a notable opportunity arising from a shift towards skills-based hiring practices. Influential

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[532] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022
[533] ICTC, cybersecurity Talent Development: Protecting Canada's digital economy, 2022

organizations such as Amazon, Google, and Microsoft have embraced this trend by investing in programs aimed at upskilling their workforces and potentially reevaluating the importance of traditional higher education credentials.[534] This shift signifies a growing emphasis on practical skills and abilities rather than solely relying on formal credentials. By leveraging this opportunity, organizations can foster a more dynamic and inclusive workforce while aligning their hiring practices with the evolving needs of the cybersecurity sector.

### Reframing Cybersecurity as an Enabler

Within the cybersecurity sector, there exists an opportunity to dispel the prevailing narrative and misconception regarding cybersecurity as a cost center. Stakeholders have highlighted this as a chance to reframe the situation and transform it into a positive outlook. By emphasizing the potential of cybersecurity as an enabler and a risk management activity for securing economic gains, the sector can redefine itself as a trusted partner rather than a mere cost burden. Seizing this opportunity will not only contribute to the sector's growth but also enhance its reputation as a strategic driver of success.

## Upskilling Opportunities

### Collaboration with Academic Institutions and Sector Associations

Collaboration with academic institutions and sector associations is another avenue for organizations within the cybersecurity sector to capitalize on this unique opportunity and align training procedures. This involves the development of specialized courses, certifications, and apprenticeship-style models that provide hands-on experience and practical skills development tailored to the specific needs of the cybersecurity sector. By equipping individuals with the necessary knowledge and expertise, the sector can cultivate a highly skilled workforce capable of effectively tackling evolving cybersecurity challenges.

### Incentivizing Upskilling

Furthermore, organizations within the cybersecurity sector can incentivize professionals to pursue cybersecurity upskilling by offering a range of incentives and creating clear career pathways. Financial assistance, scholarships, and sponsored training programs can provide tangible support to individuals seeking to enhance their cybersecurity skills. By implementing these measures, organizations can harness the potential of this opportunity and foster a culture of upskilling, attracting top talent and ensuring a highly skilled workforce capable of addressing the evolving challenges in the cybersecurity landscape.

# Conclusion

In conclusion, the cybersecurity sector is at a critical juncture, facing both challenges and opportunities that will shape its future. The implications of occupational and skill shortages, recruitment and retention difficulties, and the misconception surrounding educational qualifications highlight the pressing need for action. However, amidst these challenges lie numerous opportunities for the sector to thrive and make significant advancements. The emergence of digitalization, the growing significance of AI, and the recognition of diversity and inclusion as drivers of innovation all present avenues for growth and development. The ongoing digitalization, coupled by the increasing significance of AI and other emerging technologies, presents an

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[534] Forbes, The Rise of Skills-Based Hiring and What It Means For Education, 2021

unprecedented opportunity for the sector to position itself as a catalyst for innovation and resilience. By strategically investing in robust upskilling programs, incentivizing professionals through financial assistance, scholarships, and career advancement prospects, and forging collaborative partnerships across sector, academia, and government, the cybersecurity sector can chart a course towards sustained success and long-term viability.
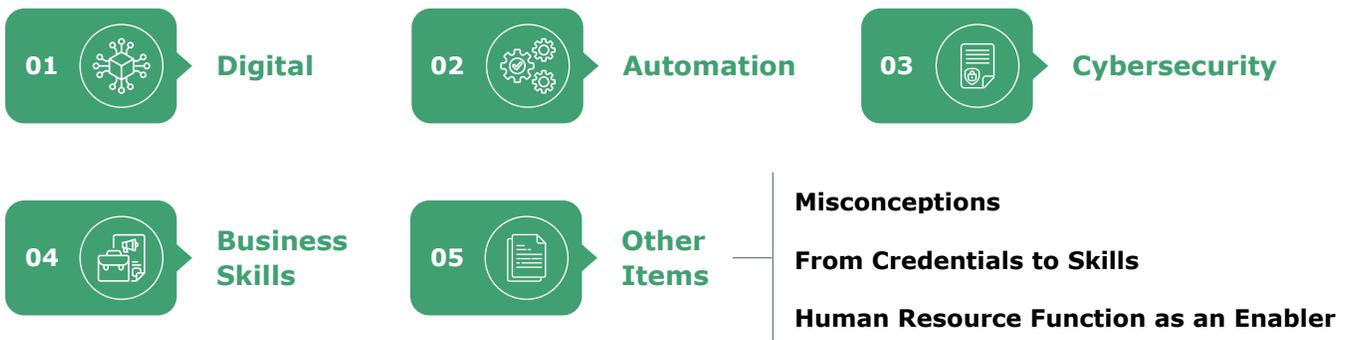
# Crosswalks

> > >

Each sector has their own set of unique and idiosyncratic challenges that are required to be addressed to remain competitive and resilient. As it relates to the occupation and skills gap challenge, each sector has its own unique characteristics and obstacles to overcome. Nevertheless, skills needs are not isolated within individual sectors but often intersect across various industries. Several cross-cutting factors will influence the skills requirements in multiple sectors, reflecting the interconnectedness and interdependencies of the modern economy.

Technological advancements, digital transformation, automation, cybersecurity, the need for business acumen and other enabling elements are critical cross-cutting factors affecting skills requirements across multiple sectors. Recognizing these factors and their implications is crucial for policymakers, employers, and individuals to develop effective strategies for workforce development and promote lifelong learning, while ensuring a skilled and agile workforce can navigate the challenges and seize the opportunities presented by an interconnected and rapidly evolving economy.

The following sections, explore the crosswalks or cross-cutting factors affecting all sectors analyzed in this study.

| 01 | Digital | 02 | Automation | 03 | Cybersecurity |

| 04 | Business Skills | 05 | Other Items | **Misconceptions** **From Credentials to Skills** **Human Resource Function as an Enabler** |

# Digital

Of all the sectors analyzed and reviewed, the digital economy presents the largest crosswalks and overlap with other sectors. With the ever-emerging technologies, numerous digital trends will create skills gaps ranging a variety of industries. The overall digitization of the economy is one of the fastest growing trends, impacting every sector. The digital economy has been growing rapidly in the past decade. As a share of the total employment, the digital economy has shown increased proportions, at 11% during the onset of the COVID-19 pandemic.[535] This is expected to continue growing as the pandemic created larger shifts to an online presence. The digital sector is one that thrived during the COVID-19 pandemic as digital firms were able to pivot to the "new normal" faster and more efficiently than other parts of the economy. However, other sectors have rapidly integrated digitization as pandemic lockdowns created unprecedented demand for digital goods and services. The digital sector has thrived in recent years, with employment in the digital economy accounting for 2 million jobs as of June 2021.[536]

Most sectors are seeing digitization in some aspects of their occupations. Due to this, there are a variety of occupations that will be shared across sectors. These occupations will include software engineers, information system analysts, computer programmers, support technicians, among others. Each industry will need expertise in the technology space specific to company needs. These

[535] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021
[536] The Information and Communications Technology Council, Onwards and Upwards Digital Talent Outlook 2025, 2021

individuals will need to have some understanding of how to create the technology required for the industry. However, this skill could potentially be outsourced as required. What will be pivotal to industries will be upskilling and finding employees that can successfully use and maintain the existing technologies, as well as continue to innovate within the digital space. Each sector will require positions with some amount of technological savvy. Many of these positions will include skills that are deeply transferable from one industry to the other.

One of the largest disruptions in the digital economy is the use of Large Language Models (LLM) and generative AI. LLMs and AI are ever evolving parts of the digital economy. LLMs are foundational machine learning models that use deep learning algorithms to process and understand natural language. These models are trained on massive amounts of text data to learn patterns and entity relationships in the language. Some recent examples of LLM include OpenAI's ChatGPT, and Google's Bard. Generative AI is a broad term used for any AI whose function is to generate content. This can include image generations, code generation tools, etc. These new technologies are creating large disruptions in our economy in every industry. While many have argued that these technologies may replace regular jobs, this is likely not the case. Rather, workers will be able to supplement their skills with the use of these LLMs and AI technologies. Due to gaps in knowledge and technical understanding of new technologies, most LLMs and AI tools have remained inaccessible to many enterprises. However, some companies have wholehearted accepted the use of AI technologies and have seen the positive impacts. A report by the International Telecommunication Union, highlights that AI's contribution growth may not be linear. Instead, AI growth will have an accelerating pace over time and may be three or more times higher by 2030 compared to the growth between 2018-2023.[537] Individuals with skills in the LLM and AI sphere will be highly sought out in every industry. Additionally, with the use of AI tools, these skills can be transferred from one industry to another.

| Industry | Examples of LLM and AI used |
| --- | --- |
| Ag-tech | • AI can provide farmers with forecasting and predictive analytics to reduce errors and minimize the risk of crop failures |
| Biomanufacturing | • AI used in predicting protein sequences |
| Advanced Manufacturing | • Using Digital Twin technologies to gain insights on complicated machinery |
| Cleantech | • AI used to optimize the recycling of materials used in clean energy systems, such as solar panels, wind turbines, and hydroelectric dams |

As the digital economy continues to grow, a skill that will be relevant in all sectors that have a digital aspect will be technology stewardship. This concept is a new and evolving one consisting of the ethical implications of utilizing various types of technology, in particular AI. Additionally, this skillset enables individuals to evaluate the tensions between sectors and its associated evolving technologies and how to navigate between them. Individuals in the digital economy need to better understand the socio-ethical questions that are posed by the increasing use of intelligent technology. Technologies and their advances are innovative disruptions that sectors need to utilize in a constructive manner. Currently, there are a few tech stewardship upskilling programs available. The Tech Stewardship Practice Program is a light and flexible program meant to overlay to existing work and educational activity, an introductory program in some ways. However, upskilling within this space will be best done by each individual sector. The core understanding of ethical technological practices will remain the same across the board. However, sector specific

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[537] International Telecommunication Union, Assessing the Economic Impact of Artificial Intelligence, 2018

understanding and the ethical questions that come by will need to be developed on an industry-by-industry basis.

# Automation

With the digitalization of the Canadian economy, it is not surprising that automation would be another key theme or crosswalk that has overlapped across all sectors. Automation has become a transformative force in industries worldwide, including Canada. While automation can bring several benefits such as increased productivity and efficiency, it also presents challenges that industries in Canada must navigate.

One of the primary challenges is the transformation of the workforce. Automation will continue to replace certain job functions, leading to the potential for job displacement and the need for upskilling. The consequences of the automation trend are not trivial. The rapid advancement of automation technologies can often outpace the availability of skilled workers to implement and manage them. Canada faces a skills gap in key emerging areas such as robotics, AI, and data analytics. The lack of skilled workers can often result in a lack of technology adoption within industries, eventually leading to a diminishing of Canada's competitive standing. To ensure that Canada's competitive standing is not imperiled by a lack of technological adoption due to the skills gap challenge, several important elements must come into place. Firstly, industries in Canada should actively address the automation challenge by ensuring that workers have the skill sets to adapt to the transformative force of automation. This can be addressed by providing training programs, career development opportunities, and support for workers affected by automation. Secondly, interdisciplinary collaboration among various stakeholders, including technology developers, policymakers, and business leaders are required. Establishing effective collaboration channels and platforms is crucial for knowledge sharing, best practices exchange, and addressing common challenges.

# Cybersecurity

One of the implications of a growing digitization of the economy is the fact that cybersecurity needs are also evolving. As more sectors are choosing and switching to digital solutions, cyber-attacks and threats have also been increasing. Canada was ranked the fourth most targeted country for cyber-attacks.[538] While cybersecurity needs and challenges may be different for each sector, the consequences of ignoring these needs can be catastrophic.

Security leaders in every industry must expand their focus beyond simply technology vulnerabilities. Every industry is at threat of cybersecurity risks. According to the Canadian Anti-Fraud Centre, there have been over 150,000 reports of fraud in Canada with over $600 million stolen since January 2021.[539] Additionally, disruptive technologies, such as machine learning and technologies that aid in automation, can be hacked, deceived, and exploited. As machine learning is more readily available and easily integrated into processes and industries with significant societal impacts, increased levels of care will need to be taken to ensure the application of these programs is equitable and secure.

With increase digitization, there will need to be a workforce transformation in almost all industries. It is not enough to have the technology to be able to make processes more efficient. Rather, there is a need for consistent maintenance and safeguarding of technology in each company where it is used to limit cyberthreats. Continued improvements in digital safety will be essential for all

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[538] Blackberry, Global Threat Intelligence Report, 2023
[539] Canadian Anti-Fraud Centre, 2023

industries. Many of the skills required for a cybersecurity expert are programming, machine learning, coding, among others. These base skills will not vary based on industry. In the near term, it is likely that all industries will require these skills and will compete for them across Canada. Upskilling in this regard will be essential for each industry.

# Business Skills

In the current era of globalization, businesses in all sectors have increased competition, both domestically as well as internationally. To keep up with this competitive landscape, acute business skills are required for businesses across all sectors. While technical skills are seen to be important for product development, business skills are seen as important to help commercialize products, as well as to help grow and scale product development. Further, with the digitalization of the business landscape, these skills will prove quite necessary. Senior executives across all sectors will require to develop corporate strategies to be able to pivot and adapt to emerging technologies to stay competitive and improve efficiency.

Employers from various industries are already experiencing a growing need for business skills. The World Economic Forum's 2023 Future of Jobs Report states that employers estimate 44% of workers' skills will be disrupted in the next 5 years.[540] Business skills and soft skills will be required to manage this disruption. Cognitive skills are reported to be growing most quickly, reflecting the increased importance of problem-solving and adaptability in the workplace. Further, increased analytics skills and creative thinking will also remain the most important skill for workers in 2023. The World Economic Forum states that the core skills required will be teamwork and collaboration as well as quality control.

Further, soft skills such as leadership, communication, problem-solving and empathy, are being sought out more than ever before. Many companies are realizing the importance of these, especially in remote settings, and are choosing to actively hire for them or upskill existing staff to take on new roles. A McKinsey survey found that the proportion of companies addressing empathy and interpersonal skills had doubled in 2020.[541] The McKinsey survey asked about 25 specific skills that may be prioritized by companies. Of these, more than half of the respondents report a focus on developing leadership, critical thinking, and project-management skills.[542] This is consistent with a changing competitive landscape as these were not the prioritized skills in 2019.

While many companies are providing internal business upskilling for current employees, the growing need for business skills is evident. With many industries initiating hiring for these specific skills, industries will need to compete with one another for individuals exhibiting these skills. However, business skill and associated soft skills may be the easiest skillset to be gained through upskilling and training programs. There already exists a plethora of short training programs that aid in developing these skills. Many industries may find it beneficial to set up their own upskilling programs as they can focus on their industry specific needs.

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[540] World Economic Forum, Future of Jobs Report, 2023
[541] McKinsey & Company, Building workforce skills at the scale to thrive during – and after- the COVID-19 crisis, 2021
[542] McKinsey & Company, Building workforce skills at the scale to thrive during – and after- the COVID-19 crisis, 2021

# Other Items

**Misconceptions**

As more sectors become intertwined and stray further away from their more traditional definitions, businesses are experiencing difficulties with misconceptions regarding the nature of their operations amongst Canadians. One of the most commonly heard complaint during the stakeholder roundtables was that new graduates and jobseekers are deeply unaware of the types of occupations available as a career path in certain sectors. Many Canadians seem to have a very cursory level understanding of the nature and characteristics of each sector and have limited knowledge of the various industries that they comprise.

As an example, the agri-food/ag-tech sector is made up of numerous industries and businesses. However, stakeholders pointed out the challenges in recruiting talent due to the fact that there is limited awareness of the key occupations within agricultural ecosystem apart from farming. Even here, the common stereotype of farming being a low-level user of technology remains persistent. Moreover, there is little knowledge or awareness of the innovative and emerging technologies utilized by the sector and the labour opportunities that it provides. In general, it is difficult to recruit when labour market participants are unaware and uncertain of what the sector entails. As such, stakeholders indicated that occupational vacancies within the sector are significantly harder to fill.

Advanced manufacturing is another sector that is the recipient of a large degree of misconceptions. Work within the sector is often viewed as laborious and difficult, a throwback to the early industrial period. Collectively, these misconceptions are adding difficulty for some of these sectors in addressing the occupation and skills gap.

**From Credentials to Skills**

As trends in technological advancements, automation, and industry transformation continue apace, firms in various sectors have found it difficult to address the occupation and skills gap challenge through hiring practices that rely heavily on credentials. Given that the technical skills can generally be evaluated in pre-employment testing, barriers to hiring based on skills - as opposed to credentials – can be low. Moreover, skills-based hiring can permit the expansion of opportunities to a larger population of potential employees who have often been excluded from consideration because of degree inflation. As a result, to help address the occupation and skills gap, several high profile and large-scale companies such as Google and IBM have embraced this hiring model in recent years, and consequently have increased their pool of potential employees from alternate sources of talent. This trend is expected to expand in the future as companies struggle to meet their personnel needs.

The consequences of this trend may not be trivial. Credential-based hiring systems generally put the onus on institutions of higher learning to ascertain the competency of an individual. In a skill-based hiring system, the onus is on the businesses to ascertain competency. Generally, this may require additional spending for talent and skills search by firms than in a credential-based hiring system. If this is to be the case, then HR departments and/or HR functions will require greater focus and attention by businesses, to ensure searching and hiring efforts are fruitful.

**Human Resource Function as an Enabler**

While upskilling is an important and necessary condition to meet the labour market demands for skills by industry, it is by no means a sufficient condition. It is also important to match employees with the right skills to the occupations needed by industry. This required matching will place added emphasis on HR functions as an enabler to achieve the needed skills capacity. Stakeholders have

indicated that HR departments play a key role over the whole life-cycle of upskilling their workforce, from (a) helping identify the occupational and skill needs of the organization, to (b) identifying the sources of talent and general assistance, to (c) helping fill in the occupation and skills gap by matching talent with the organization. Significant focus and investment in HR functions is critical to achieving the occupation and skills demanded by industry. The importance of a mature HR function cannot be overstated. In their annual cybersecurity workforce study, (ISC)$^2$ found that hiring managers within the cybersecurity sector who do not have a strong working relationship with HR are more than 2.5 times more likely to have significant staffing shortages compared to those who have built a strong relationship[543].

Naturally, such HR capabilities vary by sector and size of enterprise. Many SMEs, however, are disadvantaged as they may not have a dedicated HR department or function to assist in their occupational and skills attainment endeavors. In addition, any HR function that may exist are likely to be limited in scope and inadequate to meet the true needs of their organization. This will only serve to exasperate their skills challenge. This highlights the importance and need of a mature HR function that adheres to best practices, regardless of the sector in which it operates.

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[543] (ISC)2, Cybersecurity Workforce Study, 2022

# Conclusion

A flexible and resilient workforce will be vital to drive economic growth and sustainability in Canada. Effectively investing in upskilling, guided by industry and local demand, will allow Canada to utilize the full potential of its workforce. Upskill Canada has the potential to support companies access the talent they need to drive success and develop new career opportunities for workers to transition into high-demand roles.

Taken together, the analysis reveals that the six-high growth sectors identified by ISED have distinct challenges and opportunities. The distinctions arise due to the diverging impacts of global and local trends, maturity, and overall nature of activities in each sector. Therefore, it will be critical to ensure upskilling programs are not designed as a 'one size-fits all' given that sectors are facing different hiring challenges and occupation/skill gaps.

However, there is a degree of commonality prevalent across sectors. The research in this report identifies converging trends and objectives that will impact occupations and skills demanded across different sectors. This includes the continuous growth of the digital economy, an increase in automation, growing demand for cybersecurity, and the heightened importance of business and soft skills. The prevalence of these trends across sectors emphasizes that workers will need to continuously adapt and upskill to ensure a sustainable career path.

To help provide pointed direction related to the findings of this whitepaper, highlights of key takeaways related directly to upskill programs are provided below.

*Key Takeaways*

## Upskill programs need to be business-led

Engaging employers ensures that upskilling initiatives will align with industry needs, encourage employer participation, and facilitate the development of relevant training programs.

## Upskill programs need to address local demand

Regions have different comprising industries and so the occupations and skills demanded will vary. Programs at a local level are often more effective than at a broader regional or national level due to industry composition and demand differences.

## Continuously partner with educational institutions

Upskilling programs should work with educational and training institutions to co-develop curricula that supports a sustainable career path. In order for these programs to be successful they need to target specific technologies or knowledgebase. Industry and institutions will need to work together to standardize training around commonly adopted technologies to the fullest extent possible.

## Provide hands on experience/ co-op/work-integrated opportunities

It will be essential for businesses to provide more hands-on opportunities to overcome barriers to skill development and drive interest in the sector. Across different sectors there is a movement to reevaluate the emphasis placed on formal educational qualifications and prioritize practical knowledge and expertise. To seize this opportunity, it will be key for workers to have hands-on opportunities to develop their skills.

**Increase the engagement of women and equity-deserving groups:**

Actively recruiting and upskilling individuals from demographic groups that are traditionally under-represented, such as Indigenous persons, newcomers to Canada, and persons with disabilities allows sectors to tap into a diverse talent pool and unlock potential.

**Ensure soft-skills and business-skills are not neglected during the development of programs**

The World Economic Forum's 2023 Future of Jobs Report states that employers estimate 44% of workers' skills will be disrupted in the next 5 years. While technical skills are important to develop products, there still is a need for strong business skills to commercialize products and bring products to market. Therefore, to help manage the disruption, increased importance will need to be placed on business skills and soft skills such as problem-solving and interpersonal skills.

Looking forward, it will be key to continuously monitor trends and their impact on occupation and skills demanded. Coordination among governments, industry-leaders, institutions, and community groups will be key to address occupation and skills gap and ensure workers have the skills they need to succeed.

# Appendix

## Appendix A: Industry and Occupation Definitions – NAICS and NOC

## Advanced Manufacturing

| NAICS | Industry Title |
|-------|----------------|
| 3241 | Petroleum and coal products manufacturing |
| 3251 | Basic chemical manufacturing |
| 3252 | Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing |
| 3253 | Pesticide, fertilizer, and other agricultural chemical manufacturing |
| 3254 | Pharmaceutical and medicine manufacturing |
| 3259 | Other chemical product and preparation manufacturing |
| 3271 | Clay product and refractory manufacturing |
| 3279 | Other nonmetallic mineral product manufacturing |
| 3311 | Iron and steel mills and ferroalloy manufacturing |
| 3313 | Alumina and aluminum production and processing |
| 3315 | Foundries |
| 3331 | Agriculture, construction, and mining machinery manufacturing |
| 3332 | Industrial machinery manufacturing |
| 3333 | Commercial and service industry machinery manufacturing |
| 3336 | Engine, turbine, and power transmission equipment manufacturing |
| 3339 | Other general purpose machinery manufacturing |
| 3341 | Computer and peripheral equipment manufacturing |
| 3342 | Communications equipment manufacturing |
| 3343 | Audio and video equipment manufacturing |
| 3344 | Semiconductor and other electronic component manufacturing |
| 3345 | Navigational, measuring, electromedical, and control instruments manufacturing |
| 3346 | Manufacturing and reproducing magnetic and optical media |
| 3351 | Electric lighting equipment manufacturing |
| 3352 | Household appliance manufacturing |
| 3353 | Electrical equipment manufacturing |
| 3359 | Other electrical equipment and component manufacturing |
| 3361 | Motor vehicle manufacturing |
| 3362 | Motor vehicle body and trailer manufacturing |

| NAICS | Industry Title |
|-------|----------------|
| 3363 | Motor vehicle parts manufacturing |
| 3364 | Aerospace product and parts manufacturing |
| 3365 | Railroad rolling stock manufacturing |
| 3366 | Ship and boat building |
| 3369 | Other transportation equipment manufacturing |
| 3391 | Medical equipment and supplies manufacturing |
| 3399 | Other miscellaneous manufacturing |

## Biomanufacturing

| NAICS | Industry Title |
|-------|----------------|
| 3111 | Animal food manufacturing |
| 3254 | Pharmaceutical and medicine manufacturing |
| 3256 | Soap, cleaning compound and toilet preparation manufacturing |
| 339110 | Medical equipment and supplies manufacturing |
| 334512 | Measuring, medical and controlling device manufacturing |

## Clean Technology

|  | Industry Title |
|--|----------------|
| BS220 | Utilities |
| BS221100 | Electricity power generation, transmission and distribution |
| BS23C | Engineering construction |
| BS23C300 | Electric power engineering |
| BS3A0 | Manufacturing |
| BS335300 | Electric equipment manufacturing |
| BS540 | Professional, scientific and technical services |
| BS560 | Administrative and support, waste management and remediation services |
| BS562000 | Waste management and remediation services |
|  | Other industries |

## Ag-Tech

| NAICS | Industry Title |
|-------|----------------|
| 111 – 112 | Farms |
| 1111 | Oilseed and Grain Farming |

| NAICS | Industry Title |
|-------|----------------|
| 1112 | Vegetable and Melon Farming |
| 1113 | Fruit and Tree Nut Farming |
| 1114 | Greenhouse, Nursery and Floriculture Production |
| 1119 | Other Crop Farming |
| 1121 | Beef and Feedlots |
| 1121 | Dairy and Milk |
| 1122 | Hot and Pig Farming |
| 1123 | Poultry and Egg Production |
| 1124 | Sheep and Goat Farming |
| 1129 | Other Animal Production |
| 3116 | Meat Product Manufacturing |
| 3117 | Seafood Product Preparation and Packaging |
| 3331 | Agricultural Construction and Mining Machinery Manufacturing |
| 3332 | Industrial Machinery Manufacturing |
| 3334 | Ventilation, Heating, Air Conditioning, and Commercial Refrigeration Equipment Manufacturing |
| 3339 | Other General Purpose Machinery Manufacturing |
| 3353 | Electrical Equipment Manufacturing |
| 3359 | Other Electric Equipment and Component Manufacturing |
| 519 | Other Information Services |
| 5417 | Scientific Research and Development Services |

# ICT

| NAICS | Industry Title |
|-------|----------------|
| 3341 | Computer & peripheral equipment manufacturing |
| 3342 | Communications equipment manufacturing |
| 3343 | Audio & video equipment manufacturing |
| 3344 | Semiconductor & other electronic component manufacturing |
| 3345 | Navigational, medical & control instruments manufacturing |
| 3346 | Manufacturing and reproducing magnetic and optical media |
| 4173 | Computer & communications equipment & supplies wholesale distribution |
| 5112 | Software publishers |
| 5173 | Wired and wireless telecommunications carriers (except satellite) |
| 5174 | Satellite telecommunications |

| NAICS | Industry Title |
|-------|----------------|
| 5179 | Other telecommunications |
| 5182 | Data processing, hosting, and related services |
| 5415 | Computer systems design & related services |
| 8112 | Electronic & precision equipment repair & maintenance |

## Cybersecurity

| NOC | Industry Title |
|-------|----------------|
| 21220 | Cybersecurity specialists |

## Core ICT Occupations

| NOC | Industry Title |
|-------|----------------|
| 20012 | Computer and information systems managers |
| 21210 | Mathematicians, statisticians and actuaries |
| 21211 | Data scientists |
| 21220 | Cybersecurity specialists |
| 21221 | Business systems specialists |
| 21222 | Information systems specialists |
| 21223 | Database analysts and data administrators |
| 21230 | Computer systems developers and programmers |
| 21231 | Software engineers and designers |
| 21232 | Software developers and programmers |
| 21233 | Web designers |
| 21234 | Web developers and programmers |
| 21311 | Computer engineers (except software engineers and designers) |
| 22220 | Computer network and web technicians |
| 22222 | Information systems testing technicians |
| 72204 | Telecommunications line and cable installers and repairers |
| 72205 | Telecommunications equipment installation and cable television service technicians |

# Appendix B: Sector Definition – Alternative Definitions

## Clean Technology[544]

| Source | Definition |
|---|---|
| Government of Canada | "Clean technology is broadly defined as any process, product or service that reduces environmental impacts through environmental protection activities, through the sustainable use of natural resources, or through the use of goods that have been specifically modified or adapted to be significantly less energy or resource intensive than the industry standard.<br><br>Clean technologies are:<br>• Any good or service designed with the primary purpose of contributing to remediating or preventing any type of environmental damage;<br>• Any good or service that is less polluting or more resource-efficient than equivalent normal products which furnish a similar utility.<br><br>Their primary use, however, is not one of environmental protection." |
| Analytica Advisors | "Clean technology does much more than produce renewable energy. Cleantech companies are those with proprietary technology or know-how that addresses one or more of the following markets:<br>• Upstream Sectors: Biorefinery Products; and Power Generation<br>• Downstream Sectors: Energy Infrastructure/Smart Grid; Energy Efficiency/Green Buildings; Industrial Processes and Products; Extractive Processes and Products; Transportation; and Recycling, Recovery and Remediation<br>• Water and Agriculture Sectors: Water and Wastewater; and Agriculture" |
| MaRS | "A clean technology company is one that is focused on the creation of IP, new products and services that protect and/or increase efficient utilization of land, energy, water or natural resources." |
| Canada Cleantech | "Clean technology is new products, services and business models that simultaneously improve economic performance and reduce environmental footprint.<br><br>Sub-sectors include:<br>• Water<br>• Cleantech related to Agriculture<br>• Cleantech related to Oil and Gas<br>• Cleantech related to Mining<br>• Hydrogen and Fuel Cell<br>• Waste<br>• Renewable Energy and Storage<br>• Energy Efficiency and Smart Grid<br>• Green Chemistry<br>• Air<br>• Eco-mobility" |

[544] ECO Canada, Cleantech Defined: A Scoping Study of the Sector and its Workforce, 2020

| Source | Definition |
|---|---|
| Cleantech Group | "Clean technology, or "cleantech", should not be confused with the terms environmental technologies or "green tech" popularized in the 1970s and 80s. Cleantech is new technology and related business models offering competitive returns for investors and customers while providing solutions to global challenges. Where greentech, or envirotech, represents the highly regulatory driven, "end-of-pipe" technology of the past with limited opportunity for attractive returns, cleantech is driven by market economics therefore offering greater financial upside and sustainability. The concept of cleantech embraces a diverse range of products, services, and processes across industry verticals that are inherently designed to: <br>• provide superior performance at lower costs, <br>• greatly reduce or eliminate negative ecological impact, and <br>• improve the productive and responsible use of natural resources." |
| Export Development Canada | "It's any process, product or service that reduces environmental impacts, fosters sustainability and provides goods that use less energy and fewer resources than the industry standard. Cleantech permeates all sectors of the economy, as our environmental footprint can be found in every conceivable activity. The most common applications are found in manufacturing, mining, oil and gas, transportation, power generation, water, agriculture, recycling and other energy efficiency activities." |
| Delphi Group | "Clean technology or Cleantech is a term used to describe products or services that improve operational performance, productivity, or efficiency while reducing costs, inputs, energy consumption, waste, or environmental pollution. <br><br>The framework includes the following high-level categories: Alternative Energies; Energy Efficiency and Clean Building Technology; Transportation; Recycling, Remediation, and Waste Management; and Support Services, Knowledge, and Conservation (includes the 'Cleantech Support' category, but also includes education and conservation)." |
| BC Cleantech CEO Alliance | "Cleantech sector has been defined to include companies with the primary purpose of developing new technologies related to clean energy production, transmission, storage, or use; water treatment and management; and/or efficiency in energy or resource management and use." |
| Alberta Clean Technology | "Cleantech are novel services, processes, products and activities that improve economic performance and reduce environmental footprint relative to the baseline." |
| Écotech Québec | "Clean technology, also known as Cleantech, green technologies, greentech, eco-innovations, ecotechnologies and Ecotech, are part of a sustainable development outlook that includes new products, services, technologies and processes that: <br><br>• Significantly reduce negative impacts on the environment (environmentally effective) <br>• Offer users superior performance at a lower cost (economically superior) <br>• Help improve the quality of life by optimizing resource use (socially responsible) <br><br>Sectors include Renewable Energy, Green Chemistry, Energy Efficiency, Electric and Smart Vehicles, Air, Soil and Agriculture, Water, and Waste." |

| Source | Definition |
| --- | --- |
| Ontario Clean Technology Industry Association | "Clean technology, or cleantech, includes novel services, processes, products, and activities that improve economic performance and significantly reduce environmental impacts. In general, this includes, but is not limited to, better solutions for energy use, water management, food production, and transportation." |

# Appendix C: Acronyms

| Acronym | Definition |
| --- | --- |
| AI | Artificial Intelligence |
| CAP | Canadian Agriculture Partnership |
| CIFA | Canadian Food Inspection Agency |
| CME | Canadian Manufactures & Exporters |
| COPS | Canadian Occupational Projection System |
| CPPA | Consumer Privacy Protection Act |
| EMC | Excellence in Manufacturing Consortium |
| ESG | Environment, Social and Governance |
| EU | European Union |
| EV | Electric Vehicles |
| GDP | Gross Domestic Product |
| HR | Human Resources |
| ICT | Information and Communications Technology |
| ICTC | Information and Communications Technology Council |
| INACCT | ICTC National Advisory Committee on cybersecurity Training |
| IoT | Internet of Things |
| IP | Intellectual Property |
| ISED | Innovation, Science and Economic Development Canada |
| IT | Information Technology |
| LLM | Large Language Model |
| NAICS | North American Industry Classification System |
| NOC | National Occupation Classification |
| OaSIS | Occupational and Skills Information System |
| PEO | Professional Engineers Ontario |
| PPE | Personal Protective Equipment |
| R&D | Research and Development |
| RNA | Ribonucleic acid |
| SDTC | Sustainable Development Technology Canada |
| SME | Small and Medium-Sized Enterprises |
| STEM | Science, Technology, Engineering, Mathematics |
| TFW | Temporary Foreign Worker |
| US | United States |
| USD | United States Dollar |

# Appendix D: Sources

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