Workforce in Motion

Labour Market Intelligence Study

2017–2022

electricity HUMAN RESOURCES CANADA · RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

ABOUT ELECTRICITY HUMAN RESOURCES CANADA

Electricity Human Resources Canada (EHRC) is a national, not-for-profit organization that researches human resources challenges and opportunities in the electricity sector — and develops tools to address them. The organization is recognized for producing and disseminating high-quality, relevant electricity industry research, and is in a unique position to bring together industry stakeholders to provide a national, big-picture perspective on issues that affect the sector. It is the only national electricity organization that supports HR and skills development and ensures industry stakeholders across Canada have a voice.

EHRC's specific objectives are to:

- Conduct and disseminate valuable research about human resources in Canada's electricity industry
- Help the industry create and sustain a skilled and diverse labour force
- Promote awareness of career and employment opportunities in the industry
- Develop partnerships that better enable the industry to meet its human resources needs

Further information on EHRC is available at www.electricityhr.ca.

Ce rapport est également disponible en français sous le titre : Main-d'oeuvre en mouvement : Étude de l'information sur le marché du travail 2017–2022 | This report also available in French.

The opinions and interpretations in this publication are those of the author and do not necessarily reflect those of the Government of Canada.

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ACRONYMS

C4SE	Centre for Spatial Economics
CCTT	Canadian Council of Technicians and Technologists
DES	Distributed energy system
EHRC	Electricity Human Resources Canada
EV	Electric vehicles
G7	Canada, France, Germany, Italy, Japan, United Kingdom, United States
G20	Argentina, Australia, Brazil, Canada, China, European Union, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, United States
GDP	Gross domestic product
GHG	Greenhouse gas
ICT/IT	Information and communication technology/Information technology
IEA	International Energy Agency
LED	Light-emitting diode
LMI	Labour market intelligence
LNG	Liquefied natural gas
MW	Megawatt
NAICS	North American Industry Classification System
NOC	National Occupatino Classification
POMS	Provincial Occupational Modelling System
PV	Photovoltaic
RAIS	Registered Apprenticeship Information System
STEM	Science, technology, engineering and mathematics
TAC	Technology Accreditation Canada
UNFCCC	United Nations Framework Convention on Climate Change
ZEV	Zero-emissions vehicle

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EXECUTIVE SUMMARY

Introduction

Building on the 2011 *Power in Motion* report, this current study presents the key results from a fourth round of research and analysis conducted by Electricity Human Resources Canada (EHRC) which examines how key transitions underway, domestically and globally – including the decarbonization of the electricity system, electrification of the economy and digitalization and democratization – will affect Canada's electricity workforce as it moves forward over the coming years.

The evidence presented in this report draws on data collected through detailed surveys and interviews with key industry and education stakeholders in 2017-2018, as well as publicly available government and academic literature and statistical data to develop a profile of the electricity sector workforce. This mixed-method approach to data collection provides new evidence of workforce demographics, identifies changes in labour markets, training programs and human resource management practices and outlines a call to action for sector human resource management planning and training through a series of key recommendations. Similar to the 2011 report, new dimensions added to this update include a detailed labour supply analysis for key occupations[i, ii, iii] and market assessments that point out potential areas of competition, job opportunities and successful recruiting.

A long-term strategic and national approach to human resource planning and training is critical to ensuring that the sector continues to maintain the level of growth, affordability, sustainability, reliability, safety and productivity.

Trends in the Electricity and Renewable Energy Industry

Industry in State of Transition – A Workforce in Motion

Decarbonization of the Electricity System

As a signatory of the 2015 Paris Agreement, Canada pledged to reduce greenhouse-gas emissions by 30% below 2005 levels by 2030.[iv] At the national level, in 2015 Canadian Premiers adopted the Canadian Energy Strategy, which identifies three key themes to guide the future of energy in Canada: sustainability and conversion; technology and innovation; and delivery of energy to people. For the electricity sector, interprovincial collaboration objectives included in the Clean Energy Strategy relate to encouraging further deployment of alternative renewable energy using innovative approaches, such as energy storage, smart grids and on-site micro-generation.

In December 2016, the Pan-Canadian Framework on Clean Growth and Climate Change was adopted. This framework describes strategies to reduce green-house gas (GHG) emissions to 30% of 2005 levels, including the introduction of carbon pricing, actions to decarbonize electricity and the electrification

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[i] Occupations are based on the 2016 National Occupation Classification.

[ii] The list of occupations included expanded from the 2011 report. The expanded list incorporates growth in renewable energy, cyber security and other developments in the industry.

[iii] Distinctions between different occupations can be dependent on province. For example, electricians and industrial electricians are the same occupation in Alberta, but are distinct occupations in Ontario. Additionally, there are no mandatory trades in British Columbia.

[iv] Generation Energy Council. (2018). *Canada's Energy Transition: Getting to Our Energy Future, Together.*

of transportation. Further, and as part of Canada's efforts to reduce GHG emissions, the federal government has introduced, or is introducing, a range of policies to regulate carbon dioxide emissions from electricity generation, such as the *Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations* (2015) and the *Natural Gas-Fired Power Regulations* (forthcoming).

At the international level, while coal is predicted to remain the largest source of global power output to 2023, an increasing proportion of electricity generation is expected to come from renewable sources. Canadian provinces and territories continue to implement regulations to reduce emissions and targets to expand renewable energy supplies. These strategies and targets are tailored to each province's local context and include generation sources such as hydroelectricity, nuclear energy, carbon-capture technology, tidal electricity, solar photovoltaic (PV) technologies, biomass and wind farms. Access to cleaner forms of electricity could also be expanded by interprovincial trade in electricity, through which high GHG emission in electricity generation is being replaced by lower GHG emission generation.

Total end-use energy demand grew approximately 1.2% from 1990 to 2016, and although total end-use energy demand is expected to increase, it is projected to do so at a slower rate than in comparison to historical trends. By 2040, end-use energy demand is projected to be 6,802 petajoules for the industrial sector, 2,430 petajoules for the transportation sector, 1,591 petajoules for the commercial sector and 1,545 petajoules for the residential sector. This accounts for overall end-use demand of 12,368 petajoules of total end-use demand, which is an annual average increase of 0.2%.

Digitalization and Democratization of the Electricity System

Over the past 10 years, technological changes in the electricity sector have been significant and are expected to continue. For example, smart grids build upon, and further expand, existing electrical grids by incorporating digital technologies that enable communication both between the utility and its customers, as well as between the transmission lines and the provider. Micro-grids have developed decentralized energy systems that can function in isolation from the centralized grid and allow consumers to generate their own energy. Energy storage has evolved to support intermittent access to solar and wind power.

The increase in interconnection required to drive these technologies has introduced an unprecedented degree of access to data and information. The electricity sector collects large amounts of data on a continuous basis and this will increase substantially as utilities strive to improve operational efficiencies and energy management on the demand side.

This increased access to data comes with both opportunities and challenges to the electricity industry. Big data analytics allows for the interpretation of the data to generate a better understanding of customers and increase monitoring of the grid. Blockchain assists in the management of data by providing a method to record and verify transactions without requiring a central authority; however, it can place significant strain on the grid. Further, the increased interconnection also makes networks more vulnerable to attacks, requiring dedicated cyber security resources necessary to ensure its safety.

Electrification of the Economy

Technology developments continue to impact consumers access and use of the grid. For example, as the sales of electric vehicles (EV) grows, so does their impact on the electrical grid. However, electrification of the economy is broader than just EVs, it includes heating in the residential, institutional, commercial, and industrial sectors, and industrial processes. Electrification can lead to a significant increase in the electricity demand, both from utility-scale projects and from prosumers, but this could be mitigated by aggressive energy efficiency and energy conservation measures.

Changes to the electrical grid also impact workers in the sector. Automation of work results in a re-deployment of workers, changing the nature of their occupations. While automation has not had an impact on net employment in the industry to date, employers anticipate a greater impact in the future. Additionally, advances in technology are seeing employees utilise different technologies. Unmanned aerial vehicles (UAVs) – drones – improve employee awareness of the grid and help in data collection for design and construction management. Further, they cut operation and maintenance costs, boost worker safety because they can fly in potentially dangerous areas and use little to no fuel.

These transitions and challenges have set in motion several factors changing Canada's energy sector competitiveness of as well as the nature of work for employers, the workforce and job seekers alike. At the same time, the impact of technological innovations requires a workforce that is continuously learning and upgrading its knowledge and skills. Industry stakeholders need to be aware of, and respond to, these developments.

Portrait of the Electricity Industry & Workforce

The electricity sector is the largest employer of utility workers in Canada. According to Statistics Canada data (2016), the electricity industry employs 106,575[v] people in Canada across multiple business lines and occupations. Respondents to the 2017 EHRC Employer Survey represented a total of 79,838 employees working in Canada. While the most commonly identified business line was electricity distribution (59%), employer reported data illustrates that electricity generation, including renewable energy, employs the greatest number of workers, accounting for over a third (37%) of the total reported workforce.[vi] Additionally, the bulk of workers in the sector are reported to be employed within larger organizations (over 500 employees).[vii] Over two-thirds (69%) of organizations operate in a relatively focused region, either locally (municipal) or provincially. [viii]

A Stable Workforce

The age distribution of the workforce has changed since the 2011 Labour Market Intelligence (LMI) study. Unlike the previous study, the current electricity workforce no longer shows a bias towards older workers (55 years and older). Similar to the 2011 LMI study, however, the representation of younger workers (under 25 years) within the electricity sector (5%) is lower than the reported general workforce in 2016 (14%). The age distribution of workers is relatively flat overall, indicating a stable workforce.

This stability is also reflected in lower voluntary termination rates and retirement rates among employees. According to employer reported data, both the overall voluntary termination rate and the retirement rate for the industry in 2016/17[ix] were 2%. Additionally, retirement rates were expected to stay relatively the same for 2018 (2%) and 2022 (3%). Employers also reported that workers were staying on the job longer than was previously expected.

According to Statistics Canada, Canada's average retirement age is 63[1] with older generations often staying in the workforce longer. Many could be working longer, in part, to make up for losses suffered during the 2008-09 recession while others for pure enjoyment. A growing trend is that older workers

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[v] Statistics Canada. 2016 Census of the Population: Catalogue no. 98-400-X2016295.

[vi] EHRC Employer Survey, 2017

[vii] Ibid.

[viii] Ibid.

[ix] Employers completing the EHRC Employer Survey, 2017 were asked to provide "the last year for which you have a full year's worth of data". As the survey ran from Autumn 2017 to Summer 2018, employers reported on different years for which they had complete information. Most employers indicated that they provided data from 2017 (90%) rather than 2016 (10%).

are choosing to stay in the workplace because they want to be there - enjoying meaningful work is a key reason for delaying retirement[2].

Occupations: Trades and Engineering Occupations Dominate
Trades (42%) and engineering (22%) are the most dominant occupational groups within the electricity workforce, accounting for nearly two-thirds of the workers. Electrical and Electronic Engineers and Powerline Technicians are the largest occupations within the industry, each accounting for 11% of the total workforce. Renewable occupations were the smallest occupational group within the industry, likely reflective of the newness of these technologies.

Workforce Diversity: Overall representation little changed
New for this study, efforts were made to gather more fulsome diversity statistics.
EHRC research and consultations to date (both as part of this LMI study and other studies) indicate that there is a recognition, interest and willingness on the part of employers to maximize the labour market relevance of being more inclusive of talent from under-represented groups and employers have engaged in various activities to increase participation. However, based on study findings, workforce diversity (not unlike other similar sectors) still poses a challenge with diversity groups continuing to remain well below the average for the Canadian workforce.

Nationwide, 48% of workers across all industries are women; however, only 26% of workers in the electricity sector[x] are women, increasing only slightly (1%) from 2011 study findings. Women continue to be underrepresented in the trades, accounting for only 7% of the trades workforce,[xi] demonstrating a marginal increase (2%) since the 2011 LMI report. In contrast, women have made marginal advances in engineering occupations, accounting for 21% of the workforce compared to 18% in 2011. The proportion of Indigenous Peoples working the electricity sector is 4.7%[3] with a high concentration in the trades. While 8% of trades workers are Indigenous, they make up less than 4% of all other occupation classes. Persons with disabilities represent less than 3% of the electricity workforce for each of the occupational groups. Visible minorities are also generally underrepresented but have a greater presence within engineering and IT occupations.

In order to affect change, industry employers need to develop and or renew attraction and retention programs to reach out to all demographics.

Contingent Workforce: Reliance on Contractors Remains the Same
Contractors and consultants continue to be regularly used within the electricity industry. Employers reported that contractors and consultants complete 27% of tasks on a routine or frequent basis, compared to 25% in 2011. Contractors assist firms with meeting sudden workload demands due to either shifts in peak demand or completing short-term projects (e.g. Powerline Technicians). Contractors also provide employers with access to specialized skills that may not yet be present in-house (e.g. cyber security). Most employers noted that they plan to utilize contractors and consultants at the same rate as in the past indicating that they represent a substantial contingency workforce in the industry.

Hiring Difficulty and Insufficient Mid-Level Experience Linked to Operation of the Grid
Employers reported that the most challenging occupations to fill in 2017 were Smart Grid Specialists, Power Systems Operators, Power Station Operators and Power Systems Electricians. Employers also expected that these occupations will continue to be the most challenging to fill by 2022.[xii]

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[x] Statistics Canada. 2016 Census of Population: Catalogue no. 98-400-X2016290.
[xi] EHRC Employer Survey, 2017
[xii] Ibid.

Additionally, not unlike other sectors, employers reported the potential for future challenges in replacing all senior managers as they begin to retire, noting the lack sufficient numbers of employees with requisite mid-level experience.

Competition with Other Employers still Looms
Employers in the electricity sector are competing for workers with other industries. With the exception of some specialized trades, e.g. power line technician, most occupations within the electricity sector share skills that are transferable to other industries. In particular, the labour markets for engineers; construction; and information and communication technology all share occupations and skills that are utilized by with the electricity sector. As such, the ability of electricity employers to recruit workers in a wide range of shared occupations will be impacted by labour market conditions within these industries.

Limited Succession Planning and Knowledge Transfer
Over two-thirds (69%) of employers had succession plans in place for management, while less than half of employers had succession plans for other occupational groups (i.e. engineers/engineering technologists (48%), trades (43%), renewable occupations (26%), information and communications technology (ICT) (32%). Internal pipelining of staff was the most prominent method of succession. Knowledge transfer through this method is achieved through coaching and mentoring (35%), updating manuals and documentation to reflect most current operational processes (14%) and cross-training (3%).

Workforce Supply

An adequate pool of trained and experienced workers is of utmost importance in terms of ensuring the long-term stability of Canada's electricity supply. Modernizing the system not only improves the way we store and get power, it also provides jobs for workers who have the right training.

The electricity sector is not a 'just in time industry'. The workforce is highly skilled and educated with the majority of jobs requiring post-secondary education and long lead times to full competency when a new employee enters a role.

Post-Secondary Education: An Increasingly Educated Workforce
The electricity sector boasts a workforce that is highly educated and is tied directly to the following three streams of post-secondary education: undergraduate and graduate programs in engineering; college programs for engineering technicians, technologists and other occupations; and apprenticeships.

Apart from renewable occupations, most workers in the sector have some level of post-secondary education. Over half of engineers and Information and Communication Technology (ICT) workers had a university degree. Within renewable occupations, 46% of workers had achieved a high school diploma or less as their highest level of education. This lower proportion of post-secondary education within renewable occupations may reflect a lack of formal training opportunities or a lack of standardization for training specific to renewable energy. A continuous change in renewable technologies implies that training may be ad hoc and on-the-job, rather than formal.

Across Canada, enrollments in undergraduate mechanical engineering programs showed steady growth, increasing 30% from 2012 to 2016, with an annual average growth rate of 7%. Enrollments in undergraduate civil and electrical engineering programs were stable from 2012 to 2016, increasing by a total of 6% and 12% respectively. Graduation rates for these programs increased by a total of approximately 18% to 20% from 2012 to 2016 at an annual average growth rate of 4% to 5%.

Like the relatively consistent enrollment figures of civil and electrical undergraduate programs in Canada, post-graduate enrollment figures for these disciplines were also relatively constant from 2012 to 2016. Enrollments for post-graduate mechanical engineering programs increased by approximately 22%; however, not at the same rate as undergraduate enrollments.

The CCTT through the Canadian Technology Accreditation Board (CTAB) accredits over 250 college programs for technicians and technologists in Canada, many of which relate to the electricity sector.[xiii] In partnership with the National Council of Deans of Technology and the Council of Registrars, CCTT developed outcome-based criteria for national accreditation and certification in Canada. These requirements have been accepted by the Association of Community Colleges for the benefit of all educational agencies in Canada.[xiv] The CCTT represents the profession of technicians and technologists in Manitoba, New Brunswick PEI, and Newfoundland and Labrador. Furthermore, Technology Professionals Canada (TPC) which advocates for the profession of technicians and technologists within Alberta, Saskatchewan, Ontario, British Columbia and the Yukon has developed a standard accreditation model which operates under Technology Accreditation Canada (TAC). A total of 55 programs have been granted national program accreditation status by TAC.

According to Statistics Canada data, the annual completion rate for apprentices was approximately 13% from 2011 to 2015. Completion rates peaked in 2013 at 14% and decreased in 2014 and 2015. The number of certificates awarded for construction electricians has decreased since 2013 by a total of 11%. Welding certificates decreased in 2015 and 2016 by 17%. Completion rates for industrial mechanics (millwrights) have been relatively stable since 2014; however, these completion rates have decreased from a high of 1,779 in 2012 to 1,626 in 2016.

Supply Trends

[xiii] Canadian Council of Technicians and Technologists (CCTT). 'Programs and Services'. Available at: https://www.cctt.ca/programs-services. [Accessed 14 November 2018]
[xiv] CCTT. *The National Technology Benchmark*. Available at: https://www.cctt.ca/programs-services. [Accessed 14 November 2018]

Student Recruitment
Educational institutions generally conduct specific outreach strategies to attract Indigenous and female students to electricity and renewable energy programs. For Indigenous students, educational institutions reported they conduct targeted promotion (39%), provide financial benefits or assistance (17%), provide a special admission stream (11%), offer additional supports e.g. educational, physical (11%) and reserve spaces (6%). Strategies for attracting female students reported by educational institutions include conducting targeted promotions (50%), financial benefits (28%), special admission stream (6%) and additional supports (6%).

Electricity and Renewable Energy Educational and Training
Post secondary institutions in Canada offer several programs designed to develop the necessary technical skills for the electricity and renewable energy sector. Institutions surveyed most commonly offered electrician certification (59%), followed by technologist programs (CET, AscT/TscA, PTech/TP) (38%) and engineering programs (29%).

For programs to remain relevant, academic institutions attempt to introduce new technologies and concepts in order to keep up with the evolving electricity and renewable energy operational environment. Educational institutions incorporate new technologies through course lab components and continuous updates of program curricula. Some institutions, particularly colleges, have established program advisory committees which incorporate feedback from industry to ensure their programming remains current.

Professional Skills
Increasingly, there is more employer demand for workers with professional skills, such as communication, social perceptiveness, time management and coordination in the electricity sector. Canada's educational institutions are responding by integrating professional skills into programming through team or group work, capstone projects, formal courses, tutorials and support programs and project and lab work. Work ethic and leadership skills are commonly taught informally, if at all, at institutions, while written communication, verbal communication, time management and problem solving are being taught more formally. When looking at the methods used to teach professional skills by educational institution type (i.e. university and non-university), the survey findings show that non-university post-secondary institutions rely more on informal teaching methods.

Educational and Training Gaps
To improve education and training in electricity and renewable energy occupations, Canadian post-secondary institutions recommend the development of national occupational training standards and certification bodies for new and emerging occupations. National standards and certification bodies can create and maintain standards for training and skill requirements which will ensure new workers, regardless of their region of training, develop common skills for new and emerging occupations. Furthermore, developing essential skills' profiles for new and emerging occupations in the electricity and renewable energy industry can help inform potential workers of the requirements of new occupations.

A significant concern among educational institutions is the speed at which technology evolves, particularly in the electricity industry. Educators noted that, on average, establishing a new program in electricity/renewables takes one to three years. To increase the speed with which skilled workers in the renewables sector are available, stakeholders noted that post-secondary institutions should incorporate required training into existing trade pathways. This implies that instead of creating new programs, post-secondary institutions should update existing programs which incorporate new technology or business practices. For example, increasing engagement with industry to communicate industry innovations and changing business practices, expanding co-op and other work-integrated learning programs, develop career awareness materials and establish post-secondary industry liaisons.

Other challenges to the provision of required training include limited capital equipment funding for training aids and space, as well as insufficient access to qualified, experienced and knowledgeable program designers, curriculum developers and instructors.

Transition to the Workforce and Further Education

Student transition is best supported through industry networking opportunities, such as tradeshows and workshops, which allow students to directly connect with industry and learn about different companies, careers and workplace opportunities. Industry networking opportunities are particularly important for foreign-trained entrants due to their lack of established relationships. Without networking opportunities foreign-trained entrants would be at a severe disadvantage in gaining employment.[xv] Furthermore, work integrated learning (WIL), a work based experiential learning activity associated with a program of study, was also viewed as a useful tool in allowing students to gain work experience while studying. Programs, such as EHRC's Empowering Futures, provides incentives for employers to create new WIL opportunities such as co-ops, field placements, capstone projects or case competitions.

Additionally, due to the lag time in implementing new programs, educational institutions felt there is a growing need for competency-based learning or alternative credentialing. Competency-based learning was described as training in specific skills needed by employers, rather than longer-term degree or credential programs. Competency-based learning would be able to keep up with the way technology quickly evolves. The cost of education was also viewed as a barrier to transitioning workers. The high cost and length of time for existing workers to retrain has resulted in increased demand for online and modular training opportunities.

A Look Ahead to 2022

Forecasted Employment

Employment in Canada's electricity and renewable industry is anticipated to increase at an annual rate of approximately 0.4%, with a cumulative increase of 2% across the 2017 to 2022 period. This rate of growth reflects the transition from coal-fired electricity generation to new forms of electricity generation, such as natural gas and renewable (solar, wind, hydro and biomass). At the occupational level, the highest rate of employment growth is expected for electrical and electronics engineers (3%) and computer network technicians (3%).

Job Openings

The forecast model calculates the number of job openings for the electricity sector by examining hiring requirements due to expansion demand (i.e. change in employment as workforce activity grows or contracts each year as a result of economic conditions), as well as replacement demand (i.e. deaths and retirements).[xvi]

Expansion Demand: Modest Employment Growth

Employment in Canada's electricity industry is anticipated to increase at an annual rate of approximately 0.4%, with a cumulative increase of 2% across the 2017 to 2022 period. This rate of

[xv] Heuser, L. (2018). 'Closed shops: making Canada's engineering profession more inclusive of international engineers'. Available at: https://www.6degreesto.com/article/closed-shops-2018/. [Accessed 21 November 2018]

[xvi] Deaths does not refer to work related deaths, but deaths from natural causes or illness. Voluntary separations are negligible and not included.

growth reflects the transition from coal-fired electricity generation to new forms of electricity generation, such as natural gas and renewable (solar, wind, hydro and biomass). At the occupational level, the highest rate of employment growth is expected for electrical and electronics engineers (3%) and computer network technicians (3%). These occupations are expected to grow due to the increase in renewable energy production and distribution, as well as the growing importance of cyber security.

Replacement Demand: Only Slight Increases in Retirement

The forecast model estimates that the proportion of retiring workers from the Canadian electricity workforce will increase slightly, from 2.3% in 2017 to 2.6% in 2022. Even when overall expansion demand is negative from 2019 to 2022, the total number of employees required by the electricity sector in the coming years is only 20% of the current workforce. Between 2017 and 2022, the industry will need to recruit 20,578 new employees; 15,414 of that will be due to employees exiting as a result of retirement, while 2,875 of the new labour force will be due to expansion demand

Supply Side Measures

It is anticipated that new entrants will comprise over half of the additional workers available to the electricity sector labour force over the coming years.[xvii] According to the forecast model, international migrants made up a significant portion of the supply of additional workers in 2017 (approximately 43%). This is expected to decrease over the next 5 years, while the share of domestic new entrants is estimated to increase, going from 50% in 2017 to 59% in 2022. Domestic new entrants refer to the labour force increase resulting from the number of young people, aged 15 to 30, entering the labour force for the first time.

Labour Market Rankings

The LMI model uses the demand and supply measures for specific occupations and consolidates them into a market ranking. The demand and supply measures are calculated for all industries as the model assumes that the supply of workers can come from any industry. Using these measures, the model develops three rankings, which include the demand rank, supply rank and unemployment gap rank. A weighted average of the three rankings has been used to calculate an overall rank related to labour market tightness for selected occupations across all industries. The labour market rankings are defined in Table E1.

Table E1– Labour Market Rankings Defined

Rankings and Descriptions	
1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what

[xvii] Supply side measures developed through the forecast model incorporates the number of workers in all industries, as it is assumed that workers in other industries can be employed in the electricity sector. For example, an electrician in oil and gas extraction can also be an electrician in the electricity sector.

Rankings and Descriptions	
	they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

The model shows that between 2017 and 2022, the majority of electricity occupations will experience balanced markets or markets with slight excess supply from 2017 to 2022. 'Balanced markets' implies normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal, organizations may have to rely on migrants to meet supply, but this situation is not different from what they have faced in the past. The unemployment rate gap is very small which means that the actual unemployment rate for occupations is roughly equal to or slightly higher than the long-term unemployment rate. Slight excess supply indicates a situation where there are slightly more workers available than expected to meet demand. Demand pressure is lower than usual; there is less reliance than expected on migrants to fill jobs. The unemployment rate is slightly higher than the normal rate making it easier than normal to find workers.

Some occupations, particularly engineers and engineering technologists, will have slight excess of demand for periods over the forecast horizon, resulting from a decrease in the size of the labour force or from an increase in number of job openings, low actual unemployment rate or reduction in net international in-migration. The labour market rankings for individual occupations are presented in Table E2.

Table E2 – Labour market rankings for electrical occupations in Canada – C4SE POMS Forecast Model

Occupations	2017	2018	2019	2020	2021	2022
Managers and supervisors						
Utilities managers	2	3	4	4	3	3
Supervisors of electricians and electrical powerline workers	2	3	3	3	3	3
Engineering managers	2	4	4	3	3	3
Construction managers	3	3	3	3	2	2
Engineers and engineering technologists						
Electrical and electronics engineers	2	4	3	3	3	3
Mechanical engineers	2	4	4	4	3	3
Civil and other engineers	2	4	4	3	3	3
Electrical and electronics technologists and technicians	3	4	3	3	3	3
Mechanical engineering technologists and technicians	3	4	4	3	3	3
Civil engineering and other technologists and technicians	2	4	4	3	2	2
Radiation technicians	2	4	4	4	3	3
Trades						
Powerline technicians and cable technicians	2	3	4	4	4	3
Utility arborists	2	3	3	3	3	3
Power systems operators (includes power station operators, wind technicians, smart grid specialists)	4	3	3	4	4	4
Power system electricians	2	4	3	3	3	3
Construction electricians	2	3	4	3	3	3
Industrial electricians	3	4	4	4	4	3
Millwrights or industrial mechanics	3	4	4	4	4	3
Electrical mechanics	2	2	4	4	4	4
Welders	2	4	4	4	3	3
Renewable energy and climate change occupations						
Solar panel installers	3	3	3	3	3	3
Information and communication technology occupations						
Information systems analysts and consultants (includes cyber security specialists)	4	3	3	4	4	4
Database analysts and data administrators	3	3	4	4	4	4
Software engineers and designers	4	3	3	3	3	4
Computer programmers and interactive media developers	4	3	3	3	3	3
Computer network technicians	3	2	3	4	4	4

Source: C4SE POMS Forecast, EHRC Employer Survey

SECTION 1: INTRODUCTION

1.1 The Industry is in a State of Change – A State of Motion

Globally and within Canada, the electricity sector is in a state of change – a state of motion. One of the most significant drivers of change is world-wide efforts to reduce greenhouse gas (GHG) emissions from high-emitting industries, including electricity. In Canada, federal, provincial and territorial energy policy focuses on reducing GHG emissions from the electricity sector by moving away from traditional coal-fired power generation and toward renewable and non-emitting sources of power generation. These policies have led to reduced GHG emissions from combustion-based electricity generation; increased electricity generation through hydroelectric, nuclear, solar, wind and biomass sources; and increased interprovincial trade in electricity.

Another significant driver of change in the sector is the digitalization and democratization of the electricity system, alongside electrification of the economy. Increasingly, smart and micro-grids are being incorporated into existing electrical grids. As a result, the sector is now having to consider and address previously unknown challenges such as how to manage and store energy generated in a circular economy[4], how to support the demand and impact of electric vehicles (EVs) and other smart appliances on the grid, how to identify and mitigate cyber threats and how to manage increased automation in the management of systems (smart grids) along with ensuing management and use of data analytics.

Given the extensive change in the electricity sector, recruitment and retention of employees with appropriate qualifications and skills are the most important human resources-related issue that businesses face. As the sector becomes more sophisticated, employers will have increasing demand for employees with the qualifications and skills required to work in an ever-changing, diverse, interconnected and technological electricity sector. To meet their labour needs, businesses may become more reliant on recruiting employees with transferrable skills from other industries, particularly those in engineering and information and communications technology (ICT).

This report is a call to action that supports the sector's human resource management plan to navigate the complex and rapidly changing environment in the coming years to 2022. Building upon the 2011 Power in Motion report from the EHRC, it provides new evidence about workforce demographics, labour market changes, training programs and human resource management practices in the context of a rapidly changing energy landscape. It provides both current information and long-term estimates and assessments of labour demand and supply, specifically for the Canadian electricity sector. Through its findings, this report aims to inform and improve the way the electricity sector conducts workforce planning, training and needs analyses, as both industry and government look to advance policy within the larger context of a national (and international) energy strategy.

1.2 Report Overview

Section 2 sets the stage for the study and its analysis by providing a description of current trends in the electricity sector. It begins with an overview of capital investment in the sector and describing factors that are contributing to decarbonization of the electricity system. Section 2 also discusses key technological developments impacting Canada's electricity sector, such as digitalization and democratization of the electricity system and electrification of the economy.

Section 3 provides a profile of the workforce, including key demographics and trends, business lines, training and future training needs, as well as the use of contractors. In addition, this section looks at diversity (Indigenous people, immigrants and visible minorities), and provides a closer look at the representation of women in the sector. Section 4 presents a description of workforce supply in Canada, including post-secondary enrollment trends, student recruitment and graduation rates, transitions to the workforce, as well as trends and issues impacting workforce supply. Section 4 also provides an update to EHRC's forecast for hiring requirements and available talent, covering the years 2017 to 2022. Highlighted in Section 5 is a summary of findings and recommendations for action to address key human resource issues in the sector.

Results presented in this report are drawn from surveys and interviews conducted with key industry and education stakeholders, as well as publicly available government and academic literature and statistical data such as Statistics Canada's 2016 Census which serves as a proxy (where needed) to provide a profile of the electricity sector workforce. The use of multiple lines of evidence ensures that this report is comprehensive, robust and in line with the highly regarded earlier studies.

To meet these project objectives (see Section 1.2), the team adopted a mixed-method approach designed to produce robust evidence-based findings. Activities included a literature review and an environmental scan, a review of secondary data available through Statistics Canada, nation-wide surveys with both employers and educational institutions, as well as interviews with key industry and educational stakeholders. Data were then run through an occupational modeling system developed by the Centre for Spatial Economics (C4SE) to forecast labour supply and demand conditions. A description of the economic modeling system used is provided in Appendix C.

ENDNOTES: SECTION 1

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[1] Retirement age by class of worker, annual. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410006001
[2] Why older workers keep staying on the job. CBS News. (2017) https://www.cbsnews.com/news/why-older-workers-keep-staying-on-the-job/
[3] Source: Statistics Canada, 2016 Census of Population: Catalogue no. 98-400-X2016359. Number of Employment Income Recipients based on Aboriginal Identity, 5,195 of 110,750 total employment income recipients.
[4] According to the Generation Energy Council's 2018 report *Canada's Energy Transition: Getting to Our Energy Future, Together*, 'circular economy' is defined as "a system that closes the supply loop and encourages the use of cleaner and longer lasting raw materials, as well as the repurposing, reuse and upgrading of all waste streams into valuable low-carbon products" (Generation Energy Council, 2018: 37).

SECTION 2: TRENDS IN THE ELECTRICITY SECTOR

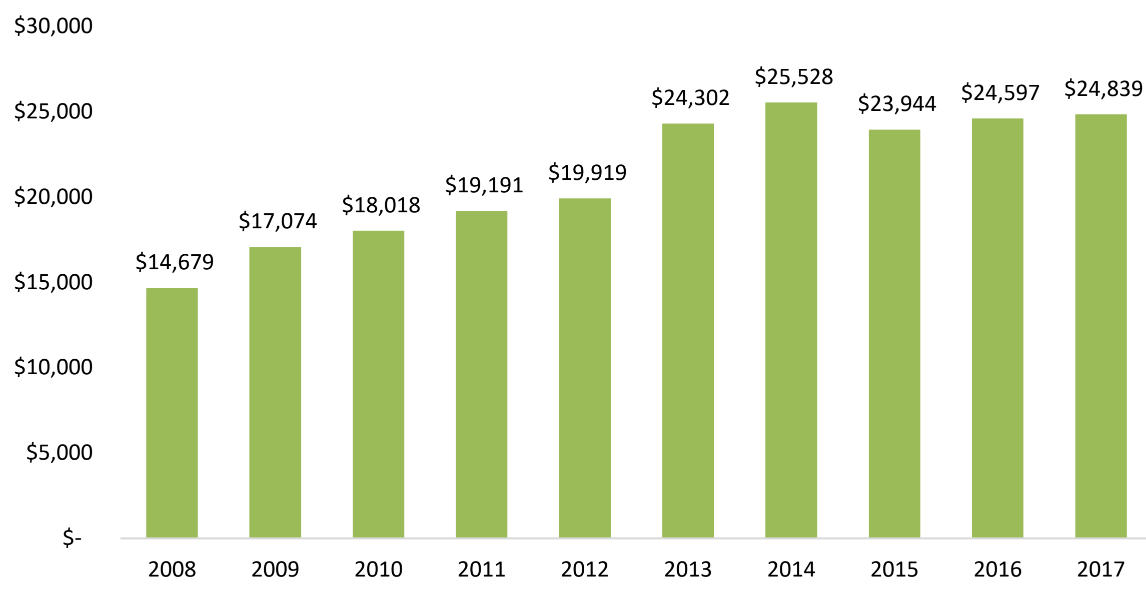
Economic and political trends, changes in generation and usage patterns, and new smart technologies with less centralized distribution models will all have tremendous impacts on the labour market in the electricity sector in the coming years. With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities — but they will demand highly specialized personnel with entirely new skill sets.

2.1 Economic Outlook: Capital Investment in the Electricity Sector

Since the 1990s, countries around the world have committed to take action to address climate change and reduce GHG emissions. As a result, investment in clean energy has increased significantly since 2015. The movement towards clean energy both within Canada and globally will have significant impacts on the labour markets of the electricity sector.

In 2016, global electricity sector investment fell by nearly 1%, in real terms, to under US$720 billion[5], while the total global investment in clean power and fuels (excluding large hydro-electric projects) reached US$287 billion worldwide, down 18% from 2015 (US$349 billion).[6] In Canada, capital investments in the electricity sector (combined generation, transmission and distribution) averaged $24.6 billion across the past five years; in 2017, capital investments in the electricity sector amounted to $24.8 billion, in current dollars, slightly up from $24.6 billion in 2016 (Graph 2.1).

Graph 2.1 – Capital Expenditures (million dollars)



Source: Statistics Canada[7, 8]

In 2016, the total global investment in clean power and fuels (excluding large hydro-electric projects) reached US$287 billion, down 18% from 2015 (US$349 billion).[9] Investments in new power generation assets represented US$440 billion globally, of which investments in renewable power amounted to US$297 billion. In Canada in 2017:

- Investment in wind energy was US$2.1 billion, up from US$0.9 billion in 2016;
- Investment in clean energy was US$3.3 billion, up 43% from 2015; and

- Investment in solar photovoltaics (PV) reached US$0.3 billion, slightly down from US$0.4 billion in 2015.[10]

2.2 Industry in Transition – A Workforce in Motion

Decarbonization of the Electricity System

In 1994, 197 Parties, including Canada, ratified the United Nations Framework Convention on Climate Change (UNFCCC). One of three 'Rio Conventions' adopted at the Rio Earth Summit in 1992, the objective of the UNFCCC was to "stabilize GHG concentrations at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system."[11]

Under the auspices of the UNFCCC, the Paris Agreement was adopted in December 2015; by November 2017, this Agreement had been ratified by 171 of the 197 Parties, including Canada.[12, 13] The principal aim of the Paris Agreement is to "strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius."[14] Under this Agreement, Canada pledged to reduce GHG emissions by 30% below 2005 levels by 2030;[15] to this end, Canadian provincial, territorial and federal governments are taking action to reduce GHG emissions from the electricity sector.[16]

Over the past five years, governments have focused on moving the electricity sector away from traditional coal-fired power generation[17] and toward renewable and non-emitting sources of energy. They have done so by regulating coal and natural gas power generation, encouraging further hydroelectricity development and transmission, expanding other forms of renewable electricity generation, investing in clean energy and supporting infrastructure and reducing reliance on diesel in partnership with Indigenous Peoples and northern and remote communities.[18, 19] New interprovincial interties are part of the strategy to decarbonize the electricity system and electrify the economy, alongside other trends like digitalization and distributed/dispersed generation. The following sub-sections provide an overview of key federal and provincial policy targets and commitments that will drive changes in the electricity sector.

Canadian Policies

Key federal-provincial-territorial initiatives guiding the future of the electricity sector include several important frameworks, strategies and policies:

2.2.1 The Pan-Canadian Framework on Clean Growth and Climate Change

Adopted on December 9, 2016, the Pan-Canadian Framework outlined the collective action that the provinces[20], territories and federal government would take to meet Canada's 2030 target of reducing GHG emissions to 30% below 2005 levels.[21] The key commitments of the plan included:

- Carbon pricing in all jurisdictions by 2018;
- Nationwide coal phase-out by 2030;
- National strategy for EV by 2018, along with an accelerated deployment of charging infrastructure;
- Implementation of a federal clean fuel standard;
- Establishment of a net-zero energy building code by 2030, along with energy use labeling for buildings by 2019;
- Renewed support for industrial efficiency, including the adoption of energy management systems; and
- Reduction in methane emissions from the oil and gas sector of 40% to 45% by 2025.[22]

As noted above, the Pan-Canadian Framework called for mandatory carbon pricing systems[23] to be implemented throughout Canada by 2018.[24] Building upon the *Vancouver Declaration on Clean Growth and Climate Change*[25], the Pan-Canadian Framework indicated that "provinces and territories have the flexibility to design their own policies to meet emissions-reductions targets, including their own carbon pricing mechanisms".[26] Jurisdictions were given a deadline of 2018 to establish their own programs, with failure to do so resulting in those jurisdictions being subject to the federal government's mandatory pricing system that would set a minimum price on GHG emissions.[27, 28] However, the original deadline of September 1, 2018 was extended to January 1, 2019 due to the federal government's ongoing negotiations with some jurisdictions.[29]

Even though approximately 80% of electricity production comes from non-emitting sources[30], the electricity sector is Canada's fourth-largest source of GHG emissions.[31] Accordingly, the Pan-Canadian Framework included four approaches to support the transition from coal-fired generation of electricity toward cleaner sources of electricity (Table 2.2).

Table 2.2 – Canadian Approaches to Decarbonization

Action	Example Provided
Increasing the amount of electricity generated from renewable and low-emitting sources.	Transitioning away from coal-fired generation and towards non-emitting sources such as hydro, wind and solar.
Connecting clean power with places that need it.	Developing stronger transmission-line interconnections, particularly intra-provincially (east-west).
Modernizing electricity systems.	Expanding energy storage, updating infrastructure and deploying smart-grid technologies, to improve reliability and stability of electric grids.
Reducing reliance on diesel working with Indigenous Peoples and northern and remote communities.	Expanding the use of clean electricity infrastructure, distributed energy systems, renewable energy microgrids, as well as grid connections and hybrid systems.

Source: Government of Canada[32]

2.2.2 Canadian Energy Strategy

At the Annual Council of the Federation meeting in July 2015, Premiers adopted the Canadian Energy Strategy, which identifies three themes to guide the future of energy in Canada: 1) sustainability and conservation; 2) technology and innovation; and 3) delivering energy to people.[33] Further, the Prime Minister's mandate letter to the Minister of Natural Resources, dated November 12, 2015, committed the Government of Canada to work with provinces and territories to advance a Canadian Energy Strategy.[34, 35] For the electricity sector, interprovincial collaboration objectives included in the Clean Energy Strategy relate to encouraging further deployment of alternative renewable energy through the use of innovative approaches, such as energy storage, smart grids and on-site micro-generation.[36]

2.2.3 Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations

Effective July 1, 2015, the *Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations* limits carbon dioxide (CO_2) emissions by coal-fired electricity plants to 420 tonnes per gigawatt-hour of electricity produced from coal per year.[37] The regulations also provide an accelerated phase-out schedule for existing coal-fired electricity plants and establish high-efficiency gas as the standard for new plants.[38] To accelerate the phase-out of traditional coal units across Canada by 2030, the federal government plans to propose amendments to the coal-fired electricity regulations.[39]

The above-described federal-provincial-territorial frameworks, strategies and policies recognize the importance of ensuring provinces and territories have the flexibility to implement actions that are tailored to their local contexts. Table 2.3 lists key emissions-reducing actions taken by each province.

Table 2.3 – Provincial Emissions-Reducing Actions

Province	Action
BC	• In 2008, BC imposed a revenue-neutral carbon tax and enacted a requirement for emitters of 10,000 tonnes of CO_2eq a year to report their emissions • In 2016, BC introduced the *Greenhouse Gas Industrial Reporting and Control Act*, which limited liquefied natural gas (LNG) facilities to emissions of 0.16 tonnes of GHG per one tonne of LNG produced.[40]
AB	• In 2015, the Alberta government announced the *Climate Leadership Plan*, aimed at reducing emissions and phasing out coal-fired electricity by 2030 and committing to replace retired coal plants with at least two-thirds renewable energy sources.[41, 42, 43] • Alberta implemented a carbon price across all sectors, starting at $20 per tonne in 2017, rising to $30 per tonne in 2018;[44] however, towards the end of 2018 the Alberta government stated that implementation of the annual increase is pending federal government support of other policy matters.[45] • The *Climate Change and Emissions Management Act & Specified Gas Emitters Regulated* placed intensity-based limits on industrial GHG emissions.[46] • "Alberta proclaimed the *Renewable Electricity Act* and launched the Renewable Electricity program to support the development of 5,000 megawatts of renewable electricity capacity by 2030."[47]
SK	• Saskatchewan's *Management and Reduction of Greenhouse Gasses Act* (2010) requires that facilities emitting 50,000+ tones of GHG will be required to reduce emissions to stated provincial limits.[48]
MB	• In 2014, Manitoba enacted the *Emissions Tax on Coal and Petroleum Coke Act*, which established an emissions tax on the use of petroleum coke in industrial facilities and began a mandatory phase-out of petroleum coke for heating purposes.[49] • In addition, Manitoba has implemented an emissions tax on coal and has banned the use of coal and petroleum coke as a space-heating fuel; however, in 2018 Manitoba cancelled its carbon tax in protest of the federal government's requirement of the annual rate increase.[50]
ON	• In 2009, Ontario enacted the *Green Energy Act*, aimed at phasing out coal as a source of energy and offering financial incentives for the development of renewable energy;[51] however, the Act was repealed in October 2018.[52] • In 2015, the Ontario government banned all future coal-fired electricity generation through the *Ending Coal for Cleaner Air Act*.[53] • As of 2017, all nuclear generation entities emitting 25,000+ tonnes of CO_2 are required to participate in the *Climate Change Mitigation and Low Carbon Economy Act, 2016*.[54] • In 2018, Ontario introduced a cap and trade system designed to set a limit on emissions from fuel marketers and industrial polluters;[55] however, following a change in government it was repealed in June of the same year.[56]
QC	• In 2016, the Quebec government released its *2030 Energy Policy*, which sets clear targets related to energy consumption and to increasing overall renewable energy

Province	Action
	outputs and bioenergy production by 15%. Targets for energy consumption include: enhancing energy efficiency by 15%, reducing the amount of petroleum products consumed by 40%, eliminating the use of thermal coal.[57]
NL	• In order to develop their emissions reduction targets, the government of Newfoundland and Labrador enacted the *Management of Greenhouse Gas Act* which will see the monitoring of GHG emissions over a two-year period.[58]
NS	• In 2016, the Nova Scotia government announced a cap and trade system would be implemented by 2018, as well as a province-wide target to reduce carbon emissions in excess of the federal government carbon-pricing requirements;[59] however, in 2018 the provincial government launched a legal challenge to the federal carbon-tax plan, claiming that "Ottawa does not have the right to impose carbon pricing on the provinces".[60, 61] • "Through the *Electricity Efficiency and Conservation Restructuring Act* (2014), the provincial electricity utility is required by law to invest in energy efficiency when it is the most cost-effective option for ratepayers".[62]
NB	• In 2015, New Brunswick introduced legislation to allow local entities to develop renewable energy-sourced electricity generation; this meant that universities, non-profit organizations, cooperatives, Indigenous communities and municipalities to contribute to NB Power's renewable energy requirements.[63] • New Brunswick's *Energy Act* requires that, by 2020, 40% of the energy acquired within the province be generated by renewable sources.[64]
PE	• In 2008, the Prince Edward Island government enacted a *Climate Change Strategy* aimed at improving awareness and education around climate change issues and knowledge related to reducing GHG emissions.[65]
Territories	• While each of the three territories has enacted policies related to climate change mitigation, there is no current legislation aimed at carbon taxation.[66] • Yukon is working to implement the *Independent Power Production* policy by early 2018 to support the participation of independent power products and the development of environmentally sound and affordable electricity.[67]

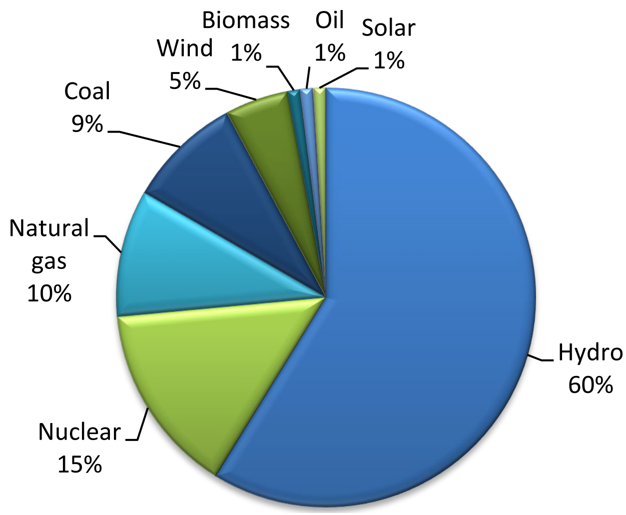
In addition, many provinces – including British Columbia, New Brunswick, Nova Scotia and Prince Edward Island – have established a variety of targets to expand renewable energy supplies, including putting in place standard offer contracts, feed-in tariff programs and legislated Renewable Portfolio Standards.[68]

The policies described above directly impact electricity generation, transmission and distribution in Canada. Canada continues to rely on non-renewable generation although over recent years there has been a notable movement towards the incorporation of renewable energy technology innovations into the sector.

Energy Generation

The Canadian electricity industry is a critical sector of Canada's economy and electricity is a fundamental input to the efficient operation of almost every industry and sector. Electric utilities and industry generated 648,415 terawatt hours of energy in Canada in 2016.[69, 70] In the same year, Canada was the world's sixth largest electricity producer (after China, USA, India, Russia and Japan) and the world's largest net exporter of electricity[71], with all Canadian electricity exports going to the United States. Canada is the second largest producer of hydroelectricity in the world: hydroelectricity accounts for 60% of the country's electricity supply, followed by natural gas, nuclear, coal and non-hydro renewable sources (Graph 2.4).[72]

Graph 2.4 – Canada's Electricity Generation by Fuel Type

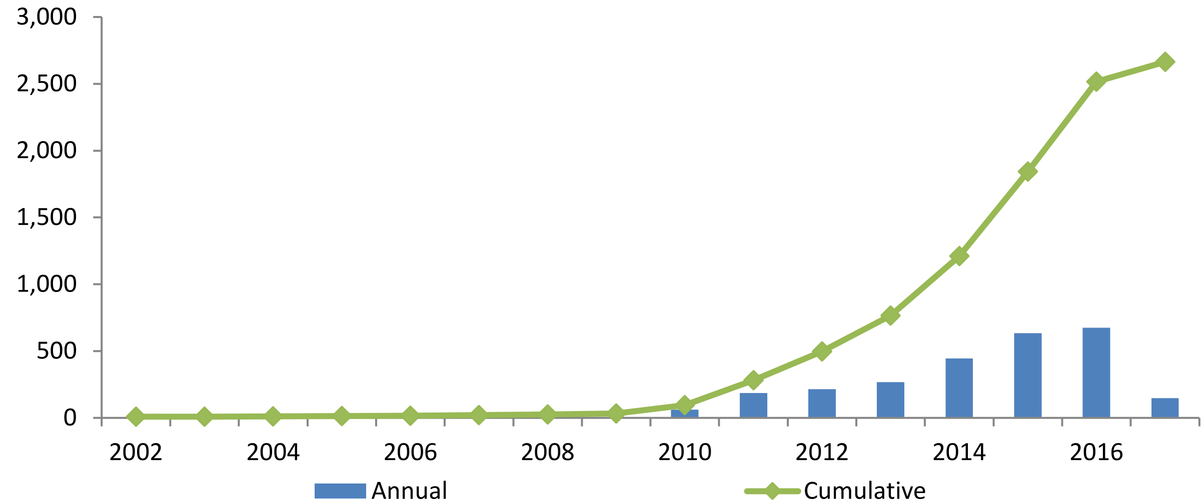


While internationally coal is predicted to remain the largest source of electricity generation in 2023, an increasing proportion of electricity generation is expected to come from renewable sources.[73] With nearly 81% of production from non-emitting sources, Canada has one of the cleanest electricity sectors in the world, up from 79.9% in 2015.[74] Indeed, in 2016 Canada placed first in G7 and second in G20 countries (after Brazil) in terms of the share of renewables in its total electricity generation;[75] when adding nuclear energy, Canada placed second in the G7 (after France) and third in the G20 (after France and Brazil) in terms of the share of non-emitting electricity.[76] More generally, Canada placed fifth in the world in terms of total renewable power generation after China, United States, Brazil and Germany.[77]

According to the International Energy Agency (IEA)'s *Renewables 2018: Analysis and Forecast to 2023* report, Canada's renewable power generation is expected to expand 8%, including onshore wind, hydropower, solar photovoltaics (PV) and bioenergy.[78, 79] Although this forecast was revised down from 2017 predictions as a result of fewer planned projects (e.g. solar PV), as well as suspended or cancelled contracts (e.g. Ontario's Large-Scale Renewable Energy Program), Canada's renewable energy capacity is expected to grow by 7% between 2017 and 2023, due mainly to hydropower[80] which considers the commissioning dates of existing large hydro developments such as Lower Churchill River Project, Keeyask, La Romaine, etc

Although hydro continues to dominate Canada's renewable energy capacity, solar PV is currently Canada's fastest-growing source of electricity. In 2017, Canada had 2,913 MW of solar PV installed capacity, up 9% from 2,664 MW in 2016 (Graph 2.5, next page).

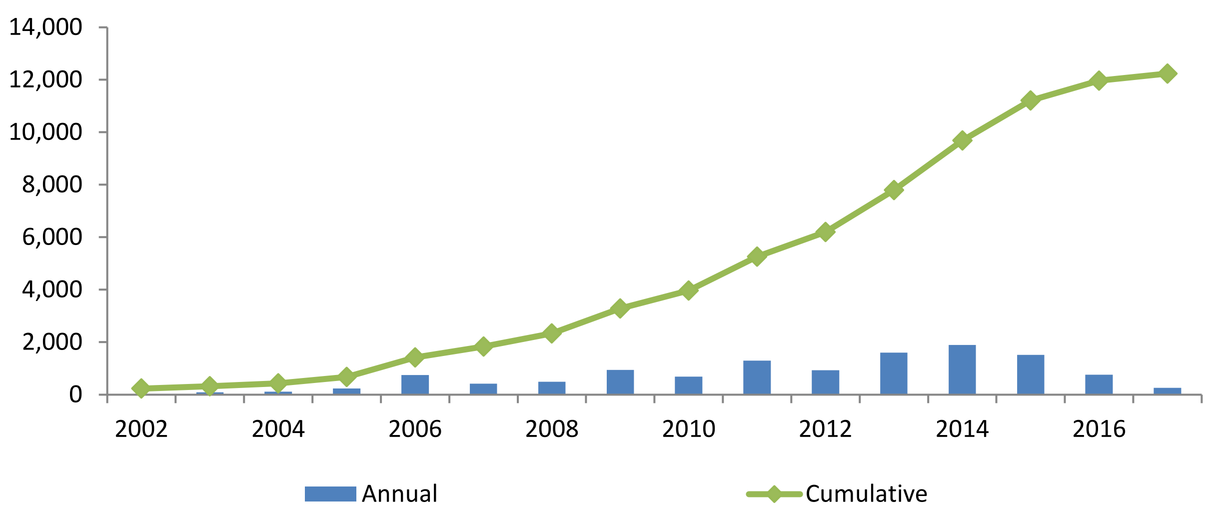
Graph 2.5 – Solar PV Installed Capacity in Canada (MW) (2002-2017)



Source: Natural Resources Canada

Further, wind energy is also a fast-growing source of electricity in Canada; indeed, with 12,239 MW of installed capacity of over 290 wind farms including nearly 6,200 individual wind turbines, Canada is now positioned ninth in the world in terms of total wind power capacity (Graph 2.6).[81, 82]

Graph 2.6 – Wind Energy Installed Capacity in Canada (MW) (2002-2017)



Source: Natural Resources Canada

Table 2.7 describes the diverse range of electricity generation practices used across Canada.

Table 2.7 – Electricity Generation Practices by Province/Territory

Province	Primary Electricity Generation Source	Electricity Generation Practices
BC	Hydropower	• Has a policy in place that new generation must be renewable (except for LNG plants)[83] • Announced plans to expand hydroelectric generation capacity[84]

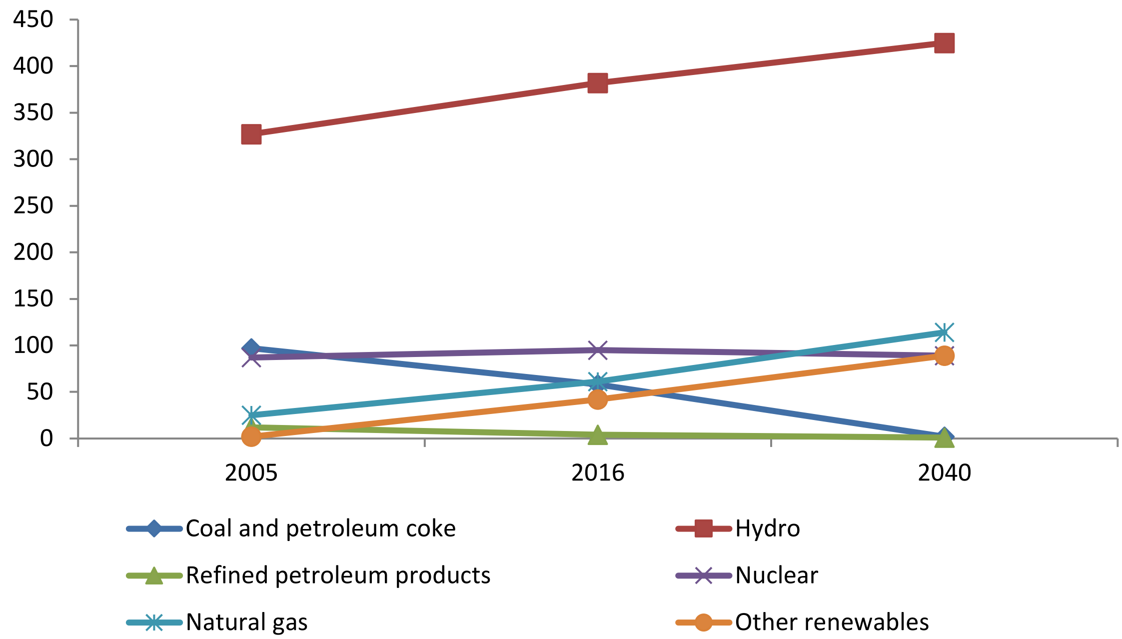
Province	Primary Electricity Generation Source	Electricity Generation Practices
AB	Fossil fuels: 81% coal and natural gas[85, 86]	• Is the province most reliant on fossil fuels for power generation[87] • Currently no nuclear capacity[88] • Announced funding for renewable and solar energy projects in First Nation and Métis communities[89] • Announced phase-out of coal-fired electricity by 2030[90]
SK	Coal-fired electricity generation, with coal and natural gas accounting for 75% of installed capacity	• Became a world leader in carbon-capture when it opened the first commercial-scale coal-fired carbon capture and storage electricity project at the Boundary Dam power station, operated by SaskPower;[91, 92] once fully operational, the is expected to capture and sequester 90% of GHG emissions at the facility[93] • Working towards achieving a target of 50% of total generation capacity from renewable energy sources by 2030[94] • Employs run-of-river hydropower generation[95] • Launched a utility-scale solar electricity generation procurement project[96]
MB	Hydropower[97]	• Manitoba's last remaining coal-fired generating facility can only operate under an emergency order; this facility will cease coal-fired operations in 2019[98] • Announced plans to expand hydroelectric generation capacity[99]
ON	Robust mix:[100, 101] • Nuclear: 53.5% • Hydropower: 21.3% • Conservation: 8.6% • Natural gas: 7.5%	• Ontario became the first jurisdiction in North America to fully eliminate coal as a source of electricity generation; between 2010 and 2014 it closed all of its coal-fired generating stations[102, 103, 104] • As part of Ontario's *Long-Term Energy Plan* (2017), the government has pledged to refurbish 10 of its 18 nuclear generation facilities, the largest nuclear fleet in Canada, by 2033[105] • Only Canadian province with a significant share (4%) of its generating capacity based on solar PV technologies • Collaborating with the Government of Canada and Wataynikaneyap Power to connect Pikangikum First Nation to Ontario's power grid; "a 117-kilometre power line from Red Lake to Pikangikum will provide clean, safe and reliable power and eliminate the community's dependence on diesel fuel"[106]

Province	Primary Electricity Generation Source	Electricity Generation Practices
QC	Hydropower (Crown corporation)[107]	• Has the largest electricity generation in Canada, at just under 40 megawatts of installed capacity[108] • The Provinces' action plan for the 2030 Energy Policy includes a commitment to increase renewable energy generation capacity by 25%[109] • Announced plans to expand hydroelectric generation capacity[110]
NL	Primarily hydropower[111, 112]	• "Newfoundland and Labrador's Lower Churchill hydroelectricity project is poised to be one of the largest renewable energy projects in North America. With the first phase of this project (Muskrat Falls) complete, 98% of Newfoundland and Labrador's electricity production will come from renewable sources"[113]
NS	Diverse portfolio: [114] • Coal • Natural gas • Wind • Petroleum	• Tidal demonstration projects being piloted in the Bay of Fundy. Permits to be issued in accordance with the province's Marine Renewable-Energy Act[115]
NB	Diverse portfolio: • Hydro • Wind • Nuclear power	• Province still relies heavily on fossil fuels, such as coal and heavy fuel oils[116]
PE	Primarily wind[117]	• Eight wind farms in Prince Edward Island now generate almost 25% of the province's electricity requirements[118] • PEI plans to further expand its wind electricity generation capacity in 2020 and 2030[119]
Territories	YK: Primarily hydro; NWT: Primarily petroleum and hydro[120]	• Installed 55 kilowatts of solar with an efficient variable-speed generator in the community of Aklavik[121] • Doing design work for megawatt scale wind in Inuvik[122] • Testing small-scale biomass combined heat and power in Fort Simpson to reduce diesel use in these remote off-grid and Indigenous communities[123] • Increased use of micro-generation due to geography[124] • Yukon announced plans to expand hydroelectric generation capacity[125]

Access to cleaner forms of electricity is also being expanded by interprovincial trade in electricity. For example, in September 2015 Manitoba and Saskatchewan signed a 20-year agreement that was designed to flow a minimum of 100 megawatts of electricity from Manitoba to Saskatchewan; this was increased by 215 megawatts in 2018.[126] In January 2016, Alberta and Manitoba signed a bilateral Memorandum of Understanding on Renewable Energy and Climate Change Initiatives. Further, starting in 2018 and through the Maritime Link transmission project, Newfoundland and Labrador will supply between 8% and 20% of Nova Scotia's electricity needs thereby reducing Nova Scotia's reliance on coal-fired electricity.[127]

As demonstrated in Graph 2.8, despite a decrease in coal, coke and refined petroleum products, there is a forecasted growth to 2040 in electricity generation due to hydro and natural gas, as well as other renewables (such as solar, wind and biomass).

Graph 2.8 – Change in Electricity Generation by Fuel Type, 2005 to 2040 (GWh)

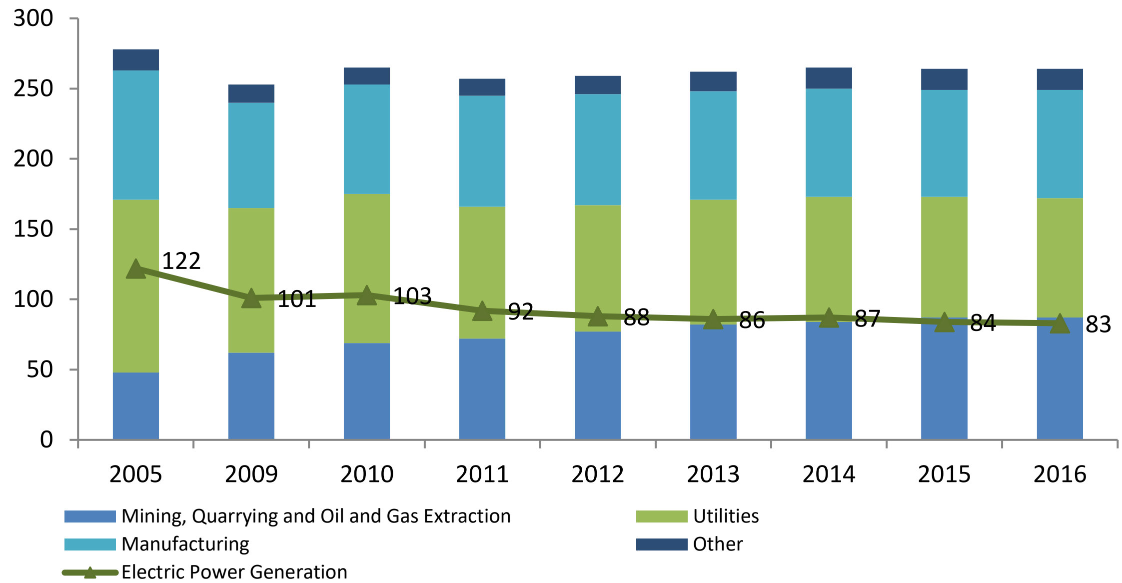


Source: Government of Canada[128]; National Energy Board[129]

2.2.4 GHG Emissions from Electricity Generation

In 2016, Canada's total GHG emissions were 704 megatonnes (Mt) of carbon dioxide equivalent (CO_2 eq), a 3.8% reduction since 2005.[130] Accounting for 11% of total national emissions, the electricity sector was the fourth largest source of GHG emissions.[131, 132] Between 2005 and 2016, GHG emissions from electric power generation fell by 38 MT CO_2 eq. (Graph 2.9).

Graph 2.9 – Reported GHG Emissions by NAICS Industry Sector (2005-2016)



Source: Government of Canada[133]

Projections of Energy Demand

Projections of energy demand developed by the National Energy Board include four sectors: residential, commercial, industrial and transportation (Table 2.10).

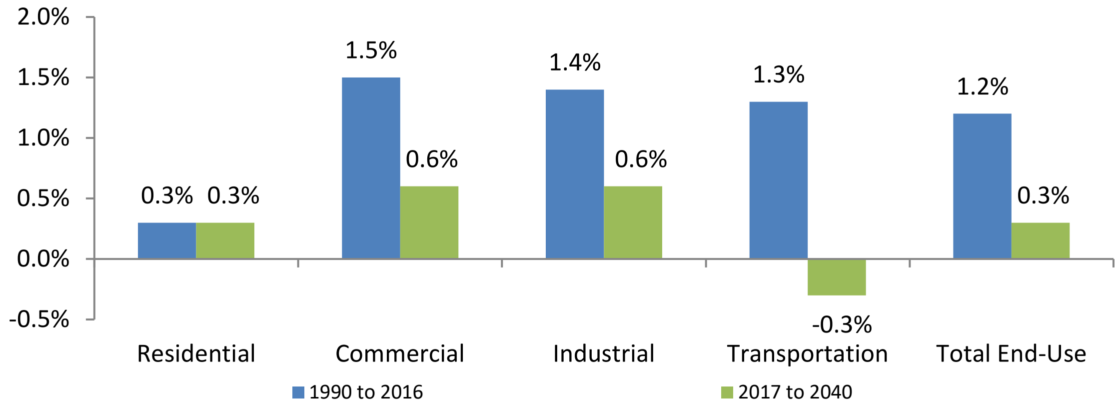
Table 2.10 – Description of Canada's Four Sectors of Energy Demand

Sector	Overview
Residential	Includes all the energy consumed by Canadian households, including energy used for space and water heating, air conditioning, lighting, large appliances and other energy-using devices.
Commercial	Includes a broad category that includes offices, stores, warehouses, government and institutional buildings, utilities, communications and other service industries. Also includes energy consumed by street lights and pipelines.
Industrial	Includes manufacturing, forestry, fisheries, agriculture, construction, mining, as well as oil and natural gas extraction.
Transportation	Includes passenger and freight on-road transportation, as well as air, rail, marine and non-industrial off-road travel, such as recreational all-terrain vehicles and snowmobiles.

Source: National Energy Board[134]

As shown in Graph 2.11, total end-use energy demand grew approximately 1.2% from 1990 to 2016 and although total end-use energy demand is expected to continue to grow, it will do so at a far slower rate than in historical trends: indeed, from 2017 to 2040 it will increase by only one quarter of the historical trend, at approximately 0.3%.[135] Overall, between 1990 and 2016 the commercial sector outpaced all other sectors with a growth rate of 1.5%; however, this is projected to slow down to 0.6% from 2017 to 2040.[136]

Graph 2.11 – Historical and Projected Growth in End-Use Energy Demand by Sector (1990-2040)



Source:

By 2040, end-use energy demand is projected to be 6,802 petajoules for the industrial sector, 2,430 petajoules for the transportation sector, 1,591 petajoules for the commercial sector and 1,545 petajoules for the residential sector. This accounts for overall end-use demand of 12,368 petajoules of total end-use demand, which is an annual average increase of 0.2%.[138] Factors identified as contributing to a forecasted deceleration in the growth of energy use include:

- Lower economic activity;
- Trend towards a less energy-intensive economy;
- Increased energy efficiency and the resulting reduction in energy demand;
- Carbon pricing;
- Declining energy use per household;
- Changes in oil and gas production;
- Fuel economy improvements and the resulting reduction in fuel demand; and
- Uptake in EV.[139]

A number of these factors represent opportunities for the electricity sector. As will be discussed in the following section, the increasing number and speed of technological developments that are impacting the electricity sector are directly or indirectly resulting from factors such as carbon pricing, changes in oil and gas production, fuel economy improvements and uptake in EV.

2.3 Technology Developments

Employers anticipate that the use of emerging technologies will only increase with the transition away from coal to renewable generation and the movement to more distributed power generation. Generation, according to many employers, will begin to shift from a centralized model to community and residential-based generation as solar roof-top panels are more commonly used. Increasingly, employers see larger industrial businesses or cities taking care of a significant proportion of their own power needs, while emerging customer preference will also shape the industry, as it begins to drive product development and service offerings. Technology changes will thus influence the potential future direction of, and associated labour requirements for, the electricity sector. Canada is currently seeing ongoing advances in smart and micro-grids, energy storage, blockchain, cyber security, big data and analytics, automation, EV use, drone technology and LED lighting. These developments are summarized below.

Digitalization and Democratization of the Electricity System

2.3.1 Smart Grids

Smart grids build upon and further develop existing electrical grids by incorporating digital technologies that enable communication both between the utility and its customers, as well as between the transmission lines and the provider.[140] The development and integration of smart grids into existing electrical grids is critical to increasing and ensuring the reliability, security, adequacy and environmental performance of the electricity system.[141, 142]

Recognizing the potential of smart grids, the federal government allocated $100 million to fund next-generation smart grid storage and clean electricity technology projects.[143, 144] Table 2.12 compares the key characteristics of traditional and smart grids.

Table 2.12 – Comparison of Traditional and Smart Grid Characteristics

Characteristic	Traditional Grids	Smart Grids
Consumer participation	Consumers are uninformed and non-participative with power system	Can be informed, involved and active
Accommodates all generation and storage options	Centralized and not designed for distributed energy resource interconnection	Designed to connect distributed energy resources, with a focus on renewables
Supports innovation	Limited markets that are not well integrated	Well-integrated market and growth of new electricity markets for consumers
Information and customer service	Focus on outages, with slow response to power quality issues	Power quality as a priority; varied quality and price options; rapid resolution of issues
Efficient	Minimal integration of operational data with asset management; business process silos	Significant data acquisition of grid parameter capability; focus on prevention, minimizing impact to consumers
Self-healing	Reactive: focus is on protecting and repairing assets following faults	Preventative: detects and responds to problems in real time
Resilient	Vulnerable to threats (physical, cyber)	Resilient to threats; rapid restoration capabilities

Source: Litos Strategic Communication[145]

Smart grids are designed to manage power from multiple sources including solar, wind, storage, digitalization, EV and other distributed sources, while traditional electric grids are designed for uni-directional power flow.[146] The integration of smart technologies into the existing electrical grid has a direct impact upon the electricity sector, not only with regards to decarbonization, but also through propagating a fundamental shift in how the sector operates.

- First, these technologies allow for 'two-way flow' between the grid and technologies such as smart meters,[147] smart appliances, smart homes and EV, meaning that consumers can also become providers.
- Second, these technologies provide both utility companies and consumers with an unprecedented amount of data on consumption for both individual consumers and providers:
    - From a customer's perspective, this will allow them to manage their own energy consumption; and
    - From a provider's perspective, this will allow management in a way that facilitates the efficient use of assets and avoids unplanned outages.[148]
- Third, the development of smart grids can enable the transmission and distribution of electricity generated from a range of small- and large-scale sources, such as through green technologies like solar PV or wind, as well as through distributed energy systems (DES) including micro-grids and micro-generation (discussed below).

Smart grids can also support the deployment of new and innovative technologies. As Table 2.13 demonstrates, British Columbia, Ontario and Quebec have been leading the way in the implementation of new and smart technologies that contribute to decarbonization and electrification of their economies.

Table 2.13 – Description of Smart Grid Application and Deployment by Province (2016)

Application	Deployment	Province(s)
Advanced Metering Infrastructure	• This category includes smart meters and the associated communications infrastructure • Supports automatic remote meter reading and interval metering, enabling new methods of data collection and network planning • Gateway for information exchanges with customers • Can be used to support outage management, new rate options, demand response, electricity system loss detection and link to in-home displays and energy management systems	All
New Rate Options	• Linked to interval metering • Promote the use of off-peak rates, encouraging customers to reduce or shift their peak demand use	ON, QC, NS
Demand Response	• Intended to decrease system peaks • Provides cost-effective methods to avoid or defer capital expenditures and operational costs of increasing the size of the system • Implemented either through a direct load control (instructional signal) sent by the utility or system operator to a customer, or through an indirect control (price signal) sent to a customer • New forms of load management (e.g. virtual power plants) provide services to the grid, such as spinning reserve, load following (e.g. wind variation smoothing) or frequency regulation	BC, AB, ON, QC, NB, NS, PEI
Distributed Energy Storage	• Includes electricity storage technologies providing services to the grid such as frequency regulation and peak shaving	BC, ON, PEI, NL

Application	Deployment	Province(s)
	• Only includes storage technology that also provides grid services when it is not providing backup power during an outage	
Self-Healing Grids	• Fault detection and location, isolation and service restoration • Increases the capacity of the distribution grid to re-route power around faulted sections, or restore power • Requires little-to-no intervention from a grid operator • Outage management systems and distribution management systems can contribute to greater intelligence through real-time feeder sensing	BC, AB, ON, QC
Microgrids	• Distributed generation or storage, within a larger network, that can be isolated and maintained as required • Can also be used to reduce peak demand in the area	BC, NB, NL, NWT, YK
Voltage and Var (reactive power) Control	• Uses substation automation and capacitors to flatten the voltage profile of a feeder, leading to energy conservation and loss reduction • Can allow distribution networks to support greater amounts of variable power from renewable electricity generation (e.g. wind, solar PV)	BC, ON, QC

Source: Smart Grid in Canada, 2014[149]; Smart Grid in Canada: Status and Outlook[150]

2.3.2 Micro-grids

Building upon smart grids, micro-grids are a type of decentralized energy system that transmit power from interconnected energy resources, that can operate in complete isolation from the centralized grid.[151] Micro-generation allows consumers to generate their own electricity via renewable resources or alternative energy; any excess energy they generate can then be sent to the grid for some form of remuneration or credit.[152] This new, circular system of energy production and consumption has led to the rise of what the Generation Energy Council has dubbed 'prosumers', that is, individuals who both produce and consume energy:

> *As Canada's electricity systems make room for smaller scale and more decentralized, grids, Canadians will see new choices for energy production and use. In particular, the shift to digitalization and the rise of prosumers will create many new opportunities as grids becomes smarter, more flexible, more secure and more distributed.*[153]

The practice of using micro-grids is known as distributed, dispersed, decentralized, district or embedded energy production. One of the defining characteristics of smart and micro-grids specifically – and new infrastructure more generally – is increased computer control and automation. As a result, computer systems analysts, network and computer systems administrators, operations research analysts and software developers are needed to create, operate and maintain the computer systems that this infrastructure uses. Educational institutions such as colleges, technical schools and apprenticeship programs will likely have an expanded role over the lifecycle of employment as people learn to adapt to changing conditions.

2.3.3 Energy Storage

Energy storage has two main applications. In terms of power configuration, batteries are used to provide a large amount of power to the grid in a relatively short period of time; the other application relates to managing peak load, where a steady amount of power is injected into the grid for an extended period in order to manage energy demand changes.[154] Due to the growing demand for EV and consumer electronics, energy storage is becoming an increasingly viable as a replacement for conventional power generation (i.e. generators) and managing peak load;[155] indeed, since 2014, the cost of producing a lithium-ion battery has decreased by almost half, resulting in an increase in viability and application of battery storage systems.[156]

The improvement in energy storage technology has implications for renewable energy integration and researchers expect global installed energy storage for the grid and ancillary services power capacity to grow from 538 megawatts in 2014 to 21 gigawatts by 2024.[157] Due to the fact that solar and wind power are intermittent, the need for energy storage is crucial as new storage technologies can integrate excess renewable power with other energy sources to upgrade grids to provide more flexibility for the entire electricity system.[158] Further, combining solar energy with battery storage can allow households to consume their own power on demand.[159]

2.3.4 Blockchain

A blockchain is a way to record and verify transactions without requiring a central entity to maintain or validate the ledger (i.e. a list of transactions).[160] The most common example of a blockchain is in recording peer-to-peer transactions of crypto-currencies. In simple terms, the blockchain is a vast, distributed network of computers which verifies and records a transaction, which is stored in the crypto-currency blockchain and is visible to all users. In theory, blockchain technology can enable quick, secure and transparent currency trading.[161]

The potential application of blockchain technology goes beyond currency trading. Blockchain technology could also be used to cope with increasingly complex electric power systems. Recent innovations in clean energy, micro-grids and energy storage are changing the way energy is generated and distributed. Renewable energy, such as wind and solar, are more volatile in their ability to generate electricity due to the fact they are reliant on the weather. Micro-grids enable consumers to control and produce their own energy, making centralized systems far more complex. Furthermore, energy generated from fossil fuels is indistinguishable from clean energy sources once it is distributed through the grid.[162] These innovations in the electricitysector increased complexity, thus creating opportunity for employing blockchain technology.

One of the more popular applications of blockchain technology in the electricitysector is the facilitation of peer-to-peer transactions which would allow consumers to trade energy between themselves and bypass a central utility or retail energy provider. For example, a private blockchain network can be used to record electricity transactions in which department stores or even individual homes can sell electricity generated by distributed batteries or solar panels; previously, such transactions would have been prohibitively expensive and time-consuming to process.[163]

A more immediate application of blockchain technology is in verifying and tracking the production and distribution of clean energy. Currently, data relating to whether a unit of electricity is renewable, as well as data relating to the amount of emissions resulting from its production, are centrally-managed, complicated and prone to fraud or errors. Moreover, the compartmentalization of platforms prevents seamless trading of this information across regions. Blockchain enables tracking of electricity generation down to the kilowatt/hour, as well as the ability to record attributes such as the carbon emissions associated with power production. This application could enable more accurate calculation of carbon offset credits or progress towards emission targets.[164]

Although the application of blockchain technology is growing, so are issues related to the amount of electricity required to run it. Indeed, concerns around the volume of electricity required to power mining companies resulted in Quebec issuing a moratorium on new crypto-mining projects so that new regulations could be developed; the moratorium was lifted in 2018. Going forward, the Canadian electricity sector may be significantly impacted as it adapts to cope with the additional volume required by blockchain technology.[165, 166, 167]

2.3.5 Cyber Security

There are many benefits to introducing smart technologies into the electricity sector. Smart grids and smart meters provide an unprecedented degree of access to data and information; further, as discussed above, blockchain developments are introducing direct peer-to-peer transactions. However, increased use of these smart technologies requires increased cyber security measures.

Cyber security is one of the most important factors for ensuring safe, secure and efficient operation. The scope of cyber security ranges from malware impacts to targeted attacks from the Internet on industrial infrastructure and processes. The risks and hazards that must be considered include unauthorized access, misuse of user login credentials and administrator rights, implantation of malware, incorrect equipment settings and system parameters, installation of fraudulent software and firmware and attacks from the Internet. That being said, cyber risks are difficult to identify because they are unpredictable and because they evolve faster than the sector's ability to develop and deploy countermeasures; it is therefore difficult to determine the likelihood and severity of potential risks and mitigating strategies.[168, 169]

In 2016, Canada and the United States collaboratively developed the *Joint United States-Canada Electric Grid Security and Resiliency Strategy*, which comprises three broad goals, along with several associated objectives and actions. To achieve these goals, the Strategy identified a range of actions, to be undertaken by federal governments (Table 2.14).

Table 2.14 – Goals, Objectives and Actions of the Joint United States-Canada Electric Grid Security and Resiliency Strategy (2016)

Objectives	Action Plan Items to Address Goals and Objectives
Goal: Protect today's electric grid and enhance preparedness	
• Enhance information sharing • Coordinate and improve forensic, law enforcement and protection capabilities • Protect against major isolated and cascading events • Align standards, incentives and investments with security goals • Understand and mitigate vulnerabilities from interdependencies with other critical infrastructure	• Developing tools to detect, avoid, deter and mitigate vulnerabilities before they impact the grid thus preventing system interruptions or failures • Providing an understanding of the inter-related nature of the energy sector and other key critical infrastructure sectors in Canada thereby assisting in the planning for the management of major isolated or cascading events which could create system failures or affect multiple jurisdictions • Sharing actionable threat information and best practices with energy sector owner/operators, regulatory bodies, government departments and agencies • Including intelligence and law enforcement representatives of the Canadian Security Intelligence Service and the Royal Canadian Mounted Police as partners in energy-related initiatives to provide classified intelligence to stakeholders with the required security clearance and the need to know

Objectives	Action Plan Items to Address Goals and Objectives
	• Assisting stakeholders to make decisions regarding grid modernization and prudent security investments • Sharing sector-specific cyber security/threat information and suggesting mitigation measures • Working with representatives of the ten key critical infrastructure sectors in Canada to raise awareness and to inform emergency preparedness, response and recovery
Goal: Manage contingencies and enhance response and recovery efforts	
• Improve emergency response and continuity • Support mutual assistance for recovering from disruptions caused by physical and cyber threats • Identify dependencies and supply chain needs during emergencies • Recover and rebuild	• Designing and conducting a tabletop exercise to increase capabilities of personnel and organization to respond and recover from physical or cyber incidents and using the lessons learned to adapt processes and procedures • Collaborating with the energy sector to exchange information and expertise related to cyber security, thereby helping both industry and government to increase cyber resilience, increase technical capacity and promote innovation
Goal: Build a more secure and resilient future electric grid	
• Understand and manage new and evolving risks from electric grid technologies and electric grid design • Develop and deploy security and resilience tools and technologies • Integrate security and resilience into planning, investment and policy decisions, coordinating cross-border grid integration between the United States and Canada • Understand and mitigate risks posed by climate change • Develop a highly skilled workforce	• Delivering hands-on skills training and knowledge transfer, in relation to cyber security, for energy facility owner/operators, senior IT professionals, control room operators, policy makers • Conducting innovative research and development to develop and test new technologies for Industrial Control Systems • Providing security facility assessments and management- level classified briefings to assist energy sector owner/operators to address deficiencies and make improvements to increase security and resilience of assets and operations • Contributing to clean energy initiatives by integrating security and resilience considerations from the onset of the process when developing new technologies • Providing tools and standards to guide industry operations and emergency response activities • Working collaboratively on cross-border initiatives to managing climate change risks and evolving cyber security issues as they relate to cross-border energy infrastructure

Source: National Electric Grid Security and Resilience Action Plan[170]

Within the electricity sector, there is increasing need for employees with cyber security expertise. These individuals are unique insofar as they require a comprehensive understanding of both traditional (e.g. legacy systems using older programming language) and emerging (e.g. smart systems) electricity systems alongside a robust understanding of emerging technologies. As electric generation, transmission and distribution systems change and evolve, so too does the need for this highly specialized occupation; that said, cyber security cuts across industries and will therefore result in inter-industry competition for good cyber talent.

2.3.6 Big Data and Analytics

'Big data' refers to very large and complex data sets. These data sets are large and complex in terms of:

- Volume: quantity of data;
- Variety: type and nature;
- Velocity: rate of receiving data;
- Variability: consistency of data; and
- Veracity: quality of data.[171]

Analytics is a method of data interpretation and communication. The use of big data and analytics allows stakeholders to utilize large and complex information to make informed decisions.

Distributed energy production and distribution is changing the electricity sector drastically. The adoption of new technologies, such as micro-grids, battery storage and smart meters has created an opportunity for stakeholders to utilize big data and analytics to improve specific functions with the sector. Big data and analytics can impact the electricity sector by:

1. <u>Demand response</u> – big data and analytics allow energy producers and distributors to predict revenue for a given sub-station through tariff rates such as time-of-use pricing.[172]
2. <u>Energy efficiency</u> – big data and analytics can allow for real-time results and trends to be presented to regulators, as well as predict the success and/or failure of energy efficiency programs.[173]
3. <u>Customer segmentation</u> – energy providers traditionally segment their customers into groups based on voltage connections. With more data, energy providers can identify the drivers and patterns of user consumption and segment them further into more meaningful groups. Providers can then develop specific programs and services that are more effective and beneficial for both customers and energy providers.[174]
4. <u>Social benchmarking</u> – Social benchmarking is the practice of providing customers their electricity consumption patterns over a period of up to 12 months. By providing this information the customer may be encouraged to lower their usage pattern to match their immediate peers.
5. <u>Asset management and proactive maintenance</u> – With the implementation of Asset Management Standards there will be an increase in the use of sensors, imagery, repair forms and schedules and geographic information systems data. Asset management practices in the utility sector are set to be inundated with large volumes of data. With enhanced data sets, asset managers will be able to identify profitability per unit, greatly improving efficiency across the board.[175]
6. <u>Improved outage management</u> – By applying asset management practices, utilities can identify the location and condition of all assets, apply historical load and outage data, upcoming weather patterns and more, in order to facilitate and predict where the next outage will occur.[176]
7. <u>Improving line loss</u> – Using big data and analytics, line loss (i.e. energy loss resulting from the transmission of energy across power lines) can be decreased through better management of voltage levels and varmeter flows and free up capacity to serve load demand.[177]
8. <u>Optimization of generating plants</u> – Information technology coupled with control systems, supervisory control and data acquisitions and communication devices integrated with real time data analysis will provide greater insight and understanding of the equipment being used and the events that occur.[178]

9. Machine learning – Machine learning entails facilitating automation. The widespread application of sensors will provide energy providers with an abundance of data that will grow and be applied within machine learning concepts. In an industry rich in capital assets and customer consumption patterns influenced by events, weather, policy and price, this may be a key benefit of big data and analytics.[179]

Electrification of the Economy

2.3.7 Electric Vehicles (EV)

Between 2010 and 2015, global GHG emissions from transportation grew by 2.5% annually;[180] within Canada, the transportation sector accounted for just under one-quarter of Canada's total GHG emissions in 2014. As part of the Pan-Canadian Framework, the federal government identified the need to increase use of low-carbon and zero-emissions vehicles in order to reduce emissions from transportation, such as passenger vehicles, freight trucks and public transportation systems; in light of Canada's commitments to reduce GHG emissions, EV are essential to helping decarbonize the transportation industry.[181] Electrification of transportation includes increased use of zero-emission vehicle (ZEV) technologies such as plug-in hybrids, EV and hydrogen fuel-cell vehicles.[182, 183] Many industry stakeholders believe EV will impact the operation of the grid as there will be another load, as well as a potential energy storage source, to integrate into the system.

In 2016, 753,000 plug-in EV were sold worldwide, representing 40% growth in global EV sales over the previous year; this result continues the upward trajectory of EV sales that is being led by China, Norway, the Netherlands, Sweden and the United States.[184, 185] EV sales are forecasted to reach 3.8 million units by 2020[186] and 150 million units by 2030.[187] Within Canada, in 2016 there were over 22,700 EV and 3,694 charging stations in Canada and by 2017, EV represented approximately 3% of new vehicle sales.[188] As the scale of EV production grows, along with the development of supporting infrastructure (such as recharging stations and public transit systems), the EV share of total vehicles sales is expected to increase.[189]

As the market for, and the production of, EV grows, so does their impact on the electrical grid. At the local level, transformers are the most vulnerable to, and impacted by, the increased use of EV. Particularly during peak demand times, the load that EV place on the electricity system can potentially lead to damage, outages due to overloading and increased transformer loss-of-life factor by up to 10,000 times.[190] One method of mitigating the risks EV place on the electrical grid is to offer price incentives that encourage consumers to charge their vehicles during off-peak times; another potential risk mitigation method is 'managed charging,' designed to encourage and support EV owners to charge their vehicles at the most productive part of the off-peak period (such as during the day for solar and at midnight for wind);[191] however, implementation of this risk mitigation strategy would require the uptake of smart technologies that are being developed.

Furthermore, smart technology has the potential to allow EV to feed directly into the electrical grid. For example, some European countries are exploring the possibility of installing special chargers at private residences that would allow EV to buy and sell electricity while they are plugged in; this technology may enable individual consumers to not only take power from their supplier, but also to give power back.[192] The potential for EV to discharge into the electrical grid, thereby effectively acting as 'one giant battery', may help improve the stability of the electricity system.[193]

In Canada, British Columbia and Quebec have introduced policies and strategies to encourage uptake and use of EV. For example, Quebec has provided access to multiple-passenger lanes, provincial-based purchase incentives and waivers on fees (e.g. tolls, parking and ferries);[194] further, by 2020 Quebec aims to increase the number of plug-in hybrid vehicles in the province to 100,000, generating 5,000 EV jobs and $500 million in investments.[195] Although Ontario had initiated an Electric and Hydrogen Vehicle Incentive Program, this was scrapped following the province's cancellation of the previously-discussed cap and trade program (Section 2.2.2.3).[196] At the local level, municipalities such as Winnipeg, Vancouver and Edmonton are beginning to introduce all-electric busses into their public transportation fleet.[197]

Ongoing growth of, and changes within, the Canadian EV market make it difficult to accurately forecast how EV uptake will impact the electricity sector. For example, Ontario's decision to scrap the Electric and Hydrogen Vehicle Incentive Program will likely result in fewer EV sales than previously anticipated; on the other hand, Canada's commitment to reducing GHG emissions will contribute to increased need for EV policies and frameworks. Thus, even though there are currently no laws in place prohibiting the production or use of conventional vehicles, the move towards policies and incentives that encourage the use of ZEV suggest that car manufacturing will increasingly focus on EV, which will in turn require an electricity system that can support an EV fleet.[198]

2.3.8 Automation

To date, automation has more commonly resulted in the re-deployment of a small proportion of the workforce to other roles within the organization rather than layoffs of employees.[199] While the majority of tasks associated with key occupations in the electricity sector have not yet been automated, it is likely that positions such as power systems operators and information systems analysts will continue to see an increase in automation. Indeed, industry stakeholders have noted that technology and information management is an area that presents considerable challenges for employers.[200] Given the critical importance of having a stable and secure energy supply, challenges in hiring and retaining individuals who are specialists in cyber-security and/or systems protection exist.

The automation of processes has not positively or negatively impacted the electricity sector's workforce; that said, employers anticipate that the impacts may be realized in the future with the move away from labour-intensive coal generation to renewable energy and new technology, as this shift is expected to result in greater automation.[201]

2.3.9 Drone Technology

The use of drone or unmanned aerial vehicles (UAV) technology within utilities is increasing in many different countries. Several utility providers are using drone technology for inspection and monitoring purposes, to help minimize losses from faults and outages and to help minimize risk to personnel.[202, 203, 204, 205, 206] For example, drones are being increasingly used in capital works projects (e.g. for aerial photogrammetry), as well as for the collection of data to aid in design and construction management. In terms of their use in inspection, the first recorded pipeline and power line inspection using drone technology took place in Alberta in early 2017.[207]

The use of drone technology is likely to continue and increase. With the US Federal Aviation Administration's enactment of Part 107 of the *Small Unmanned Aircraft Regulations*, anyone who passes a remote pilot certificate exam is legally permitted to legally fly drones for commercial purposes. Further, the European Union projections for drone use within the energy sector predict the use of 30,000 drones by 2035 and 35,000 drones by 2050.[208] It is anticipated that the use of drone technology will become particularly salient for the Canadian electricity sector, especially as generation becomes more diverse and grids become more decentralized.

2.3.10 Light-Emitting Diode (LED) Lights

Throughout the years, federal, provincial and territorial governments have implemented various programs to promote energy efficiency and retrofitting to improve efficiency and lessen energy consumption. This includes programs such as the *Commercial Energy Conservation and Efficiency*

Program, which assists businesses in achieving the efficient use of energy and water to help businesses reduce costs.[209] Further, the *Energy Efficiency Incentive Program* helps homeowners and consumers purchase new, more energy efficient models of products (i.e. LED technology).

LED light bulbs use, on average, 70 to 90% less energy than traditional incandescent light bulbs and last up to 15 years.[210] These technological improvements have resulted in costs savings and improved energy efficiency. According to Natural Resource Canada energy efficiency in the residential sector has improved 45%, resulting in Canadians saving 639 petajoules of energy and approximately $12 billion in energy costs in 2013.[211]

2.4 Summary

There are thousands of highly-skilled Canadians running our electricity businesses. They are trades people – engineers, line maintainers, transmission operators and electricians – working in generating stations, transmission companies and distribution utilities. The Canadian electricity industry must operate within the context of regulatory and technological changes, as well as within the shift away from fossil fuels and towards cleaner forms of energy. Further, and as discussed in the upcoming sections, there will be a need for these occupations to uphold and maintain legacy systems; at the same time employees will need to support the emergence of new energy infrastructure by up-skilling or re-skilling while engaging in continuous and lifelong learning practices.

ENDNOTES: SECTION 2

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SECTION 3: PORTRAIT OF THE WORKFORCE

To provide a profile of the electricity sector's workforce, this section draws on data from Statistics Canada's 2016 Census; the EHRC Employer Survey, 2017[212]; the EHRC Educator Survey, 2017; as well as key informant interviews with electricity sector employers, educational institutions and organizations representing diverse groups. It is important to note that employers who completed the 2017 EHRC Employer Survey did not provide responses to all questions, resulting in different bases across questions.

3.1 Business Lines

Just under half (45%) of employers reported being engaged in multiple lines of business with distribution being the most common (59%) followed by renewable power generation (33%) (Table 3.1). In terms of electricity generation, 21% of employers reported operating in fossil fuels, while only 7% reported operating in nuclear. Within the green energy operations, the greatest proportion of EHRC employer survey respondents (23%) reported operating in hydro, while fewer reported operating in solar (17%), wind (16%) or geothermal (6%).

Table 3.1 – Employer Business Lines

Lines of Business	Percentage of Sample
Generation	23%
Renewable*	33%
Transmission	22%
Distribution	59%
Construction	14%
Customer-facing or "direct access"	8%
Electrical Contracting	6%
Other	11%

Source: EHRC Employer Survey, 2017 (QA2); n=80
Note: Percentages may not sum to 100% due to multiple responses.
* Renewable refers to electricity generation through renewable means (Hydro, wind, solar, geothermal, tidal/wave, bioenergy). This separate business line was included to increase consistency with the 2011 LMI survey.

Although over half of organizations reported operating in distribution, generation employs the greatest number of workers. Collectively, 24,037 workers are employed in generation, including renewable energy, accounting for over one third (37%) of the total workforce (Table 3.2, next page).

Table 3.2 – Number of Employees among EHRC Employer Survey Participants by Business Lines

Line of Business	N=*	Number of Employees	Percent of Total**
Generation	65	24,037	37%
Transmission	63	8,998	14%
Distribution	66	13,055	20%
Construction	62	4,244	6%
Customer-facing or "direct access"	62	6,066	9%
Renewable Energy	62	1,063	2%
Other	24	8,290	13%
Total	**66**	**65,753**	**101%**

Source: EHRC Employer Survey, 2017 (QB1)
* Number of employers who provided data
** Number may not total to 100% due to rounding.

3.2 Operational Scope

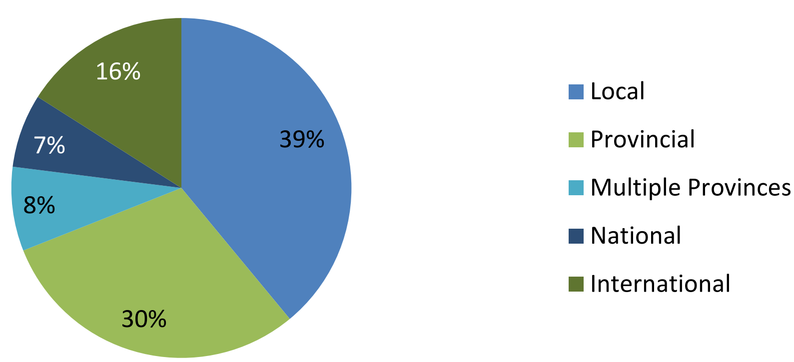
According to EHRC employer survey findings, the electricity sector workforce is concentrated within large organizations (500 or more employees) (Table 3.3). Further, over two-thirds (69%) of organizations operate in a relatively focused region, either locally (municipal) or provincially (Table 3.4a).

Table 3.3 – Employer Size

Business Size	Number of Organizations	Average Number of Employees
Small (less than 100 employees)	37	22
Medium (100 to 499 employees)	20	254
Large (500 or more employees)	25	2,959

Source: EHRC Employer Survey, 2017 (QA5)

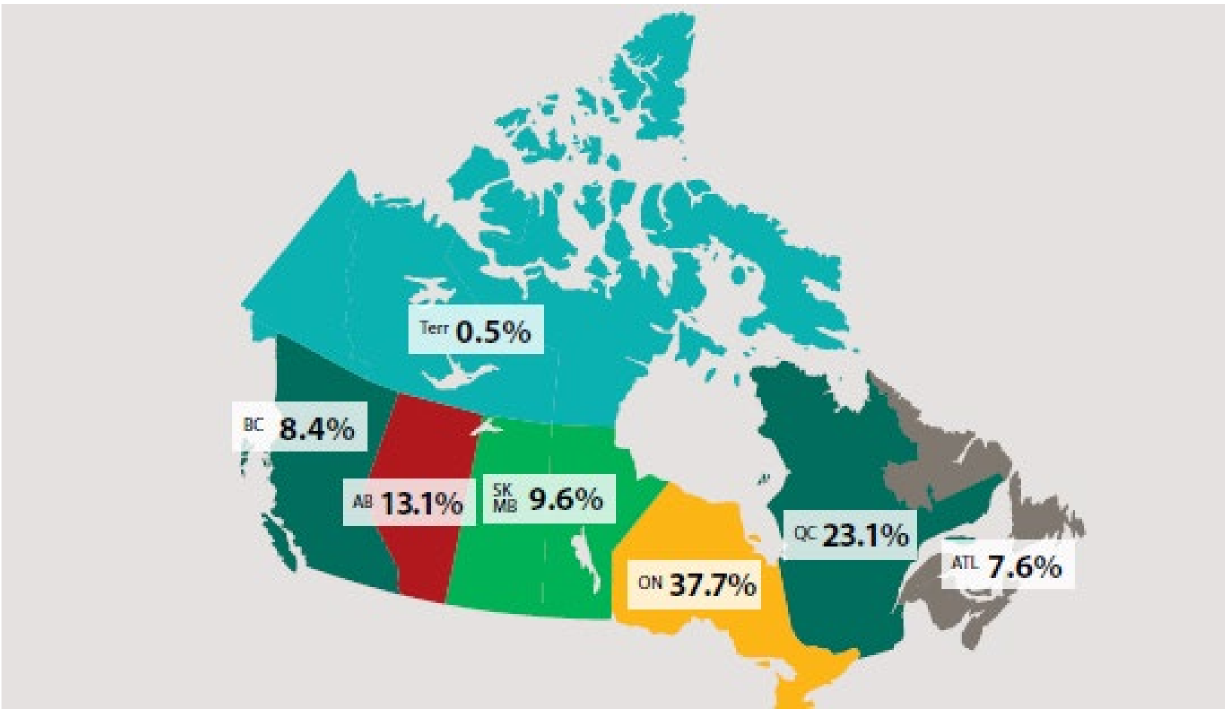
Figure 3.4a – Operational Scope of Employers



Source: EHRC Employer Survey, 2017 (QA1); n=92

Over half (61%) of the electricity workforce was in Ontario (38%) and Quebec (23%) (see Figure 3.4b).

Figure 3.4b – Geographic Concentration of Electricity Sector Workers



Source: Statistics Canada[213]

3.3 Current Labour Pool

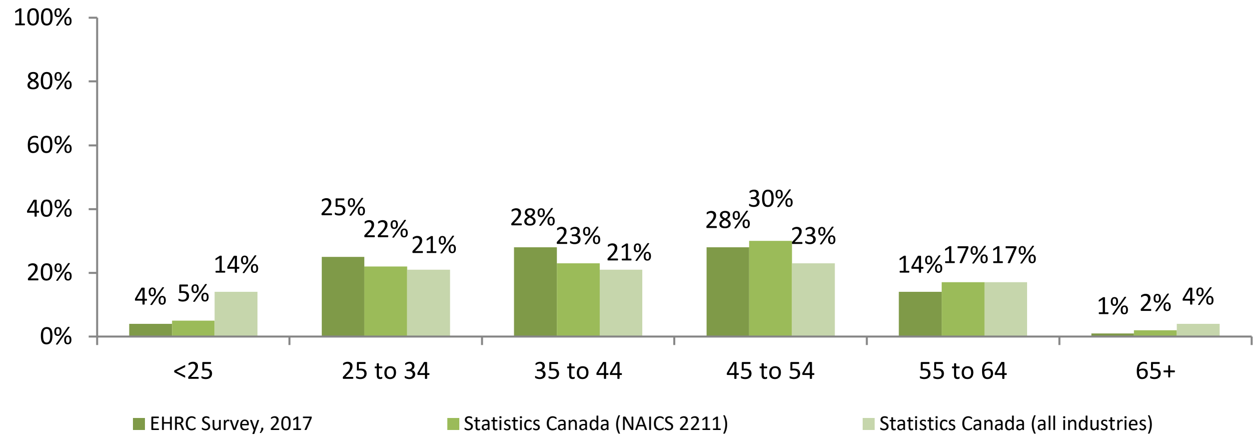
Size

The electricity sector is the largest employer of utility workers in Canada. According to Statistics Canada data (2016), of the 136,350 individuals working in utilities[214] the electricity sector employs 106,575 people.[215] Respondents to the 2017 EHRC Employer Survey represented a total of 79,838 employees working in Canada.[216] Support staff, as reported by survey respondents, (including administrative, customer service, call centre, legal, communications, regulatory, risk management, finance, information technologists (IT), human resources, supply chain and internal audit) account for just over one third (39%) of workers with the remainder being non-support/technical employees.[217] Most employees working in the sector, as in all utilities, are unionized. Unionization of utilities' workers in 2017 was 64%, over twice the national rate.[218]

Age

The age distribution of the workforce has changed since the 2011 LMI study. Data from both the EHRC survey and Statistics Canada illustrate the overall distribution for workers in the electricity sector is no longer biased towards an older labour force (55 years and older). However, there are disproportionately fewer younger workers (under 25 years) in the sector than the general workforce. In all industries in Canada, 14% of workers are under the age of 25 years, compared to 5% of workers in the electricity sector. These findings suggest a need to attract younger workers to the sector for longer-term planning.

Graph 3.5 – Overall Age Distribution



Source: EHRC Employer Survey, 2017; Statistics Canada[219]

Overall, the age distribution of electricity sector workers varies considerably by occupation (see Table 3.6). Some occupations, particularly managers and supervisors, are skewed towards an older work force; for example, approximately two-thirds of the supervisors of electricians and supervisors of electrical power line workers (69%); utility managers (67%); and smart grid specialists (65%) are 45 years or older; succession planning may be particularly needed for these occupations (see Section 3.4.4). Conversely, some occupations show a bias towards a younger workforce; for example, over half of powerline cable technicians (70%); construction electricians (60%); and wind technicians (56%) are under the age of 35 years. In general, there is a flattening of the age curve, in comparison to the 2006 Census data used to report on age distribution in the 2011 LMI study, meaning that the electricity sector is now more closely aligned with all industries than it was previously.[220]

Table 3.6 – Electricity Sector Occupations by Age Distribution

Occupational Group/Occupations	Percentage of Occupation by Age						
	n	<25	25-34	35-44	45-54	55-64	>65
Managers and Supervisors							
Utilities Managers	42	0%	7%	26%	41%	25%	1%
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	41	0%	7%	25%	46%	22%	1%
Engineering Managers	43	0%	12%	31%	35%	20%	2%
Construction Managers	40	0%	14%	27%	32%	23%	4%
Engineers/Engineering Technologists							
Electrical and Electronics Engineers	43	6%	26%	27%	24%	14%	3%
Mechanical Engineers	39	1%	35%	31%	22%	10%	1%
Civil and other Engineers	38	2%	21%	28%	28%	19%	3%
Electrical and Electronics Engineering Technologists and Technicians	41	6%	33%	24%	24%	12%	1%
Mechanical Engineering Technologists and Technicians	38	3%	18%	25%	31%	20%	3%

Occupational Group/Occupations	Percentage of Occupation by Age						
	n	<25	25-34	35-44	45-54	55-64	>65
Civil and other Engineering Technologists and Technicians	38	3%	22%	30%	26%	18%	1%
Radiation Technicians	36	2%	14%	44%	20%	17%	4%
Trades							
Powerline Technicians	44	9%	40%	23%	17%	9%	1%
Powerline Cable Technicians	37	8%	62%	9%	8%	14%	0%
Utility Arborists	37	4%	23%	19%	32%	21%	1%
Power Systems Operators	41	2%	28%	30%	27%	12%	1%
Power Systems Electricians	39	4%	37%	29%	19%	10%	2%
Power Station Operators	38	7%	35%	28%	20%	10%	0%
Construction Electricians	37	14%	46%	19%	17%	4%	0%
Industrial Electricians	36	7%	21%	35%	24%	13%	0%
Millwrights or Industrial Mechanics	38	7%	21%	35%	24%	13%	0%
Electrical Mechanics	39	5%	27%	23%	30%	13%	2%
Welders	37	2%	15%	25%	30%	27%	1%
All Other Trades[t]	37	2%	23%	25%	29%	20%	1%
Renewable Energy Occupations							
Wind Technicians	40	12%	44%	34%	10%	0%	0%
Solar PV Installers	39	6%	14%	26%	26%	23%	6%
Smart Grid Specialists	39	12%	6%	18%	41%	24%	0%
Information and Communication Technology Occupations							
Information systems analysts/consultants; database analysts/data administrators; software engineers/designers; computer programmers; interactive media developers; computer network technicians; cyber security specialists.	43	4%	14%	33%	32%	16%	1%

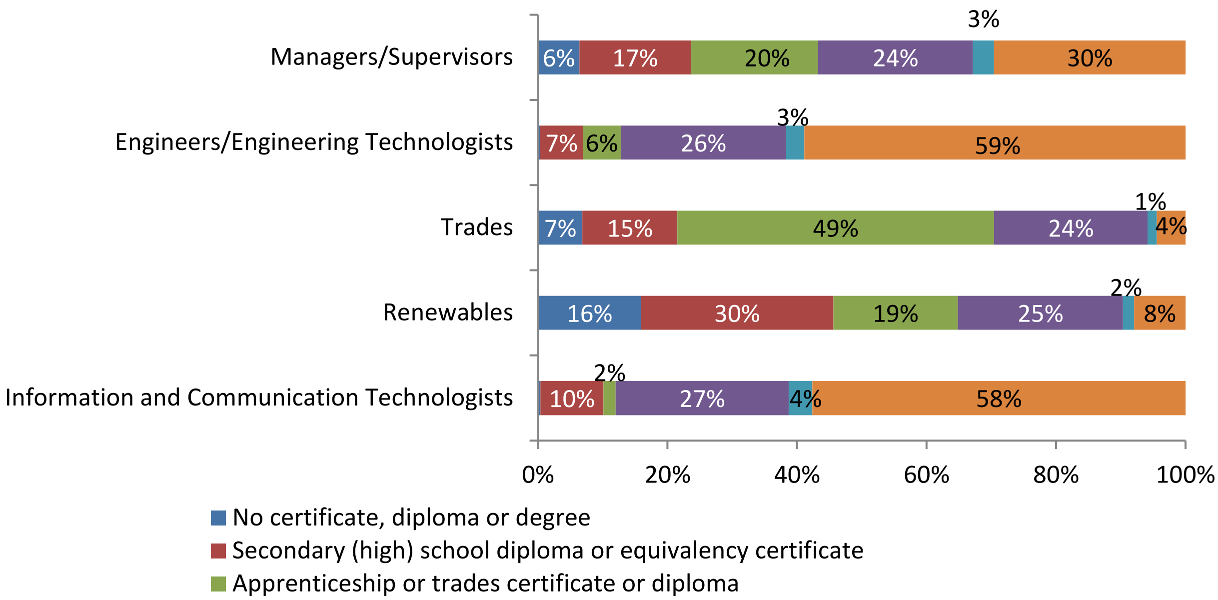
Source: EHRC Employer Survey, 2017 (QB4)
[t] Any trades working in the electricity sector that is not referenced in the list above.

Education

Engineers and engineering technologists, along with information and communication technologists, have the highest level of education, with over half receiving a university certificate, diploma or degree. Conversely, workers in renewable occupations have the lowest education level. Just under half of workers in renewable occupations (46%) had a high school diploma, or less (Graph 3.7 and Table 3.8, next page).

In part, education levels appear to reflect the maturity of certain occupations. For example, engineering and IT have clearly defined skills and qualifications that have been validated over many years, while renewable occupations are still determining their standards. Although there is growth in training programs for wind and solar, it "is uneven and certification standards are not widely applied."[221] As such, employees in renewable occupations are obtaining much of their required experience 'on the job'. It is therefore realistic to expect the education levels of these workers to increase as the technologies mature.

Graph 3.7 – Educational Attainment by Occupational Class



Source: Statistics Canada[222]

Table 3.8 – Educational Attainment by Electricity Sector Occupation

	No certificate, diploma or degree	Secondary (high) school diploma or equivalency certificate	Apprenticeship or trades certificate/ diploma	College, CEGEP, or other non-university certificate/ diploma	University certificate or diploma below the bachelor level	University certificate, diploma, or degree at bachelor level or above
Managers and Supervisors						
Utilities managers	5%	18%	11%	24%	4%	37%
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	3%	13%	46%	27%	3%	9%
Engineering managers	<1%	0%	5%	17%	4%	74%
Construction managers	9%	22%	18%	25%	3%	23%
Engineers/Engineering Technologists						
Electrical and electronics engineers	0%	2%	2%	10%	2%	84%
Mechanical engineers	0%	2%	2%	11%	2%	83%
Civil engineers	0%	2%	1%	8%	2%	87%
Electrical and electronics engineering technologists and technicians	2%	14%	13%	53%	4%	15%
Mechanical engineering technologists and technicians	<1%	14%	12%	52%	4%	18%

	No certificate, diploma or degree	Secondary (high) school diploma or equivalency certificate	Apprenticeship or trades certificate/ diploma	College, CEGEP, or other non-university certificate/ diploma	University certificate or diploma below the bachelor level	University certificate, diploma, or degree at bachelor level or above
Civil and other Engineering technologists and technicians	0%	15%	7%	58%	4%	16%
Radiation technicians	0%	18%	33%	33%	3%	13%
Trades						
Powerline Technicians and Powerline Cable Technicians	3%	13%	57%	23%	1%	3%
Utility Arborists	25%	37%	21%	14%	1%	2%
Power system and power station operators (includes smart grid specialists, wind technicians and wind station operators)	4%	13%	25%	45%	2%	11%
Power system electricians	1%	5%	55%	32%	2%	6%
Construction Electricians	2%	13%	57%	22%	2%	5%
Industrial electricians	1%	7%	53%	31%	2%	7%
Millwrights and industrial mechanics	7%	13%	49%	27%	1%	4%
Electrical mechanics	4%	11%	57%	22%	2%	5%
Welders	12%	17%	52%	17%	1%	2%
Renewable Energy Occupations						
Solar Panel Installers	23%	40%	16%	14%	1%	6%
Information and Communication Technology Occupations						
Information systems analysts/consultants (includes cyber security specialists)	0%	9%	2%	26%	4%	59%
Database analysts and data administrators	0%	9%	2%	24%	4%	61%
Software engineers and designers	0%	6%	1%	11%	2%	80%
Computer programmers and interactive media developers	<1%	9%	1%	24%	3%	63%
Computer network technicians	2%	15%	5%	45%	4%	29%

Source: Statistics Canada[223]

Occupational Distribution

Trades make up the largest occupational group of workers in the sector, accounting for 42% of all workers. Among all occupational groups, not just trades, Electrical and Electronic Engineers and Electrical Power Line Workers have the greatest number of workers, each accounting for 11% of the total electricity workforce. Renewable occupations make up the smallest proportion of the workforce (Table 3.9). This may be due, in part, to a concern among employers about investing in newer technologies, such as renewable technologies, without a clearer idea of where the industry is heading. This includes a fear of having stranded assets, i.e. money spent on technologies that are abandoned one or two years after implementation.

Table 3.9 – Employee Distribution by Occupational Category

Occupation Category	Percent of Total Sample	Occupation	Percent of Occupation Category
Managers	15%	Utilities Managers	40%
		Supervisors of Electricians & Supervisors of Electrical Power Line Workers	26%
		Engineering Managers	21%
		Construction Managers	12%
Engineers	22%	Electrical and Electronics Engineers	51%
		Mechanical Engineers	29%
		Civil and other Engineers	20%
Technologists/ Technicians	14%	Electrical and Electronics Engineering Technologists and Technicians	66%
		Mechanical Engineering Technologists and Technicians	10%
		Civil and other Engineering Technologists and Technicians	15%
		Radiation Technicians	9%
Trades	42%	Electrical Power Line Workers	25%
		Powerline Cable Technicians	<1%
		Utility Arborists	2%
		Power Systems Operators	20%
		Power Systems Electricians	6%
		Power Station Operators	15%
		Construction Electricians	4%
		Industrial Electricians	5%
		Millwrights or Industrial Mechanics	12%
		Electrical Mechanics	2%
		Welders	2%
		All Other Trades	7%
Renewable Occupations	1%	Wind Technicians	85%
		Solar PV Installers	1%
		Smart Grid Specialists	14%
ICT Occupations	5%	ICT Occupations	100%

Source: EHRC Employer Survey, 2017 (QB3a)

Workforce Diversity

EHRC research and consultations to date (both as part of this LMI study and other previous studies and initiatives) indicate a recognition of the business case for diversity and inclusion (D&I) as well as interest and willingness to maximize the labour market relevance of being more inclusive of talent from under-represented groups. This is reflected by the extensive list of well-known electricity employer partners of the Canadian Centre for Diversity and Inclusion employers and through the various D&I initiatives various employers have engaged in over the years to increase participation and engagement.

As the data in the following sections highlight, however, women and other diversity groups continue to remain well below the average for the Canadian workforce and despite reported efforts only 32% of employers reported having a formal diversity strategy or plan.

Of those employers who noted having implemented a diversity plan, several noted the importance of framing efforts on the full employment lifecycle including - attracting, acquiring, engaging, and retaining diverse talent. Furthermore, it is important to expand efforts beyond the usual to focus not only on women, minorities, persons with disabilities and Indigenous communities but to also include youth, LGBTQ and new Canadians. Plans should include foundational as well as targeted initiatives and be multi-year.

A key to effectiveness of any diversity strategy is the integration of partnerships – whether this be a partnerships with agencies, school boards, universities and colleges. It's through partnerships that employers have and will be able to reach out to those who normally would not look at the electricity industry as a place where they could have a career.

This calls into action the need to further develop and or renew attraction and retention programs to reach out to all demographics.

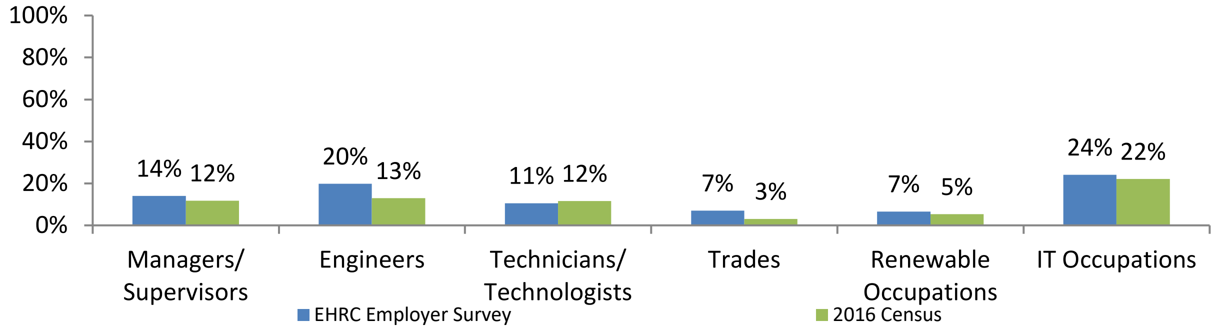
Women: Marginal increases, but overall representation remains low

Women continue to be underrepresented in the electricity sector. In 2016, women made up just over one-quarter (26%) of workers in the electricity sector, up only slightly from the 2011 LMI study (25%).[224]

The low representation of women in electricity has been noted both as an occupation and industry-level issue. While women's representation has remained low relative to the general workforce (48%) data is in line with many other trade intensive industries such as oil and gas (22%), manufacturing (28%), and construction (12%). One notable exception is agriculture where nearly one-third (30%) of the workforce in 2016 was made up of women.

As illustrated in Graph 3.11, women are particularly underrepresented among trades and renewable occupations, accounting for less than 8% of workers in these fields. Despite the low representation of women in the trades, the current proportion does however show modest growth over the 2011 LMI study.[225] Additionally the proportion of female engineers in the electricity industry (20%) is greater than their current proportion of new graduates (17%).[226]

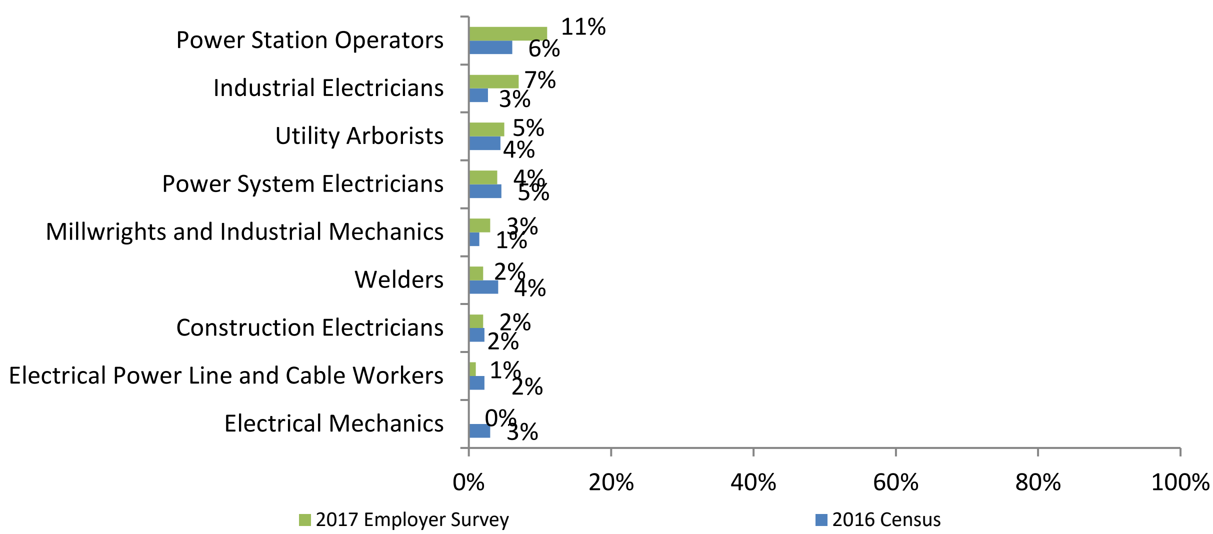
Graph 3.11 – Percent of Women in the Workforce



Source: EHRC Employer Survey, 2017 (QB3a); Statistics Canada[227]

Power Station Operators and Industrial Electricians were the most common trades for women (see Graph 3.12, next page). In contrast, Electrical Power Line and Cable Workers and Electrical Mechanics had fewer women working in these occupations.

Graph 3.12 – Percentage of Women in Trades, Electricity Industry



Source: EHRC Employer Survey, 2017 (QB3a); Statistics Canada[228]

Employers recognize the need to increase the number of women in the workforce. Building on this momentum industry can benefit from proactively encouraging initiatives that support the increased engagement and promotion of women in the workforce starting at the earliest stages of learning and career exploration (e.g. elementary and/or highscool).

It is important to note that women can only gain traction from these initiatives within the context of wider socially progressive policies and more transformative shifts in societal attitudes and organizational culture about gender roles. Women face particular constraints relevant to employment in the sector, including their self- perception of jobs that are acceptable, a lack of role models, technical skills, and the long-standing gender wage gap. Industry must be proactive about enabling women to establish a stronger equity stake.

EHRC has developed several initiatives to better support the attraction, integration and retention of women in the industry including its Connected Women Mentorship Program[229] which has a particular focus on the trades. More recently, EHRC launched its Leadership Accord on Gender Diversity[230] designed to address systemic and cultural change that is needed within the sector while promoting the values of diversity and inclusion. To date, 46 employer have signed onto the Leadership Accord with many organizations appointing Diversity Ambassadors responsible to shepherd different initiatives and ensure that the workforce is representative of the clientele it serves and the community in which it operates. In addition to broader diversity initiatives, partner organizations such as Engineers Canada have set a "30 by 30" goal i.e. 30% of graduated engineers in 2030 to be women.

In addition to promoting initiatives for trades and engineering there is potential to create livelihoods for women in the clean energy/renewables sector. The clean energy sector is perceived to be less discriminatory than the fossil fuels industry because it is a new and non-traditional field. Based on EHRC's own research[231], there is some evidence that women are drawn to choose career paths that resonate with desires to make a difference in the world. The sector provides jobs that are stable and well-paying with good benefits and opportunities for continuous learning. Career pathways are such that individuals may have many different roles within their career.

Industry is encouraged to continue to avail of these engagement opportunities.

Indigenous peoples: Interested in greater participation

Growth in workforce representation amongst Indigenous Peoples from 2011 to 2016 in the electricity sector has improved albeit slowly (3% percent in 2011 versus 4.7% in 2016) [232]. The sector had the highest concentration of Indigenous workers in the trades. While employer data noted 8% of Indigenous workers in the trades, they make up less than 4% of all other occupation classes (see Table 3.13).

Indigenous workforce representation has been comparatively higher in the oil and gas industry than other trade-intensive industries. By 2016, Indigenous Peoples made up 6.3% of their industry's workforce. This compares to 5.2% in construction, 4.7% in agriculture, and 3.9% in the total Canadian workforce.

Based on EHRC's own research, Indigenous communities across Canada seek increased participation in the economic, political, and social affairs of this country. While sharing this common objective, these communities represent a complex and diverse set of interests. Indigenous communities exercise some measure of influence – and in the case of reserve lands, direct control – over a significant percentage of Canada's land area. The resolution of land claims may see the percentage of lands under direct control increase significantly. As well, effective political representation and success in the courts have given issues of importance to Indigenous people a key place in provincial and federal political agenda.

Electricity is a major natural resource-derived commodity critical to the Canadian economy, meeting the needs of residential homeowners, business and industry from coast to coast to coast. A large part of both current and potential Canadian electricity generation and transmission originate in or cross over land traditionally used by communities. Indigenous communities and the electricity industry must work together to ensure mutual benefit and preserve the land, waterways and natural resources of Canada that form the heritage of various communities.

As ethical employers, the electricity industry is also seeking to better represent its customer base - the people of Canada. Much of the industry's generation and transmission capability travels through Indigenous lands and relationships with its peoples are crucial to the industry. Partnerships with communities increasingly figure in the strategic business plan of every utility in Canada. At the same time efforts have been underway to promote change and create a Canada with affordable, reliable, green energy with the opportunity for Indigenous communities to work towards ownership of new clean energy infrastructure. Engagement with Indigenous communities is no longer about consultation, rather these communities desire co-ownership and/or social and economic benefits, and wish to be directly involved in the project development, construction and operations.

Northern and remote communities form a particular focus and indeed, provide a unique opportunity for increased and sustained electricity Indigenous workforce engagement. Many Aboriginal communities rely on expensive diesel fuel for power generation or lack electrical service altogether. These communities are seeking to improve the living conditions of their peoples and often, the first priority on the list, is improved electrical service. Communities also hope for employment initiatives as a corollary to their investment in electrical infrastructure and seek to promote the training, development and employment of their own community members in positions which support electrical construction, maintenance and other activities. Equally, as Canada seeks to expand its resource-based activities in mining, petroleum and forest products, these industrial efforts require expertise in co-generation and therefore an effective electrical labour force, which translates into a significant employment opportunity for the northern and remote communities and a "natural pipeline" for the electricity industry.

Employers noted the implementation of targeted programs within Indigenous communities to build capacity and skills such as job shadowing, youth hire programs which include short-term assignments, as well as apprenticeship and trades programs. To further address the long-term challenges in staffing remote locations employers noted the importance of hiring local and finding ways to further strengthen ties with the local Indigenous communities while ensuring they are aware of and understand the trades and programming available to them. Employers are also active in communicating these opportunities to Indigenous communities so that they know what the projects look like and what skills they are looking for

Despite, these efforts industry needs to continue to develop longer-term workforce strategies to ensure participation and sustained engagement. At the same time as suggested through key informant interviews that employers embrace these efforts in response to the Truth and Reconciliation report as opposed to demand for a certain workforce composition.

Immigrants and non-permanent residents: New policies make integration more efficient

The electricity industry is below average in the proportion of immigrants with over 15% of the workforce compared to 25% for all other industries.[233] Meanwhile, immigrants and non-permanent residents participate in the electricity workforce at rates similar to other trade-intensive industries including: Oil and Gas (16%), Agriculture (13%), Construction (19%). One notable exception was manufacturing, where nearly one-third (30%) of the workforce in 2016 was made up of immigrants or non-permanent residents.

Under its Multi-Year Levels Immigration Plan, Canada is expecting to welcome nearly one million new immigrants between 2018 and 2020. Under the plan, 310,000 new permanent residents will settle in Canada in 2018. This target will be increased to 330,000 newcomers in 2019, with a further 340,000 to settle in 2020. At the same time, the government has now made it a priority to focus on and give precedence to those immigrants who have the skills that are most in-demand in Canada. The current, more demand-focused immigration policies will allow the federal government to bring newcomers into the industry more efficiently than is currently possible.

Persons with disabilities: Reaching out to become more inclusive

According to the Canadian Disability Survey, the prevalence of disabilities in Canada may be more common than one may think. In 2017, 22% of the Canadian population aged 15 years and over – or about 6.2 million individuals – had one or more disabilities[234]. The meaning of the term disability is continually changing and the number of intellectual, physical and mental conditions that are referred to as disabilities is increasing.

Persons with disabilities made up 12.6% of the total Canadian workforce as of 2016. Among those aged 25 to 64 years, persons with disabilities were less likely to be employed (59%) than those without disabilities (80%). As the level of severity increased, the likelihood of being employed decreased. Among individuals aged 25 to 64 years, 76% of those with mild disabilities were employed, whereas 31% of those with very severe disabilities were employed.

According to employer reported data, persons with disabilities represent less than 3% of the electricity workforce for each of the occupational groups. See Table 3.13 for reported workforce diversity among employers who participated in the 2017 EHRC employer survey.

For people with disabilities seeking employment and long-term careers the sector provides opportunities in a wide array of occupations, often in careers that one does not readily associate with the sector. Job opportunities include, but are not limited to: trades positions, engineering, customer service, operations, transportation, conservation, information system analysts, planners, environmentalists, arborists, telecoms, consumer behaviors psychologists, smart energy specialists, project managers, solar installers, wind-turbine technicians, and communications.

Like other untapped talent pools, EHRC and the electricity industry have long identified the need to diversify its workforce through the recruitment of those with disabilities (both visible and invisible). EHRC has spoken with a number of industry employers to discuss current practices and ascertain industry needs in this area both through this study and other recent project work. While the companies we heard from showed a sincere desire to hire people with disabilities and have indicated efforts to carve out specific positions, provide workplace accommodations or work with non-profit partners that have employment-focused programs it was acknowledged that further education and training are required to overcome cultural barriers including efforts to dispel myths (e.g. hiring those with disabilities means more work for able bodied employees) and put theory into practice.

In response, EHRC engaged in the following activities through its From Disability to Inclusion project[235]. which included extensive consultation and engagement sessions, the development of a communications video and at its core an online portal was developed to help employers improve or enhance equity of access and supports for people with disabilities - both visible and invisible - who work or wish to work in the Canadian electricity industry.

Efforts to increase engagement and opportunity for this demographic need to continue and employers are encouraged to consult with and adapt as needed the materials that form the above-noted portal.

Visible minorities: Similar representation as in other trades

The total share of visible minorities in the workforce was 21% in 2016 (21%), with visible minorities generally underrepresented in the sector (13%). By comparison, the participation rates for visible minorities in other trade-intensive industries include representation at 13% for oil and gas, 7% for agriculture and 12% for construction. Unsurprisingly, manufacturing, noted for its relatively high rate of immigrant workforce representation, had a larger proportion of visible minorities than Canada's total workforce. In 2016, nearly one-quarter (24%) of manufacturing's workforce was composed of individuals who were visible minorities.

Within electricity employer reported data noted the greatest presence of visible minorities amongst engineering and ICT occupations. See Table 3.13 for reported workforce diversity among employers who participated in the 2017 EHRC employer survey.

Table 3.13 – Other Diversity Groups in the Workforce

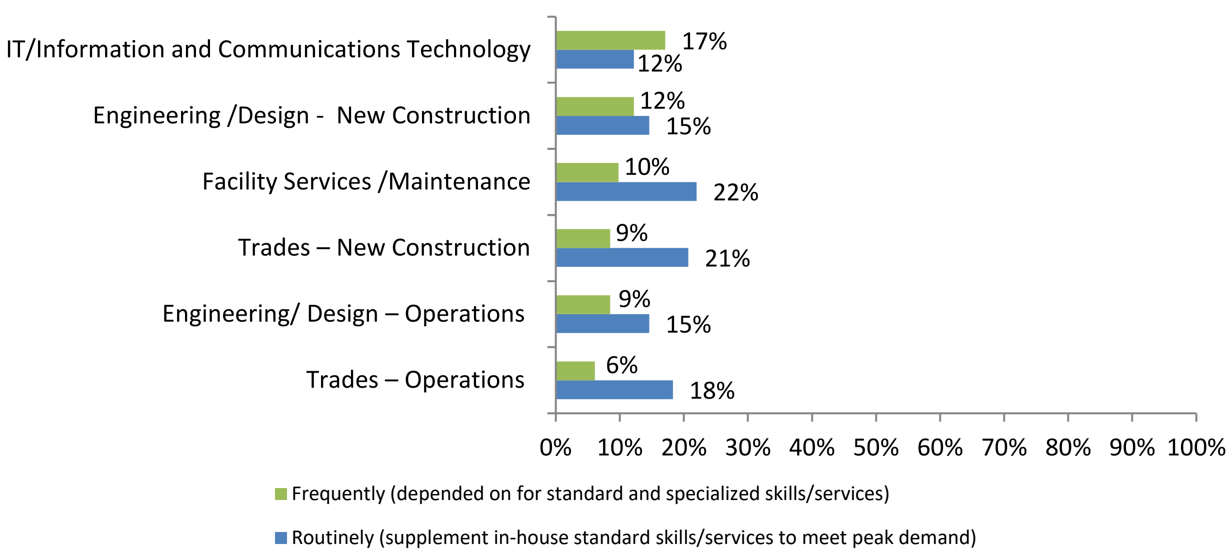
Occupation	Indigenous Peoples		Visible Minority		Persons with Disability	
	N*	%	N*	%	N*	%
Managers	35	2%	34	7%	33	1%
Engineers	33	2%	34	26%	33	2%
Technologists and Technicians	34	3%	34	5%	33	2%
Trades	34	8%	33	2%	33	2%
Renewable Occupations	31	2%	32	2%	32	0%
Information and Communication Technology Occupations	34	1%	35	10%	34	1%

Source: EHRC Employer Survey, 2017 (QB2b, QB3a)
* The number of organizations that provided data

Contractors/Consultants

As shown in Graph 3.14, electricity sector employers regularly consult or contract with specialists and outside resources for the labour to generate, transmit and distribute electricity. Firms reported using contractors to assist with sudden workload demands, and on specific projects, such upgrading legacy technologies. The use of contractors and consultants is especially prevalent for facility services and maintenance and trades for new construction. The reliance on contractors and consultants to meet regular or peak demand work requirements generally fell from the 2011 LMI report for all categories except trades.[236]

Graph 3.14 – Use of Contractors and Consultants by Electricity and Renewable Energy Providers



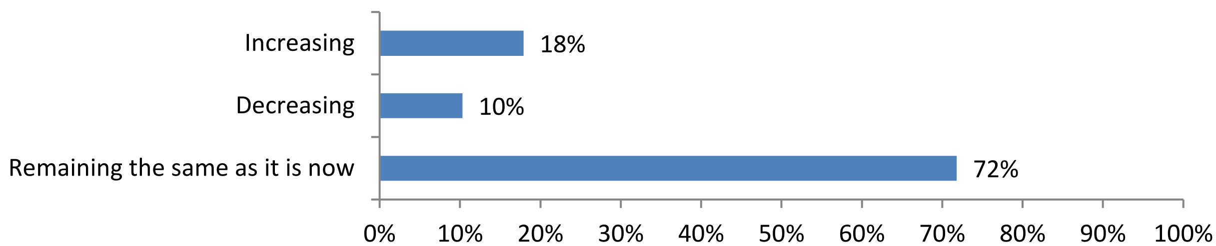
Source: EHRC Employer Survey, 2017 (QA7)

While contractors and consultants are regularly used within the industry, much of the work is still done in-house. On average, for each service or task, just under half (43%) of employers reported that only permanent employees completed work within their organizations. This is compared to the average of just over a quarter (27%) of employers who routinely or frequently use contractors and consultants. The use of contractors and consultants is particularly high for IT (29%), Trades – New Construction (29%) and Facility Services/Maintenance (32%).

The number of contractors used in the electricity industry was equal to 15% of the permanent workforce, while consultants were equal to 2%. Among those organizations who reported, contractors and consultants undertook 16% (n=18) of the duties and received 9% (n=25) of wages.

The use of contractors and consultants allowed employers to quickly respond to short term increases in workload (e.g. capital projects, peak times). Additionally, contractors and consultants allowed employers to react to changes in skill demands or need, ensuring they had the required skill inventory to meet the needs of customers and regulators. Finally, contactors and consultants provided employers with specialized knowledge and skill requirements, e.g. IT, regulation changes. Thus, most employers (72%) reported that they expected to continue to use contractors in the future as much as they currently did (Graph 3.15).

Graph 3.15 – Expected Change in the Use of Contractors



Source: EHRC Employer Survey, 2017 (QA9); n=78

Source of External Hires

Except for renewable occupations, most external hires had prior experience within the electricity industry (Table 3.16). For renewable occupations, recent post-secondary graduates were the most common source of external hires by employers. Given the relative infancy of renewable energy, this may reflect a lack of experienced workers with skills in this area. For other occupational categories, external hires tended to come from other provinces, other electricity employers or other industries. The electricity industry is below average in the proportion of immigrants with over 15% of the workforce compared to 22% for all other employers.[237]

Table 3.16 – Source of External Hires by Occupation Category

Occupation Group	Recent PSE Graduate	Inter-Provincial	Recent Immigrant*	Electricity Related	Non-electricity Related	No Previous Work Experience
Manager	2%	41%	4%	32%	21%	0%
Engineer	14%	22%	3%	33%	20%	7%
Technologist/ Technician	9%	32%	1%	39%	16%	3%
Trade	14%	9%	2%	47%	16%	11%
Renewable Occupation	60%	0%	0%	30%	9%	0%
ICT	17%	20%	4%	30%	28%	1%

Source: EHRC Employer Survey, 2017 (QD3)
* Within the survey, recent immigrants were defined as: "Individuals who are foreign-trained and who have arrived in Canada within 24 months of being hired".

3.4 Human Resource Trends

Retirement

While there was minor variation between occupations in the electricity sector, the average age of retirement was consistently over 60 years, across all occupations. This represents an increase of over two years from the average retirement ages reported in the 2011 LMI study.[238] The greatest increase in average retirement age was among mechanical engineering technologists and technicians who went from 55.4 years in 2011 to 63.2 years in 2017, an increase of almost eight years.

By comparison, Canada's average retirement age is 63[239] according to Statistics Canada, with older generations often staying in the workforce longer. Many could be working longer, in part, to make up for losses suffered during the 2008-09 recession while others for pure enjoyment. A growing trend is that older workers are choosing to stay in the workplace because they want to be there - enjoying meaningful work is a key reason for delaying retirement.

The majority of workers who retired in the electricity sector did so with full benefits. Except for powerline cable technicians and electrical mechanics, over half of the workers within each of the occupations retired with full eligibility (Table 3.17).

Table 3.17 – Retirement Pattern, Electricity Sector Occupations*

Occupation	Number in Sample	Average Age of Retiremen t	Number of Retirement s in 2017	Number of Staff Eligible for Retirement	Percent of Staff Who Retired on Full Eligibility
Managers and Supervisors					
Utilities Managers	1,485	61.1	25	157	52.2%
	n=51	n=18	n=37	n=35	n=8
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	954	61.1	57	176	72.5%
	n=49	n=17	n=33	n=33	n=8
Engineering Managers	780	61.4	30	105	65.8%
	n=48	n=14	n=33	n=34	n=6
Construction Managers	448	62.2	13	78	62.8%
	n=44	n=11	n=32	n=32	n=4
Engineers/Engineering Technologists					
Electrical and Electronics Engineers	2,582	62.8	43	202	58.8%
	n=49	n=14	n=32	n=32	n=5
Mechanical Engineers	1,636	62.9	9	57	61.2%
	n=43	n=10	n=31	n=31	n=5
Civil and other Engineers	1,104	63.3	9	63	50.5%
	n=43	n=9	n=31	n=31	n=2
Electrical and Electronics Engineering Technologists and Technicians	2,316	61.8	71	143	66.9%
	n=48	n=20	n=36	n=35	n=8
	344	63.2	6	57	67.0%

Occupation	Number in Sample	Average Age of Retirement	Number of Retirements in 2017	Number of Staff Eligible for Retirement	Percent of Staff Who Retired on Full Eligibility
Mechanical Engineering Technologists and Technicians	n=41	n=9	n=29	n=30	n=3
Civil and other Engineering Technologists and Technicians	528	62.5	17	77	67.0%
	n=39	n=10	n=30	n=30	n=3
Radiation Technicians	308	62.6	6	4	67.0%
	n=37	n=8	n=28	n=28	n=3
Trades					
Electrical Power Line Workers	2,679	60.3	61	145	61.8%
	n=44	n=16	n=34	n=33	n=9
Powerline Cable Technicians	45	62.0	2	7	42.0%
	n=36	n=8	n=29	n=28	n=3
Utility Arborists	317	61.9	14	36	50.5%
	n=31	n=7	n=28	n=28	n=2
Power Systems Operators	2,090	60.5	44	172	79.2%
	n=42	n=12	n=32	n=31	n=5
Power Systems Electricians	584	61.7	14	55	69.0%
	n=40	n=9	n=31	n=30	n=4
Power Station Operators	1,615	60.6	25	51	50.5%
	n=37	n=10	n=29	n=28	n=2
Construction Electricians	407	61.8	12	15	52.8%
	n=38	n=9	n=28	n=27	n=4
Industrial Electricians	475	61.6	14	40	57.8%
	n=38	n=11	n=30	n=29	n=5
Millwrights or Industrial Mechanics	1,269	61.8	37	129	50.0%
	n=40	n=11	n=31	n=30	n=4
Electrical Mechanics	180	61.9	6	16	35.3%
	39	n=9	n=29	n=29	n=3
Welders	261	61.6	12	16	53%
	n=39	n=11	n=30	n=29	n=4
All Other Trades	693	61.7	26	71	75.3%
	n=37	n=10	n=29	n=28	n=4
Renewable Occupations					
Wind Technicians	n=295	61.6	3	3	50.5%
	34	n=8	n=29	n=28	n=2
Solar PV Installers	n=4	61.9	1	1	50.5%
	17	n=7	n=28	n=27	n=2
Smart Grid Specialists	50	61.4	1	1	67.0%
	n=35	n=8	n=29	n=28	n=3
Information and Communication Technology Occupations					
Information systems analysts and consultants; database analysts and data administrators; software engineers and designers;	1,344	60.4	43	129	57.4%

Occupation	Number in Sample	Average Age of Retiremen t	Number of Retirement s in 2017	Number of Staff Eligible for Retirement	Percent of Staff Who Retired on Full Eligibility
computer programmers; interactive media developers; computer network technicians; cyber security specialists.	n=43	n=15	n=35	n=33	n=8

Source: EHRC Employer Survey, 2017 (QC1)
* "n=" The number of organizations that provided data

Table 3.18 (next page) shows the projected number of retirements as a percentage of the current workforce over the coming years as based on employer reported survey data. The overall proportion of the workforce that is expected to retire is 2.5% in 2019 and 2.8% in 2022, lower that the 2011 and 2016 projection provided in the last report.[240] With the exception of solar panel installers and supervisors of electricians and supervisors of electrical power line workers employer projected retirement rates were less than 5%, in both 2019 and 2022.

Table 3.18 – Retirement Projections, Electricity Occupations

Occupational Group/Occupations	N*	Percent of Current Workforce Retiring in 2019	Percent of Current Workforce Retiring in 2022
Managers and Supervisors			
Utilities Managers	51	2.8%	3.5%
Engineering Managers	48	4.4%	4.6%
Construction Managers	44	4.5%	6.5%
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	49	7.7%	9.0%
Engineers/Engineering Technologists			
Electrical and Electronics Engineers	49	1.8%	2.0%
Mechanical Engineers	43	1.0%	0.9%
Civil and other Engineers	43	0.7%	1.0%
Electrical and Electronics Engineering Technologists and Technicians	48	1.8%	1.6%
Mechanical Engineering Technologists/Technicians	41	3.8%	3.5%
Civil and other Engineering Technologists and Technicians	39	2.5%	2.1%
Radiation Technicians	37	0.3%	1.6%
Trades			
Electrical Power Line Workers	44	2.4%	3.1%
Powerline Cable technicians	36	4.4%	2.2%
Utility Arborists	31	0.5%	0.9%
Power Systems Operators	42	1.8%	2.0%
Power Systems Electricians	40	1.5%	1.4%
Power Station Operators	37	1.4%	1.4%
Construction Electricians	38	1.2%	0.7%
Industrial Electricians	38	4.0%	3.4%

Occupational Group/Occupations	N*	Percent of Current Workforce Retiring in 2019	Percent of Current Workforce Retiring in 2022
Millwrights or Industrial Mechanics	40	3.9%	4.6%
Electrical Mechanics	39	1.1%	3.9%
Welders	39	1.9%	3.1%
All Other Trades	37	6.1%	7.1%
Renewable Energy Occupations			
Wind Technicians	34	0.3%	0.3%
Solar PV Installers	17	25.0%	25.0%
Smart Grid Specialists**	35	2.0%	2.0%
Information and Communication Technology Occupations			
Information systems analysts and consultants; database analysts and data administrators; software engineers and designers; computer programmers; interactive media developers; computer network technicians; cyber security specialists.	43	3.1%	4.3%

Source: EHRC Employer Survey, 2017 (QC1)
* The number of organizations that provided data
** Across all employers, a total of 4 Smart Grids Specialists were reported working in the electricity sector.

Staff Turnover and Recruitment

Voluntary termination rates for the electricity industry were reported as relatively modest overall. Apart from Wind Technicians, employers reported voluntary termination rates were less than 5% in 2017 across all electricity occupations, reflecting the stable nature of the workforce. New hires for the industry in 2017 continued to be robust. Except for powerline cable technicians, construction electricians, welders and solar PV installers, the new hire rate exceeded the voluntary termination rate (Table 3.19).

Table 3.19 – Changes in the Workforce, Electricity Sector Occupations

Occupational Group/Occupations	Number in Sample*	Voluntary Termination Rate (%)	New Hires (%)
Managers and Supervisors			
Utilities Managers	1,485	1.7%	7.3%
	n=51	n=45	n=37
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	954	2.2%	13.4%
	n=49	n=44	n=35
Engineering Managers	780	2.3%	10.6%
	n=48	n=45	n=35
Construction Managers	448	0.9%	4.9%
	n=44	n=43	n=36
Engineers/Engineering Technologists			
Electrical and Electronics Engineers	2,582	3.0%	7.7%
	n=49	n=46	n=35
Mechanical Engineers	1,636	1.2%	8.9%
	n=43	n=43	n=33
Civil and other Engineers	1,104	0.5%	1.3%
	n=43	n=42	n=32
Electrical and Electronics Engineering Technologists and Technicians	2,316	0.7%	5.1%
	n=48	n=44	n=38
Mechanical Engineering Technologists and Technicians	344	1.5%	18.6%
	n=41	n=42	n=34
Civil and other Engineering Technologists and Technicians	528	2.3%	6.1%
	n=39	n=42	n=32
Radiation Technicians	308	0.3%	4.5%
	n=37	n=41	n=30
Trades			
Electrical Power Line Workers	2,679	1.6%	5.6%
	n=44	n=44	n=34
Powerline Cable Technicians	45	2.2%	0.0%
	n=36	n=41	n=30
Utility Arborists	317	3.2%	8.8%
	n=31	n=42	n=30
Power Systems Operators	2,090	0.7%	6.3%
	n=42	n=44	n=33%
Power Systems Electricians	584	0.9%	12.3%
	n=40	n=42	n=31
Power Station Operators	1,615	2.5%	9.5%
	n=37	n=43	n=33
Construction Electricians	407	1.5%	1.0%

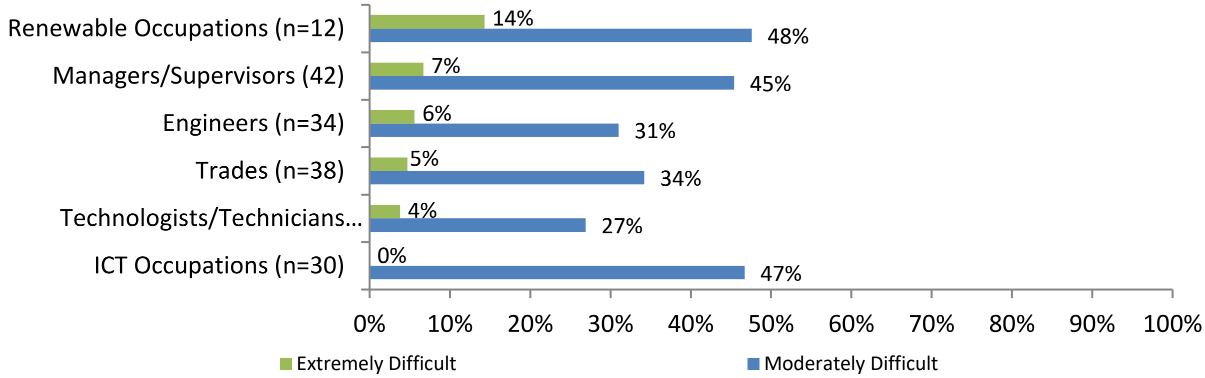
Occupational Group/Occupations	Number in Sample*	Voluntary Termination Rate (%)	New Hires (%)
	n=38	n=41	n=31
Industrial Electricians	475	3.8%	13.1%
	n=38	n=43	n=32
Millwrights or Industrial Mechanics	1,269	1.7%	6.3%
	n=40	n=42	n=33
Electrical Mechanics	180	3.3%	15.6%
	39	n=43	n=32
Welders	261	2.7%	2.7%
	n=39	n=41	n=31
All Other Trades	693	3.5%	16.8%
	n=37	n=43	n=32
Renewable Energy Occupations			
Wind Technicians	295	12.5%	17.3%
	n=34	n=43	n=30
Solar PV Installers	4	0.0%	0.0%
	n=17	n=41	n=28
Smart Grid Specialists	50	2.0%	4.0%
	n=35	n=42	n=28
Information and Communication Technology Occupations			
Information systems analysts and consultants; database analysts and data administrators; software engineers and designers; computer programmers; interactive media developers; computer network technicians; cyber security specialists.	1,344	2.9%	14.5%
	n=43	n=46	n=37

Source: EHRC Employer Survey, 2017 (QD2, QD3)
* "n=" The number of organizations that provided data

Difficulty Hiring Staff

As demonstrated in Graph 3.20, renewable occupations were reported as the most difficult to hire for in 2017. The introduction of new technologies, coupled with a lack of clarity concerning skill requirements, make it difficult to find appropriate staff. Managers and supervisors were the next most challenging occupation group to hire for. Employers noted that there was a dearth of mid-level staff within their organizations to step into senior positions. EHRC has observed, that this is likely due to the high level of baby boomers and lower cohort of younger workers or Gen X who don't have requisite experience. This is indeed a challenge within the trades too where it impacts safety. Employers have a key role to play in ensuring employees are given the support they need to step into managerial or supervisory roles.

Graph 3.20 – Hiring Challenges by Occupation Group, 2017



Source: EHRC Employer Survey, 2017 (QD5)

In 2017, over half of employers reported that they had no difficulty hiring staff for most electricity occupations. For Supervisors of Electricians & Supervisors of Electrical Power Line Workers, Construction Managers, Power Systems Operators, Power Systems Electricians, Power Station Operators, Solar PV Installers, Smart Grid Specialists, over half of employers stated they had moderate difficulty in hiring. In 2017, only two occupations, Power Systems Operators and Smart Grid Specialists had more than 10% of employers reporting that it was extremely difficult to hire.

Employers anticipate that in 2022 there will be more occupations that are challenging to hire. Over half of employers stated that supervisors of electricians and supervisors of electrical power line workers, engineering managers, construction managers, power systems electricians, solar PV installers, smart grid specialists and ICT occupations would be moderately difficult to hire in 2022. Additionally, there were six occupations that more than 10% employers stated would be extremely difficult to hire in 2022: utilities managers, electrical and electronics engineers, electrical power line workers, power systems operators, power station operators and smart grid specialists.

In 2017, the most challenging occupations to fill were smart grid specialists, power systems operators, power station operators and power systems electricians (Table 3.21, next page). Employers reported that they expect that these occupations will continue to be the most challenging to fill through to 2022. Additionally, while not as great a challenge in 2017, it is expected that it will be difficult to hire managers, particularly engineering and construction managers, within the industry by 2022 (Table 3.22, page 53). As senior management staff begin to retire, organizations expect that they will find it challenging to find replacements with the requisite mid-level experience to take over these roles. Organizations need to develop appropriate succession planning and knowledge transfer to ensure the availability of appropriate replacements. EHRC has observed a reliance by some organizations on utilizing retirees (as casual employees or contractors) to fill knowledge gap which signifies lack of succession planning and solid knowledge management processes. Organizations need to ensure they do not build an undue reliance on retirees which can cause a retention issue amongst its younger workforce who may not see opportunities to advance materialize.

Table 3.21 – Difficulty Hiring Staff, 2017

Occupational Group/Occupations Occupation	N*	No Difficulty	Moderate Difficulty	Extreme Difficulty	Average**
Managers and Supervisors					
Utilities Managers	32	50%	41%	9%	1.59

Occupational Group/Occupations Occupation	N*	No Difficulty	Moderate Difficulty	Extreme Difficulty	Average**
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	32	44%	50%	6%	1.63
Engineering Managers	32	50%	41%	9%	1.59
Construction Managers	32	48%	52%	0%	1.52
Engineers/Engineering Technologists					
Electrical and Electronics Engineers	33	55%	39%	6%	1.52
Mechanical Engineers	19	68%	26%	5%	1.37
Civil and other Engineers	19	74%	21%	5%	1.32
Electrical and Electronics Engineering Technologists and Technicians	31	68%	29%	3%	1.35
Mechanical Engineering Technologists and Technicians	19	74%	26%	0%	1.26
Civil and other Engineering Technologists and Technicians	20	70%	25%	5%	1.35
Radiation Technicians	8	63%	25%	13%	1.50
Trades					
Electrical Power Line Workers	27	52%	37%	11%	1.59
Powerline Cable Technicians	8	63%	38%	0%	1.38
Utility Arborists	14	57%	36%	7%	1.50
Power Systems Operators	22	32%	55%	14%	1.82
Power Systems Electricians	14	36%	64%	0%	1.64
Power Station Operators	18	39%	56%	6%	1.67
Construction Electricians	12	92%	8%	0%	1.08
Industrial Electricians	13	77%	23%	0%	1.23
Millwrights or Industrial Mechanics	20	80%	15%	5%	1.25
Electrical Mechanics	13	77%	23%	0%	1.23
Welders	15	87%	13%	0%	1.13
All Other Trades[ŧ]	17	71%	29%	0%	1.29
Renewable Energy Occupations					
Wind Technicians	8	50%	38%	13%	1.63
Solar PV Installers	5	40%	60%	0%	1.60
Smart Grid Specialists	8	25%	50%	25%	2.00
Information and Communication Technology Occupations					
ICT Occupations	30	53%	47%	0%	1.47

Source: EHRC Employer Survey, 2017 (QD5)
* The number of organizations that provided data
** Average score on a three-point scale; higher score reflects greater difficulty
ŧ Any trades working in the electricity sector that is not referenced in the list above.

Table 3.22 – Projected Difficulty Hiring Staff, 2022

Occupation	N*	No Difficulty	Moderate Difficulty	Extreme Difficulty	Average**
Managers and Supervisors					
Utilities Managers	30	47%	43%	10%	1.63

Occupation	N*	No Difficulty	Moderate Difficulty	Extreme Difficulty	Average**
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	32	44%	50%	6%	1.63
Engineering Managers	30	37%	50%	13%	1.77
Construction Managers	22	32%	64%	5%	1.73
Engineers/Engineering Technologists					
Electrical and Electronics Engineers	33	42%	42%	15%	1.73
Mechanical Engineers	17	58%	42%	0%	1.41
Civil and other Engineers	17	59%	41%	0%	1.41
Electrical and Electronics Engineering Technologists and Technicians	30	60%	37%	3%	1.43
Mechanical Engineering Technologists and Technicians	18	67%	33%	0%	1.33
Civil and other Engineering Technologists and Technicians	19	68%	26%	5%	1.37
Radiation Technicians	8	63%	25%	13%	1.50
Trades					
Electrical Power Line Workers	27	41%	41%	19%	1.78
Powerline Cable Technicians	7	71%	14%	14%	1.43
Utility Arborists	13	54%	39%	8%	1.54
Power Systems Operators	21	29%	43%	29%	2.00
Power Systems Electricians	12	17%	75%	8%	1.92
Power Station Operators	16	31%	44%	25%	1.94
Construction Electricians	10	80%	20%	0%	1.20
Industrial Electricians	13	69%	31%	0%	1.31
Millwrights or Industrial Mechanics	19	68%	21%	11%	1.42
Electrical Mechanics	12	67%	25%	8%	1.42
Welders	15	80%	20%	0%	1.20
All Other Trades[t]	20	50%	45%	5%	1.55
Renewable Energy Occupations					
Wind Technicians	7	57%	43%	0%	1.43
Solar PV Installers	4	50%	50%	0%	1.50
Smart Grid Specialists	6	17%	67%	17%	2.00
Information and Communication Technology Occupations					
ICT Occupations	27	44%	52%	4%	1.59

Source: EHRC Employer Survey, 2017 (QD5)
* The number of organizations that provided data
** Average score on a three-point scale; higher score reflects greater difficulty
[t] Any trades working in the electricity sector that is not referenced in the list above.

Competition with Other Employers

The majority of employers (60%) noted that they were in competition for labour (Table 3.23) with the most common source of competition being other utilities. Employers also noted a growing trend among employees to resign, rather than to retire, or to seek employment in other industries as contractors or consultants. Despite these trends, employers did not feel it had any significant impact on operations.

Table 3.23 – Competition for Labour

Do you compete with other employers for labour	Percentage
No	25%
Yes, other utilities	60%
Yes, contractors and consultants	51%
Yes, employers in the oil and gas industry	22%
Yes, employers in the construction industry	31%
Yes, other	8%

Source: EHRC Employer Survey, 2017 (QD6); n=65
Note: Percentages do not add up to 100% due to multiple responses.

Additional, challenges to recruitment were reported including difficulties in finding applicants with the necessary skills or experience for the work (45%), the remoteness of the work was also reported as an on-going challenge (29%). Many power generating facilities are located away from major population centres reducing the attractiveness of positions to new employees. Employers with remote facilities tried to engage and recruit from local, rural centres, especially Indigenous communities. However, these efforts have met with limited and mixed success. Finally, employers noted that limited future employment options (5%) impacted the ability to recruit new employees. For example, coal-powered electricity plants, in some jurisdictions, are targeted for closure. This has resulted in employers being faced with the challenge of retaining staff with knowledge of these legacy systems who may be disengaged and looking for other work.

Finally, employers in the electricity sector are competing for workers with other industries. With the exception of some specialized trades, e.g. power line technician, most occupations within electricity share skills that are and transferable to other industries. In particular, the labour markets for engineers; construction; and information and communication technology all pull occupations and skills that are utilized by with the electricity sector. As such, the ability of electricity employers to recruit workers in shared occupations will be impacted by labour market conditions of these industries.

Engineers and Engineering Technicians and Technologists[241]

The *Engineer Labour Market in Canada: Projections to 2025* report was completed by Engineer Canada in 2015. The report forecasts supply and demand projections for 14 engineering occupations. Overall, the report highlights a growing need to replace retiring engineers. The need to replace retiring engineers is especially relevant for electrical/electronic, mechanical, civil and computer engineers. The report also highlights the role of Canadian universities in meeting supply requirements through training new entrants to the market.

It was projected that between 2015-2020, there would be an average of 1,800 job openings for electrical and electronic engineers. Most of these job openings (67%) were expected to be due to retirements, with the remainder coming from expansion demand. Between 2021-2025, job openings are expected to shrink to about 1,350 per year, with retirements being responsible for most (89%). Canadian universities are expected to grant over 2,000 degrees a year to electrical and electronic engineers, providing an adequate supply for demand requirements. However, it is estimated that there will only be 1,100 new entrants to the occupation a year, requiring net in-migration to meet remaining demand requirements. International in-migration is expected to provide the majority of the remaining demand.

The demand for mechanical engineers is expected to be slightly higher, with an average of 2,100 job openings per year between 2015-2020 and 1,400 job openings per year between 2021-2025. The bulk of these job opening are expected to be due to retirement between 2015-2020 (60%) and 2021-2025 (91%). Canadian universities are providing over 3,000 degrees to mechanical engineers a years, with 1,200 new entrants expected to enter the occupation each year. Net in-migration, particularly international in-migration, is expected to supply the remaining demand.

Civil engineers are expected to have slightly higher demand, with an average of 2,500 job openings per year between 2015-2020 and 1,800 job opening per year between 2021-2025. The majority of these job openings are due to anticipated retirements between 2015-2020 (60%) and 2021-2025 (83%). Canadian universities grant over 2,700 civil engineering degrees a year, with approximately 1,300 new entrants to the occupation annually. Interprovincial mobility and international in-migration are expected to meet remaining demands.

Construction and Maintenance[242]

The construction industry plays a large role in the development, building, maintenance and refurbishment of the necessary infrastructure for electricity generation. As such, 12 occupations have been identified as having in-house roles with electricity companies or working as contractors and consultants with electricity companies. Table 3.24 shows the current and projected workforce size for these 12 occupations.

Table 3.24 – Current and Projected Workforce, Construction Industry

Construction Trades & Occupations	2017		2022	
	Construction	All Industries	Construction	All Industries
Boilermakers	8,201	10,979	8,725	11,581
Carpenters	170,306	194,185	165,839	190,386
Crane operators	6,965	15,028	6,762	15,084
Electricians (including industrial and power system)	95,980	139,357	98,528	143,410
Heavy-duty equipment mechanics	7,694	48,390	7,601	50,000
Heavy equipment operators (except crane)	55,081	97,320	53,550	97,430
Ironworkers and structural metal fabricators	12,099	23,516	11,895	23,706
Sheet metal workers	15,298	22,902	15,589	23,349
Steamfitters, pipefitters and sprinkler system installers	14,813	23,694	15,146	24,550
Trades helpers and labourers	152,140	187,793	148,288	185,353
Truck drivers	24,289	308,777	23,360	316,769
Welders and related machine operators	13,347	99,139	13,151	101,334
Total	576,215	1,171,081	568,433	1,182,953

Source: BuildForce Canada. (2018) Construction and Maintenance Looking Forward, 2018 - 2027

BuildForce Canada produces an annual *Construction and Maintenance Looking Forward* review of 34 trades and occupations. The review uses a scenario-based forecast system to determine the workforce needs for heavy industrial, residential and non-residential construction markets. The review is supplemented through consultations with industry stakeholders, such as owners, labour groups, and contractors. Stakeholder feedback validates the assumption and construction project lists incorporated as part of the review. The resulting review provides Labour Market Intelligence to help employers manage their workforce.

The results of the review indicate that the growth within construction is expected to slow over the next ten years. For the past 20 years, the construction industry experienced almost uninterrupted growth, resulting in the workforce doubling. As the pace of residential construction is expected to decline, and many large non-residential construction projects are nearing completion, demand is expected to soften. Despite this decline in demand, moderate overall growth is still expected in the industry.

Slowing population growth is expected to lower demand for new housing starts. However, it is anticipated that this decline in new construction will be partially offset by rising renovation and maintenance activity. As a result of these changes, employment in residential construction is expected to decline by 12,500 jobs by 2017, or by 2% of its 2017 levels. In spite of this decline in employment, hiring pressures are still expected as an anticipated 122,100 experienced workers are expected to retire over the next ten years.

The anticipated timing of major transportation, utility, and other infrastructure projects is expected to nudge non-residential employment up a further 3 percent, or 18,400 workers, to a near term peak in 2020. Growth is concentrated in Ontario and British Columbia, driven by major nuclear refurbishment, LNG (liquefied natural gas), and energy and transportation infrastructure projects. The anticipated start of a major hydro refurbishment project in New Brunswick should also increase demands later in the scenario period.

Long-term demand is expected to be sustained through growth in commercial and institutional building construction and gains in maintenance work. It is expected that these changes in the will result in an increase of 5% in non-residential employment or by 26,700 workers by 2027. In addition to expansion demand, employers will also be challenged to replace retiring workers. It is expected that 132,700 workers will retire by 2027.

These retirements represent a significant loss of skilled workers which includes those key construction trades and occupations that are common to engineering and industrial work in the electricity industry. One such trade in particular is Boilermakers needed for any current and future nuclear refurbishment plans.

In Ontario alone, Ontario Power Generation and Bruce Power will have parallel refurbishments underway in 2020 creating a huge demand for highly skilled tradespeople. The companies are arranging the schedules to minimize having the same trades in demand at both sites at the same time, building capacity within the current skilled trades workforce and trying to entice more people to enter the trades (encouraging more women, members of Indigenous communities and people who are new to Canada to join the nuclear workforce). It has already been established that the number of boilermakers available in Ontario will be insufficient to meet refurbishment requirements over the next decade of work.

The above challenges are made more difficult by a shrinking number of young people available to enter the workforce as population growth slows, and recruitment competition increases from other sectors of the economy that face similar age demographic challenges. As such, attracting and recruiting new workers presents a challenge for the construction industry. Similar to the electricity industry, Canada's construction sector will need to look to new demographics for recruitment to meet the growing need for more employees.

Information and Communication Technology[243]

The Information and Communications Technology Council (ICTC) released *The Talent Wave: Navigating the Digital Shift – Outlook 2021*. This report outlines past growth with ICT (2009-2016) and forecasts employment in Canada's digital analysis from 2017 to 2021. The report utilized Statistics Canada data, existing academic and business literature to conduct analyses of demand drivers and supply streams.

Not unlike the electricity sector, technology innovations continue to change business operations and reshape traditional markets. Digital disruption is being felt in all areas of the economy. Businesses are continually challenged to adapt to the changing face of the marketplace. A requirement to succeed in this environment is to have workers equipped with the needed technology skills. Demand for these skills has expanded the ICT workforce. From 2011 to 2016, the digital economy labour force grew at around 2.4% , compared to 1.2% for the rest of the economy. By 2017, the digital labour force had 1,389,000 professionals. However, competition and lead-time for critical staff positions continues to be a challenge for many Canadian businesses.

Canadian companies are already reporting challenges filling skilled ICT positions that support technological innovation. The top five occupations with labour shortages in 2017 were: computer and information system mangers; computer engineers (expect software engineers and designers); database analysts and database administrators; computer programmers and interactive media developers; and graphics arts technicians. Each of these occupations shares certain characteristics as outlined below and which in turn influence competition for talent:

- Broad potential to grow the scale and scope of the Canadian economy.
- Greater potential for job mobility between sectors, and therefore less risk of being out-phased from the job market in a changing economy.
- Can be easily re-skilled or up-skilled to meet new industry demands given strong baseline of education.
- Potential for career progression with minimal training costs (hence business growth) compared to occupations with skills that are narrowly defined and have limited career prospects.

A workforce that is skilled in digital technology is crucial for the continued growth of the economy, especially for small and medium sized enterprises. It is expected that employment in the ICT sector will expand to 1,636,000 workers by 2021, growing at an average rate of 3.6% a year.

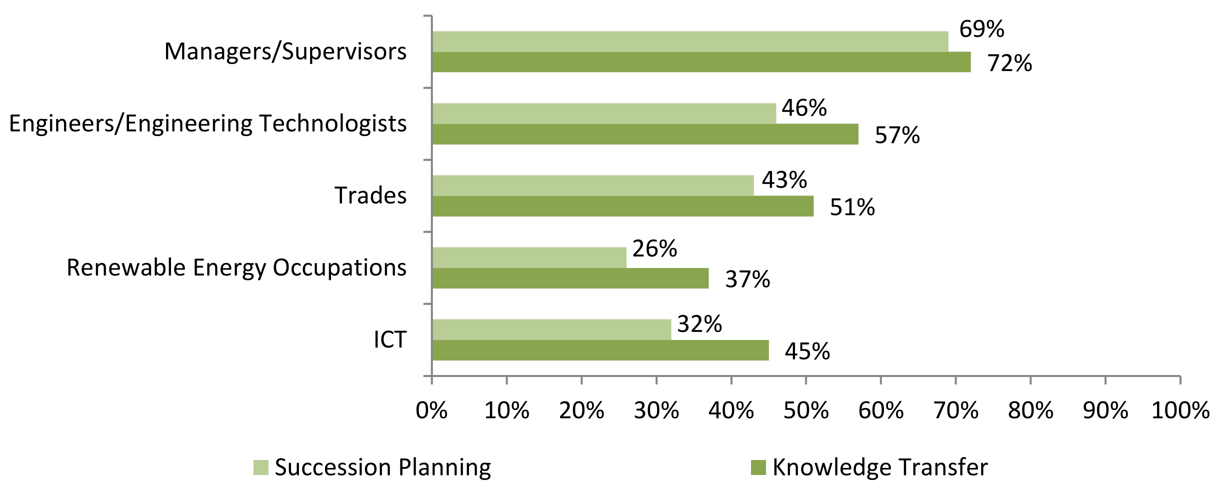
Succession Planning and Knowledge Transfer

The retirement rate among the sample of electricity industry employers surveyed was 2%, with expected retirement rates remaining stable for both 2019 (2%) and 2022 (3%). The majority of employers surveyed (91%) reported that they did not have retirement programs in place to alter the retirement patterns of their employees.

Employers commonly reported having succession planning for key positions in their organizations. Over two-thirds of employers (69%) had succession planning in place for management. However, for other occupational groups, less than half of employers had succession plans (see Graph 3.24), potentially leading to shortages of operational knowledge and skills. Succession planning most commonly consisted of internal talent pipelines to promote and develop promising staff. Additionally, employers reported that staff were often tasked with preparing their replacement before leaving their position.

Knowledge transfer was most commonly achieved through coaching and mentoring (35%), having new hires shadow more experienced workers at the start of the job or having retirees train their replacements. Manuals and documentation (14%) were also used for knowledge transfer. Cross-training, where staff were trained in different aspects of the organization, was mentioned by a few participants (3%). Job training, wherein the organization ensured that staff had the requisite skills to perform their job (e.g. were provided with necessary external training) was also mentioned (14%); however, it was unclear how information specific to the organization was passed along. Some organizations (12%) reported that they did not have a knowledge transfer program in place, while others (23%) did not provide details about their plan, if they had one.

Graph 3.24 – Employer Succession Planning and Knowledge Transfer



Source: EHRC Employer Survey, 2017 (QC3ai, QC3aii); n=65

ENDNOTES: SECTION 3

[212] EHRC survey was administered from Fall, 2017 to Summer, 2018. Respondents were asked to respond to the survey using the year for which they had the most complete data available, 2016 or 2017. Most respondents indicated that they used 2017 data to complete the survey.
[213] Statistics Canada. 2016 Census of Population: Catalogue no. 98-400-X2016358.
[214] Utility workers include the electricity sector, natural gas distribution, and water, sewage and other systems.
[215] Statistics Canada. 2016 Census of Population: Catalogue no. 98-400-X2016290.
[216] EHRC Employer Survey, 2017 (QA5).
[217] Ibid.
[218] Statistics Canada. Union Status by Industry: Table 14-10-0132-01.
[219] Statistics Canada. 2016 Census of Population: Catalogue no. 98-400-X2016290.
[220] Electricity Sector Council (ESC). (2012). *Power in Motion: 2011 Labour Market Information Study – 2012 Update* (p25).
[221] EHRC (n.d.) 'Renewing Futures: Meeting the Human Resources Needs of Canada's Renewable Energy Industry – Final Report.' pp. 5
[222] Statistics Canada. 2016 Census of Population: Catalogue no. 98-400-X2016295.
[223] Ibid.
[224] Statistics Canada. 2016 Census of Population: Catalogue no. 98-400-X2016290.
[225] ESC. (2012). *Power in Motion: 2011 Labour Market Information Study – 2012 Update* (p29).
[226] Engineers Canada. '30 by 30'. Available at: https://engineerscanada.ca/diversity/women-in-engineering/30-by-30. [Accessed 15 November 2018]
[227] Statistics Canada. 2016 Census of the Population: Catalogue no. 98-400-X2016295.
[228] Ibid.
[229] https://electricityhr.ca/workplace/diversity/connected-women-mentorship-program-2/
[230] https://electricityhr.ca/workplace/diversity/accord/
[231] Profile of Women Working in Clean Energy In Canada. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/energy-resources/Profile_of_Women_Working_in_the_Clean_Energy_Sector_in_Canada_compressed.pdf
[232] Source: Statistics Canada, 2016 Census of Population: Catalogue no. 98-400-X2016359. Number of Employment Income Recipients based on Aboriginal Identity, 5,195 of 110,750 total employment income recipients.
[233] Source: Statistics Canada, 2016 Census of Population, Statistics Canada Catalogue no. 98-400-X2016290.
[234] Canadian Survey on Disability. A demographic, employment and income profile of Canadians with disabilities aged 15 years and over, 2017. https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2018002-eng.htm
[235] https://electricityhr.ca/workplace/diversity/from-disability-to-inclusion/
[236] ESC. (2012). *Power in Motion: 2011 Labour Market Information Study – 2012 Update* (p23).
[237] Source: Statistics Canada, 2016 Census of Population, Statistics Canada Catalogue no. 98-400-X2016290.
[238] Ibid.: 47.
[239] Retirement age by class of worker, annual. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410006001
[240] Ibid.: 49.
[241] Information for this section was drawn from: Engineers Canada (June, 2015). *Engineering Labour Market in Canada: Projections to 2025.*
[242] Information for this section was drawn from: BuildForce Canada (2018). *Construction and Maintenance Looking Forward: Highlights 2018-2027.*
[243] Information for this section was drawn from: The Information and Technology Council (2017). *The Talent Wave: Navigating the Digital Shift – Outlook 2021.*

SECTION 4: WORKFORCE SUPPLY

Data presented is drawn from Statistics Canada's Registered Apprenticeship Information System (RAIS), Engineers Canada, the Canadian Council of Technicians and Technologists (CCTT), as well as EHRC surveys and key informant interviews with post-secondary institutions (colleges/universities) across Canada. Post-secondary institution representatives provided information on enrollments, graduations, student recruitment and programming related to the electrical power systems.

4.1 Post-Secondary Education

The electricity sector workforce is tied directly to the following three streams of post-secondary education:

- Undergraduate and graduate programs in engineering;
- College programs for engineering technicians, technologists and other occupations; and
- Apprenticeships.

Engineering

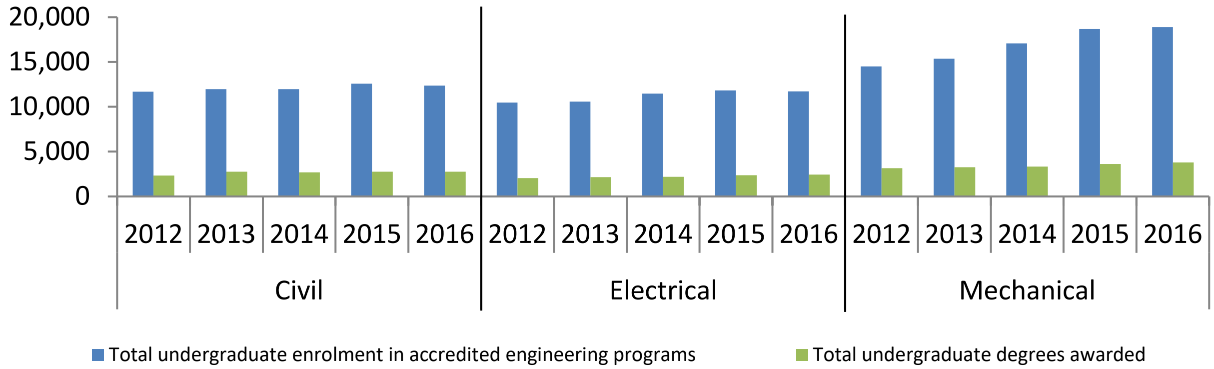
In Canada, civil, mechanical and electrical engineering programs are directly linked to the electricity sector. Across Canada there are 25 accredited four-year bachelor's degree programs in civil engineering, 26 in electrical engineering and 27 in mechanical engineering.[244] Many of these programs include an additional co-op or internship placement. Furthermore, postgraduate courses (Master's and doctoral degrees), also available, contribute to the electricity sector, particularly for those interested in pursuing research.

Graph 4.1 (next page) presents the number of undergraduate enrollments and degrees awarded in accredited engineering programs by related discipline in Canada between 2012 and 2016. Mechanical engineering enrollments showed steady growth from 14,489 in 2012 to 18,890 in 2016. This represents a total growth of 30% or an annual average growth rate of 7%. Educational institutions indicated that changes to student enrollments are due to perceptions of job market opportunities. This implies that current Labour Market Intelligence studies are critical to ensure youth have the necessary information in order to determine the educational opportunities that are in demand by employers.

The increase in mechanical engineering enrollments may also be the result of increased demand for cross-training, specifically between electrical and mechanical engineering. It is now becoming more marketable for current and future electrical engineers to develop a background in mechanical engineering. This may have resulted in new students and experienced electrical engineers pursuing mechanical engineering. Further, development of new programs such as the mechatronics program may also impact enrollment figures. Enrollments in civil and electrical engineering programs were stable from 2012 to 2016 increasing by a total of 6% and 12% respectively. Educational institutions felt stable growth rates were due to programs already being at full capacity.

Completion rates of civil, electrical and mechanical engineering programs increased by a total of approximately 18% to 20% from 2012 to 2016 respectively (Graph 4.1, next page). The annual average growth was between 4% and 5%. The growth rate in completion rates for these programs coincides with the growth of student populations.

Graph 4.1 – Total Undergraduate Enrollment and Degrees Awarded by Discipline

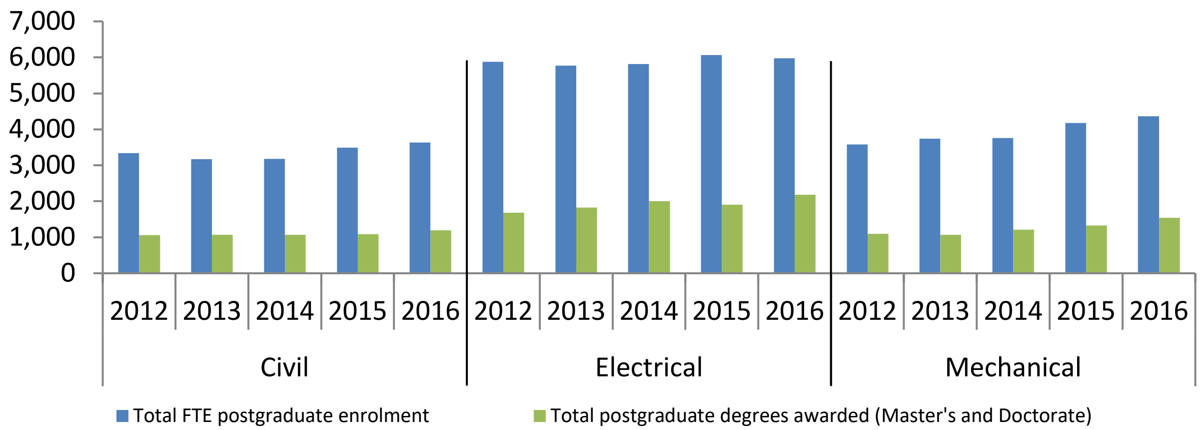


Source: Engineers Canada[245]

As demonstrated in the graph above, there is relative consistency in undergraduate enrollment and graduation for civil and electrical engineering programs across Canada. In 2016, there was a minor decline in civil engineering enrollments and graduations, 2% and 1% respectively. Electrical engineering has seen a small decline in enrollment (1%), but an increase in the number of degrees awarded (3%).

Like the relatively consistent enrollment of civil and electrical undergraduate programs in Canada, postgraduate enrollment for these disciplines were also relatively constant from 2012 to 2016 (Graph 4.2). Enrollments for post-graduate mechanical engineering programs increased from 2012 to 2016; however, the increase was not as high compared to undergraduate enrollments. While enrollments in post-graduate engineering programs showed similar trends as undergraduate enrollments, post-graduate graduation rates increased at a much higher rate. The post-graduate graduation rate increased 13%, for civil engineering, 30% for electrical engineering and 41% for mechanical engineering from 2012 to 2016. Increases in post-graduate enrollments coincide with growth in overall student populations. In addition, the higher growth rate for mechanical engineering may also be due to the increase demand for cross-training as described for undergraduate enrollments, as well as the development of mechatronics programming which combines mechanical and electrical engineering disciplines.

Graph 4.2 – Total Post-graduate Enrollment and Degrees Awarded by Discipline



Source: Engineers Canada[246]

Technicians, Technologists and Other Occupations

Technicians, technologists and other occupations working in the electricity sector require a range of education and training. Engineering technicians (NOC 2231, 2232, 2241) are required to complete a two-year diploma program; while other skilled trades such as solar PV installers (NOC 7441) require a two-year diploma or its equivalent in training and experience. Other related trades, such as power engineers (NOC 9241), require certification as opposed to a diploma or degree.

The CCTT through the Canadian Technology Accreditation Board (CTAB) accredits over 250 college programs for technicians and technologists in Canada, many of which relate to the electricity sector.[247] In partnership with the National Council of Deans of Technology and the Council of Registrars, CCTT developed outcome-based criteria for national accreditation and certification in Canada. These requirements have been accepted by the Association of Community Colleges for the benefit of all educational agencies in Canada.[248] The CCTT represents the profession of technicians and technologists in Manitoba, New Brunswick PEI, and Newfoundland and Labrador. Furthermore, Technology Professionals Canada (TPC) which advocates for the profession of technicians and technologists within Alberta, Saskatchewan, Ontario, British Columbia and the Yukon has developed a standard accreditation model which operates under Technology Accreditation Canada (TAC). A total of 55 programs have been granted national program accreditation status by TAC.

Both the CCTT and TAC have agreed to work collaboratively to develop a set of national educational standards for Canadian engineering technology and applied science profession. The standards are a set of learning outcomes for technicians and technologists.[249]

Apprenticeships

There are over 200 skilled trades or occupations within Canada. These occupations are classified by each province as either compulsory (require workers to be certified) or voluntary (does not require certification). For an individual to be an apprentice, they must be employed in their trade and work with a certified journey person.

Apprenticeship programs are post-secondary pathways where training primarily takes place at the workplace. Training for an apprenticeship combines on-the-job training, as well as technical training, which occurs at a college, union training centre, private trainer or online. Apprenticeship programs are typically four years with the majority (approximately 80%) of training occurring on-the-job. Once an apprentice has completed the required hours of on-the-job training and technical training for their trade, they are eligible to write a Certificate of Qualification exam. Those who achieve a passing grade of at least 70% become certified journeypersons.[250]

The Red Seal Program, formally known as the Interprovincial Standards Red Seal Program, sets common standards to assess the skills of trades people/apprentices across Canada. For Red Seal designated trades, the period of apprenticeship ranges from a three- to four-year term depending on the occupation (between 4,500 and 9,000 total hours).[251] For example, in Ontario, electrician certification requires 8,000 to 9,000 hours of apprenticeship training, which takes approximately four years to complete. In addition, all provinces offer a Prior Learning Assessment and Recognition System meaning that inter-provincial employees can have previous education, training and experience recognized for credit towards the apprenticeship program.[252] Further, some provinces (e.g. Alberta) offer high school students the opportunity to begin to earn credits towards an apprenticeship while still in high school, through programs such as the Registered Apprenticeship Program.[253]

In Canada, sector-related trades for which apprenticeships are available vary by province. Table 5.3 provides an overview of provinces in which specific trade apprenticeship training is recognized (grey ✓) and/or available (black ✓), several of which are Designated Red Seal trades.

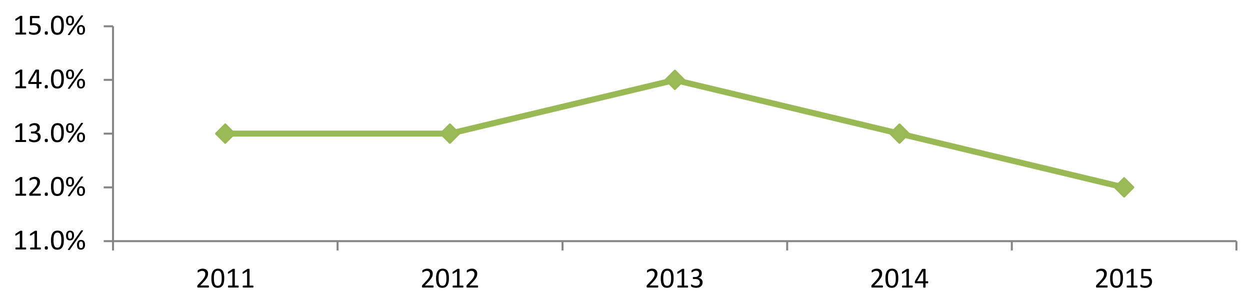
Table 5.3 – Apprenticeship Training Availability by Province

Trade	NOC	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Welder*	7237													
Construction electrician*	7241													
Millwrights or Industrial Mechanics*	7311													
Industrial electrician*	7242													
Powerline technician/Power Cable Technician*	7244													
Electrical Mechanics[254]*	7333													
Power system electrician	7243													
Utility arborist	7522													
Power system operator[255]	9241													

Source: Employment and Social Development Canada[256]
* Designated Red Seal trade.
** Includes electrical motor and equipment repairer – winding (Que.) (not Red Seal designated).
*** Includes process operator – power (Ont.).

According to RAIS data, the annual completion rate for apprentices was approximately 13% from 2011 to 2015. Graph 4.4 presents the annual completion rate for apprenticeships calculated by dividing the number of annual apprenticeship or trade qualifier certificates awarded by the total number of registered apprentices.

Graph 4.4 – Annual Apprenticeship Completion Rate



Source: Statistics Canada[257]

The 2016 Annual Review of the Red Seal program developed by the Canadian Council of Directors of Apprenticeship indicates that in 2014, 78% of continuing apprentices were Red Seal trades. Furthermore, 90% of all apprentices reside in Ontario, Quebec, Alberta and British Columbia. The number of women registered for Red Seal trades increased from 6,990 in 2013 to 7,521 in 2014 while the number of continuing apprentices increased from 24,996 to 26,568 over the same period. The number of apprenticeships completed by females was 3,057 in 2014 and has remained consistent since 2009. The median age of new apprenticeship registrants in Red Seal trades was 24 for males and 24 for females. Males made up 90% (65,727) of all new registrations while females represented the remaining 10% (7,521). Almost three-quarters (71%) of all new apprenticeship registrants in Red Seal trades were under the age of 30.[258]

Table 4.5 provides the total number of apprentices registered by trade in Canada, as well as the number of certificates awarded from 2012 to 2016. RAIS reports the number of registered apprentices and certificates awarded for the top 10 Red Seal Trades. As a result only electricity specific occupations in the top 10 are presented in Table 4.5.

As highlighted in Table 4.5, it appears that there has been little change in the number of apprentices in electricity specific occupations. However, the number of certificates awarded for construction electricians has decreased since 2013 by a total of 11%. Welding certificates decreased in 2015 and 2016 going from 3,099 to 2,565 which represents a 17% decrease.

Table 4.5 – Registrations and Certificates Awarded from Apprenticeship Programs in Canada, 2012-2016

Skilled Trades	2012	2013	2014	2015	2016
Construction Electrician					
Registrations	49,611	52,653	54,174	56,043	54,582
Certificates Awarded	6,306	7,563	6,909	7,098	6,732
Industrial electrician					
Registrations	11,049	12,123	10,542	10,449	10,035
Certificates Awarded *	--	--	--	--	--
Welder					
Registrations	14,781	16,413	18,753	18,741	16,290
Certificates Awarded	1,968	2,115	3,099	2,790	2,565
Industrial mechanic (Millwright)					
Registrations	11,049	11,421	11,007	11,310	10,062
Certificates Awarded	1,779	1,455	1,581	1,686	1,626

Source: Statistics Canada. Number of apprenticeship program registrations. Table 37-10-0023-01.
* Data concerning certificate awarded was not available for Industrial Electricians.
Note: Current data for power line technicians were unavailable.

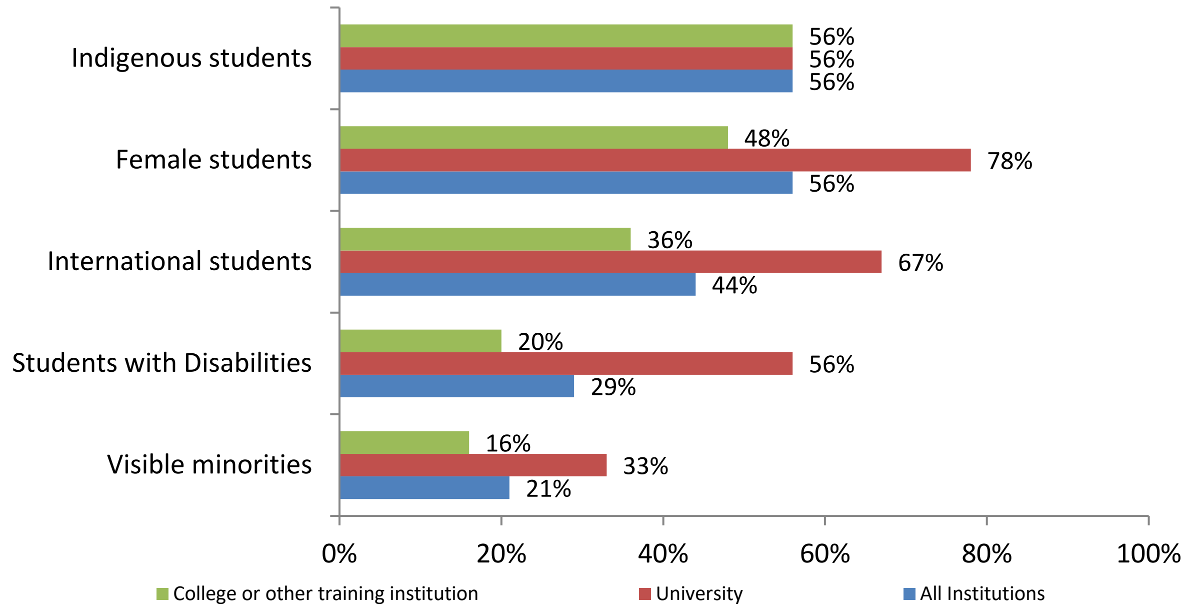
4.2 Supply Trends

Student Recruitment

Educational institutions indicated they have specific outreach strategies for attracting Indigenous and female students to electricity and renewable energy programs.

Key strategies as part of Indigenous student outreach include: targeted promotion (39%), providing financial benefits or assistance (17%), providing special admissions stream (11%), offering additional supports (e.g. educational, physical) (11%) and reserving spaces (6%). Strategies as part of female student outreach include: conducting targeted promotions (50%), providing financial benefits (28%), offering special admission streams (6%) and additional supports (6%).

Graph 4.6 – Outreach Strategies by Diversity Group



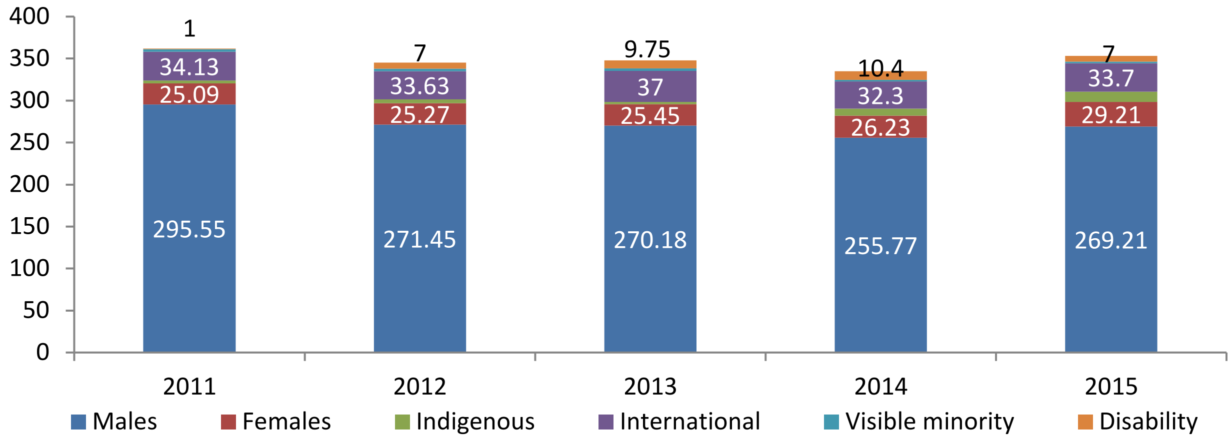
Source: EHRC Survey of Post-Secondary Institutions, 2017

As illustrated in Graph 4.6 (previous page), less than half of survey respondents reported having targeted outreach strategies for international students (44%), students with disabilities (29%) and visible minorities (21%). It was more common for Universities to have targeted programs in place to recruit female students, international students, students with disabilities and visible minorities. With regards to indigenous students, just over half of both universities and colleges or other training institutions (56%) had a recruitment program in place.

Student Enrollment, Retention and Graduation Trends

Historically, enrollments in electricity programming in Canada have been relatively stable. Educational institutions indicated that their enrollment rates have remained stable or increased slightly over the past five years. Applications and enrollments into any educational program are highly dependent on future job prospects, the current state of the economy or short-term job market trends. Graph 4.7 presents the average number of enrollments reported by educator survey respondents from 2011 to 2015 by student demographic.

Graph 4.7 – Student Enrollments by Demographics



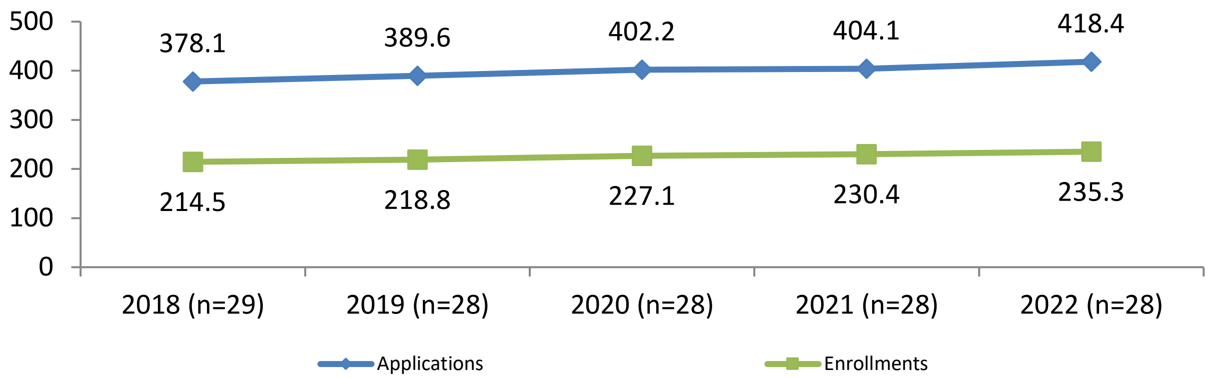
Source: EHRC Survey of Post-Secondary Institutions, 2017

Most survey respondents (73%) reported enrollment in science, technology, engineering, mathematics and computer science (STEM) related programs was significantly higher among male students than female students. Fewer respondents (56%) reported that male enrollment in clean energy programs was higher than female enrollment. In programs related to electricity and renewables, males made up most of the enrollments accounting for three-quarters or more of student enrollments. The majority of survey respondents (94%) reported no difference in dropout rates or program changing between male and female students. Furthermore, 78% of survey respondents indicated no difference in retention rates by gender.

Survey findings are consistent with research conducted by Engineers Canada which shows that as of December 2017, females represent 17% of newly licensed engineers across Canada. The Yukon had the highest share of females who were newly licensed at 29% and New Brunswick had the lowest share at 13%. The low share of female students in engineering programs has prompted initiatives by universities, engineering regulators, as well as Engineers Canada who have established a goal of increasing the share of female newly licensed engineers to reach 30% by 2030.[259]

Over the coming years enrollment in electricity stream programming in Canada is expected to stay relatively stable. Graph 4.8 provides the average number of applications and enrollments for educator survey respondents. According to survey results, applications are expected to increase from an average of 378 to 418 in 2022 with an annual average increase of 3%. Enrollments will follow a similar trend, increasing from 2014 in 2018 to 235 in 2022 with an average annual increase of 2%.

Graph 4.8 – Expected Applications and Enrollments in Electricity or Renewable Programs



Source: EHRC Survey of Post-Secondary Institutions, 2017

The availability of co-op programs, internships or job placements were viewed as a motivator for students choosing to enroll in a specific program. Obtaining hands on experience was important for student job prospects to develop practical skills and provide an understanding of the industry to students. Stakeholders also indicated that there was a correlation between enrollments and the availability of apprenticeship programming. These stakeholders reported that apprenticeship programming was in high demand and highly competitive.

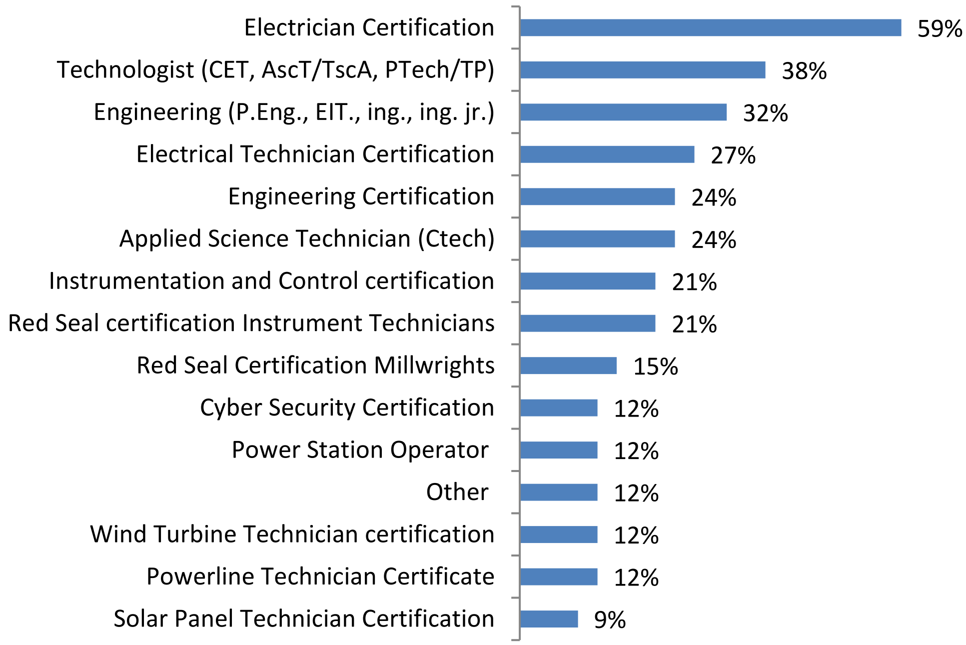
Electricity and Renewable Energy Educational and Training Programming

Canadian universities and colleges offer a diverse set of programs that ensure students have the necessary skills to both transition into and within the electricity industry. Examples of programs offered include:

- Electrical foundations or electrical apprenticeship;
- Electrical engineering;
- Electrical engineering technician;
- Power electronics;
- Automation and environmental engineering;
- Mechatronics;
- Renewable energies;
- Power system operation;
- Power engineering;
- Computer engineering technology;
- Wind turbine technician; and
- Power system and distributed energy resources.

Institutions surveyed most commonly offered electrician certification (59%), followed by technologist (CET, AscT/TscA, PTech/TP) programs (38%) and engineering programs (29%). Graph 4.9 lists the electricity standards and certifications that are met as a result of completing their institutions programs and curricula.

Graph 4.9 – Canadian Programs and Curricula Meeting Electricity Standards and Certifications



Source: EHRC Survey of Post-Secondary Institutions, 2017

To keep pace with the ever-changing energy environment, educational institutions have introduced new and emerging technologies and concepts (modules e.g. cyber security) into their programming. Just under half (47%) of survey respondents indicated that their educational institutions offered modules in cyber security. These modules were apart of the following departments:

- Applied technology, School of Media Studies;
- Electrical Engineering;
- Computer Engineering;
- Business;
- IT;
- Business Information Technology;
- Systems and Computer Engineering; and
- Technology and Visual Arts.

Additionally, over the past five years there has been increased demand for graduates who are cross-trained or hold more than one certification to support the interdisciplinary work within the energy sector.

For example, stakeholders noted that employers were demanding students be cross-trained in electrical and mechanical engineering, as well as electrical engineering and computer or civil engineering. In response to these demands, institutions have developed hybrid programs, which incorporate a combination of disciplines, for example, the combination of electrical and mechanical engineering (e.g. mechatronics program). The hybrid programs are result of a changing system where multidisciplinary skills are valued. The programs cross-train students so they are proficient with multiple disciplines or an overall system of energy production or distribution which combines more than one discipline. Further, some programs focus on a specific system of energy generation or distribution, as opposed to a specific discipline (e.g. electrical or mechanical engineering). This type of programming intertwines multiple disciplines that apply to the specific system resulting in the development of a multi-disciplinary skill set amongst new graduates.

Education and training will be required to support the transition away from coal generation to renewables and micro-generation with the corresponding new and emerging technology. Training will have to prepare students to work with the evolving power grid. However, traditional skill sets will still be needed, so students will have to learn a broader set of skills. Stakeholders noted that given the emerging occupations in the renewable sector, some attention should be given to develop standardized competencies or skills requirements for such positions. Establishing a set of recognized occupational standards for such positions would enable education and training providers to customize their curriculum to meet the specific requirements of these new and evolving occupations.

Communication between industry and post-secondary institutions is critical to ensuring programs remain nimble and up-to-date with industry trends as well as employer needs while enhancing the supply of trained workers. As such, some institutions have formed industry advisory committees and regularly incorporate their feedback into curriculum development – a requirement of accredited undergraduate engineering programs. At the same time, undergraduate engineering programs rely on advisory committees to support accreditation.

A strong relationship with provincial and federal governments is also important to ensure program and learner alignment with continuously changing policy and regulations. Government policy also has a direct impact on the standards and certification requirements of the industry.

Support of applied research will also be required to determine how new technology and alternative energy can be adapted to Canada's electricity marketplace. Programs and courses related to policy and regulations are typically offered at the post-graduate level; however, courses/programs are being introduced which involve industry-specific regulatory specialization at various levels of education (e.g. undergraduate, diploma).

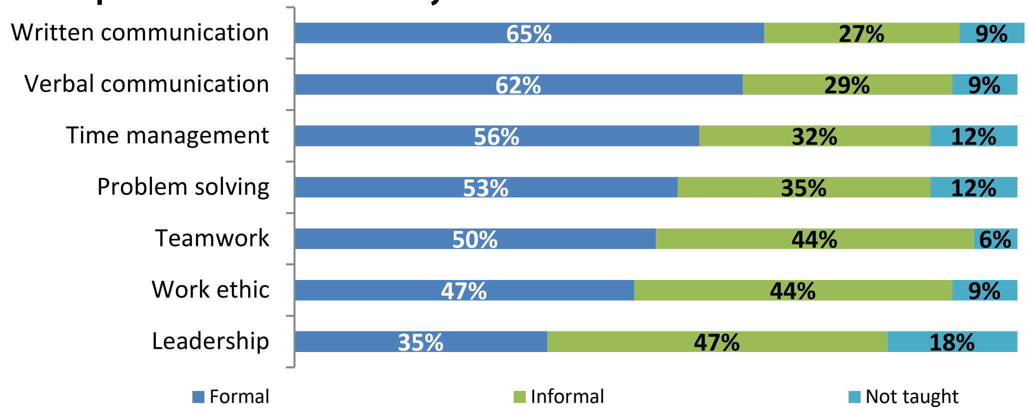
Educational institutions commonly reported their relationship with the electricity industry was the same or less developed compared to other industries signalling a continued need to further develop these relationships.

Professional Skills

Increasingly, there is more employer demand for workers with professional skills (or soft skills as referred to during consultation), such as communication, leadership, critical thinking, project management and problem solving in the electricity sector. Some stakeholders noted that these skills are becoming as important as technical skills, as some employers have reported that they were able to teach technical skills faster compared to professional skills. Moreover, technological innovations and modes of communication (i.e. social media) have evolved. Employees who previously might not have been involved in significant communication, both within and outside their organizations, were now expected to participate on a regular basis. Professional skills were also viewed as a significant component for professional development and laddering. Communication, project management and problem-solving skills were viewed as essential for employees to advance their careers.

Canada's educational institutions are responding to these needs by integrating professional skills into programming through team or group work, capstone projects, formal courses, tutorials and support programs and project and lab work. Work ethic and leadership skills are commonly taught informally, if at all, at institutions, while written communication, verbal communication, time management and problem solving are being formally taught by over half (50%) of institutions surveyed. Graph 4.10 presents the methods used by academic institutions to teach professional skills.

Graph 4.10 – Methods Used by Academic Institutions to Teach Professional Skills



Source: EHRC Survey of Post-Secondary Institutions, 2017

It is important to note that written communication, leadership, project management and problem-solving skills are required to be taught by university undergraduate engineering programs in order to be accredited. When looking at the methods used to teach professional skills by educational institution type (i.e. university and non-university) the survey findings show that non-university post-secondary institutions rely more on informal teaching methods compared to formal methods (i.e. established teaching procedures part of the curriculum or mandated). Table 10b presents the methods used to teach professional skill by post-secondary institution type. As shown in Table 4.11, aside from verbal communication, non-university institutions relied more on informal methods compared to universities.

Table 4.11 – Methods Used by Academic Institutions to Teach Professional Skills by PSI Type

Professional Skill	Formal		Informal		Not Taught	
	University	Other	University	Other	University	Other
Written Communication	67%	64%	22%	28%	11%	8%
Verbal Communication	56%	64%	33%	28%	11%	8%
Time Management	89%	44%	0%	44%	11%	12%
Problem Solving	78%	44%	11%	44%	11%	12%
Team Work	78%	40%	11%	56%	11%	4%
Work Ethic	56%	44%	33%	48%	11%	8%
Leadership	44%	32%	33%	52%	22%	16%

Source: EHRC Survey of Post-Secondary Institutions, 2017

4.3 Educational and Training Gaps

To improve education and training in electricity sector occupations, Canadian institutions recommend the development of national occupational training standards and certification bodies for new and emerging occupations. These standards and certification bodies can develop and update national standards for training requirements for new occupations and ensure new workers, regardless of their region of training, develop necessary skills. These standards would also work to inform training institutions of what is required by them to train potential workers. Furthermore, developing essential skill profiles for new and emerging occupations in the electricity industry can inform potential workers of the training and skill requirements of new occupations.

Another gap identified by industry stakeholders relates to continuous learning. Stakeholders noted that there is a growing need for workers to keep up-to-date on current developments in the electricity industry and be able to continuously learn and adapt. With rapid innovation and technological change, workers are required to maintain and uphold legacy systems while supporting the emergence of new energy infrastructure. As such, the ability to continue to learn will be increasingly important for workers as they are required to re-skill and up-skill through their career.

To increase the speed with which skilled workers in renewables are available to industry, it is essential that post-secondary educational institutions incorporate required training into existing trade pathways. This implies that instead of creating new programs, post-secondary institutions should update existing programs which incorporate new technology or business practices. Over half (53%) of educator survey respondents indicated that establishing a new program in electricity/renewable would take one to three years. Effective methods of enhancing the supply of trained workers reported by survey respondents included:

- Increased engagement with industry (71%);
- Expansion/promotion of co-op programs (68%);
- Establishment of post-secondary industry liaisons (50%); and
- Development of career awareness materials for students/counselors (35%).

Challenges to providing required training include: limited capital equipment funding for training aids and space, insufficient access to qualified, experienced and knowledgeable program designers, curriculum developers and instructors.

4.4 Transition to the Workforce, Apprenticeship and Further Education

Educator survey respondents felt that it took less than one year of job experience for recent graduates to be considered fully competent in the following occupations:

- Electrician (56%);
- Electrical technician (56%);
- Cyber security (40%);
- Industrial millwrights (40%);
- Industrial instrument technicians or mechanics (33%)

Occupations in which it took longer, approximately one to three years, for new graduates to become fully competent include:

- Power station operator (83%);
- Engineering certification (78%);
- Certified engineering/applied sciences technician (CTech) (75%);
- Instrumentation and control certification (70%);
- Solar panel technician (50%);
- Wind turbine technician (50%);
- Powerline technician (50%);
- Engineering (43%); and
- Technologist (42%).

While many of the educational institution representatives estimated that many of the jobs required at least 3 years experience before new graduates become proficient, many employers believed that it takes much longer (e.g. five to seven years) for new graduates to become proficient in the aforementioned occupations.

Student transition is best supported through industry networking opportunities or work integrated learning, such as tradeshows and workshops, which allow students to connect with industry and learn about different companies, careers and workplace opportunities. Industry networking opportunities are particularly important for foreign-trained entrants due to their lack of established relationships. Without networking opportunities, foreign-trained entrants would be at a severe disadvantage in gaining employment.[260] Further, due to the lag time in implementing new programs, educational institutions felt there is a growing need for competency based learning or alternative credentialing. Competency-based learning was described as training in specific skills that are needed by employers, as opposed to longer-term degree or credential programs. Competency-based learning would be able to keep up with the way technology quickly evolves. The cost of education was also viewed as a barrier to transitioning workers. The high cost and time for existing workers to retrain has resulted in an increase demand for online and modular training opportunities.

SECTION 5: ASSESSING FUTURE LABOUR MARKETS

An economic forecast model (POMS) maintained by C4SE was used to forecast future employment levels in the electricity industry, as well as the total number of hires required to meet needs associated with expansion of the workforce and to replace exiting workers.[261] The forecast model incorporates numerous economic variables including provincial gross domestic product (GDP) growth, population growth, migration trends and other variables to generate an estimate of total employment and hiring requirements for the electricity sector nationally and provincially.

This section of the report provides an overview of the labour market conditions for the core electricity sector occupations and provides the demand and supply measures from 2017 to 2022 based on the C4SE POMS analysis, which uses data from Statistics Canada Labour Force Survey.

5.1 Forecasted Employment

Electricity industry employment estimates in Canada for each occupation are projected to 2022 using a weighted average of the annual rate of change in output (measured by GDP) and investment in the electricity and renewable energy industry. Employment in Canada's electricity and renewable industry is anticipated to increase at an annual rate of 0.4%, with a cumulative increase of 2% across the 2017 to 2022 period. The rate of growth reflects the transition from coal-fired electricity generation to new forms of electricity generation, such as natural gas and renewable (solar, wind, hydro and biomass). The highest rate of employment growth is expected for electrical and electronics engineers (3%) and computer network technicians (3%).

Employment growth by occupation is provided in Table 5.1. As highlighted in this table, forecasted employment relating to the trend growth in electricity generation and distribution is modest. For provincial breakdown of forecasted employment graphs, please see Appendix A.

Table 5.1 – Current and Forecasted Employment in the Electricity Industry by Occupation, 2017 and 2022

Occupation	2017	2022	% Growth 2017-2022	Average annual Growth Rate
Managers and Supervisors				
Utilities Managers	3,492	3,582	3%	0.52%
Supervisors of Electricians & Supervisors of Electrical Power Line Workers	1,612	1,638	2%	0.32%
Engineering Managers	820	835	2%	0.37%
Construction Managers	507	518	2%	0.43%
Engineers/Engineering Technologists				
Electrical and Electronics Engineers	5,146	5,278	3%	0.51%
Mechanical Engineers	2,422	2,462	2%	0.34%
Civil and Other Engineers	1,409	1,441	2%	0.45%
Electrical and Electronics Technologists and Technicians	4,318	4,386	2%	0.32%
Mechanical Engineering Technologists and Technicians	956	965	1%	0.20%

Occupation	2017	2022	% Growth 2017-2022	Average annual Growth Rate
Civil Engineering and Other Technologists and Technicians	731	746	2%	0.41%
Radiation Technician	139	140	1%	0.15%
Engineering Inspectors and Regulatory Officers	156	159	2%	0.38%
Trades				
Powerline Technicians and Power Cable Technicians	7,627	7,783	2%	0.41%
Utility Arborists	751	766	2%	0.41%
Power Systems Operators* (includes Power Station Operators, Wind Technician, Smart Grid Specialists)	7,550	7,646	1%	0.26%
Power System Electricians	4,005	4,083	2%	0.39%
Construction Electricians	45	47	4%	0.89%
Industrial Electricians	123	124	1%	0.17%
Millwrights or Industrial Mechanics	2,366	2,396	1%	0.26%
Electrical Mechanics	749	760	1%	0.29%
Welders	433	441	2%	0.37%
Renewable Energy Occupations				
Solar Panel Installers	230	232	1%	0.18%
Information and Communication Technology Occupations				
Information Systems Analysts and Consultants (includes Cyber Security Specialists)	2,035	2,083	2%	0.47%
Database Analysts and Data Administrators	279	286	3%	0.50%
Computer Programmers and Interactive Media Developers	449	455	1%	0.27%
Software Engineers and Designers	208	212	2%	0.39%
Computer Network Technicians	648	665	3%	0.52%
Electricity Sector Occupations	**49,206**	**50,129**	**2%**	**0.38%**
Other Occupations	**52,494**	**53,535**	**2%**	**0.40%**
Total	**101,700**	**103,664**	**2%**	**0.39%**

Source: C4SE POMS Forecast
Note: % Growth 2017-2022 reflects total growth from 2017 to 2022, Average annual Growth Rate reflects average year to year growth rate. Other Occupations includes all occupations in the electricity sector that are not listed in the table, for example, administrative staff.
* Occupations which are included in the same NOC code
# Workforce estimates for C4SE POMS Forecast are generated from the Labour Force Survey[262]

5.2 Job Openings

The forecast model calculates the number of job openings by examining hiring requirements due to expansion demand (i.e. change in employment as workforce activity grows or contracts each year as a result of economic conditions), as well as due to replacement demand (i.e. deaths and retirements).

What the forecast model does not forecast is the hiring requirements due to 'other separations' (i.e. people leaving the workforce due to non-retirement issues, such as returning back to education or for extended temporary leave and people leaving their employer to work for another employer. The forecast model does not account for such losses of employees from one industry to another, which means that the estimates of the total number of workers needed to be hired in the sector will typically under-estimate the numbers actually needed if based on the forecast model. The electricity sector may also lose employees who become independent contractors but who would be engaged in other sectors (i.e. move from electricity to set up their own business as a general contractor or consultant). This is the same as leaving the industry to work in another. If the consultant solely works in the electricity sector then there is no change in employment as they would be captured in electricity industry, it becomes purely an accounting issue for firms. Additional information regarding the POMS model is contained in Appendix C of this report.

Expansion and Replacement Demand

Expansion demand is the number of job openings created from industry growth. The results of the C4SE model suggest that employment growth due to expansion demand will be limited compared to replacement demand (retirements and deaths). Replacement demand is the number of positions that need to be filled to replace workers who leave the sector due to deaths or retirements. Replacement demand has been estimated for each occupation and the electricity sector (as a whole) using the C4SE forecast model.

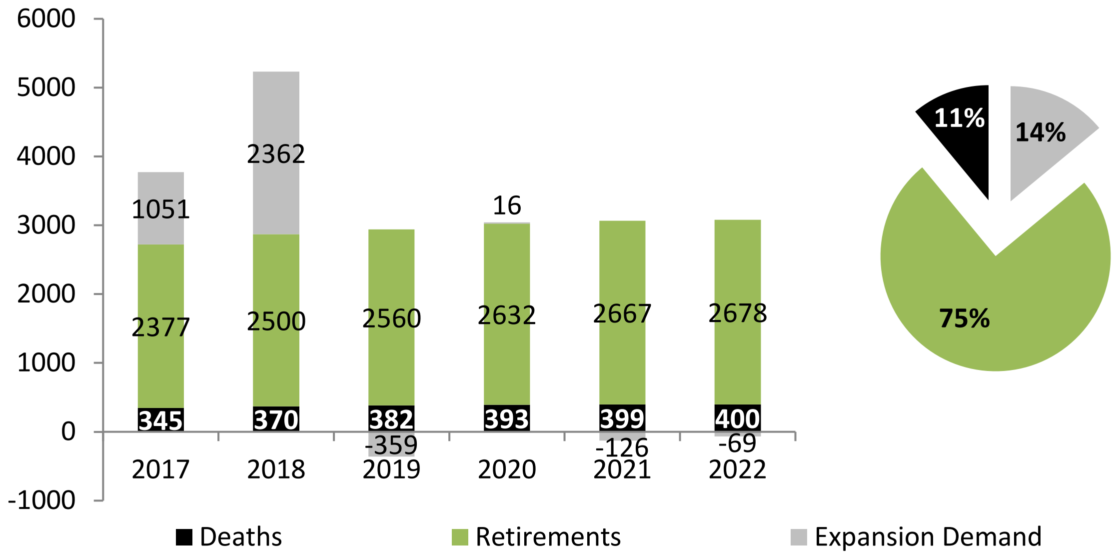
The analysis estimates that the proportion of retiring workers from the Canadian electricity workforce will increase slightly, from 2.3% in 2017 to 2.6% in 2022. Graph 5.2 shows the rate of retirement across the coming years. The results of the C4SE model suggest that there will be limited growth in the total number of workers due to demand expansion, although there will be a cumulative requirement to replace approximately 14% to 16% of the current workforce that will leave due to deaths or retirements over the coming years. The total annual change in labour force requirements by expansion, retirements and deaths are provided in the graph below:

Graph 5.2 – Retirement Projections for the Electricity Industry Workforce

Source: C4SE POMS Forecast

While retirements and deaths remain relatively consistent across 2017 to 2022, expansion demand increased significantly in 2017 and 2018, but declines in 2019. Expansion increases slightly in 2020 and declines thereafter. Overall, as highlighted in Graph 5.3 (next page), more than three quarters of the new hires projected for the Canadian electricity sector will be needed to replace those workers who are retiring from the industry, with 14% of hires required to meet the needs of an expanding labour demand.

Graph 5.3 – Total Recruitment Requirements: Electricity Sector Occupations, 2017 to 2022



Source: C4SE POMS Forecast

Even when overall expansion demand is negative from 2019 to 2022, the total number of new employees required by the electricity sector in the in the coming years is 20% of the current workforce. Between 2017 and 2022, the industry will need to recruit 20,578 new employees: 15,414 due to employees exiting as a result of retirement and 2,875 due to expansion demand (Table 5.4).

Table 5.4 – Total Labour Requirements: Electricity Industry, 2017 to 2022

Demand Type	Total Requirement 2018-2022	Percent of Current Labour Force (2018)	Share of Total Requirement
Expansion Demand	2,875	3%	14%
Retirements	15,414	15%	75%
Deaths	2,289	2%	11%
Total	**20,578**	**20%**	**100%**

Source: C4SE POMS Forecast

5.3 Supply Side Measures

While the C4SE model does not provide an analysis of workforce supply by specific industry, in examining national trends, the model does provide supply sources for individual occupations for all industries, these patterns can generally be assumed to provide an insight as to where the electricity sector's future workforce will be sourced from.

The supply of labour needed to meet the workforce requirements of the Canadian electricity industry will be met from a combination of sources. Historically, workforce demands were met through the recruitment of new entrants, international migrants and other in-mobility.

New entrants (or new domestic entrants) refer to the labour force increase resulting from the number of young people, aged 15 to 30, entering the labour force for the first time. New entrants are not the same as the number of school leavers as many individuals will have joined the labour force during school. New entrants increase slightly over the forecast for the occupations in the electricity industry, however this growth is relatively low due to the ageing of the population, roughly equal to a 1.1% increase from 2017 to 2022.

International migrants refer to persons moving into Canada to take or find a job and other net in-mobility refers to the movement of workers in and out of the labour force and movement between occupations, such as workers moving into supervisory or management occupations. Workers' movement in and out of the labour force is captured as a result of changes in participation rates due to economic cycles, wages and social factors. International migration is often used to clear labour markets, in times of extreme shortages where domestic sources can't meet the need for workers, firms will look further afield to meet their employment requirements. Any increase in new entrants is for new entrants to *all industries* that includes (but is not exclusive to) the selected occupations under this LMI study.

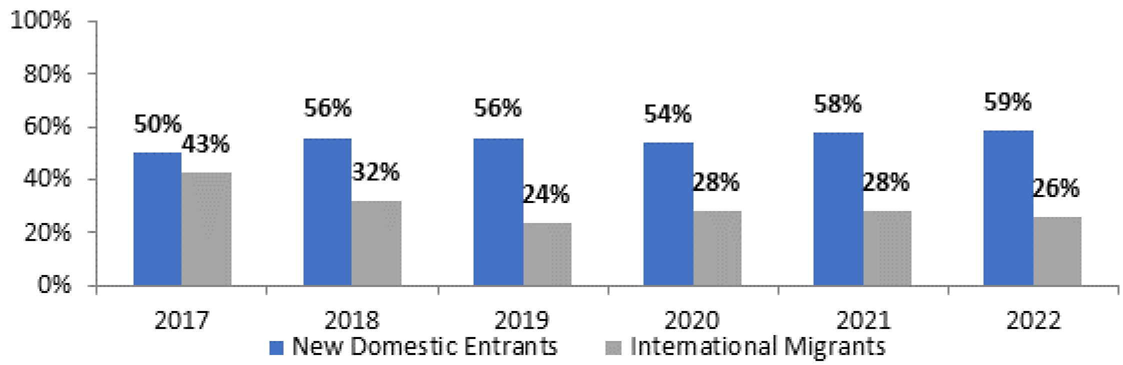
International migrants made up a significant portion of the supply of additional workers in 2017 (approximately 43%); however, this is expected to decrease over the coming years to 26%, while the share of new domestic entrants is estimated to increase. As shown in Graph 5.5, it is anticipated that new domestic entrants will comprise over half of the additional workers available to the electricity sector labour force over the coming years. The decline in international migrants is due to declining demand for additional workers over the forecast. Firms will look to domestic sources first, leaving fewer vacancies that need to be filled from international sources due to the fact that they are relatively more expensive to hire, and given the potential need for work permits and sending recruitment materials to other countries.

The C4SE model currently expects immigration to stay inline with the federal immigration policy where roughly 1 million immigrants will enter the county from 2018 to 2020. It is anticipated that immigration numbers will recede slightly thereafter, as slower growth in the economy means that fewer additional workers from outside Canada are required.

Although the C4SE model predicts a slight decline in the inflow of workers from other countries over time, it can be expected that there will be significant competition to recruit new labour force entrants from across all industries in Canada. Therefore, the Canadian electricity sector will still need to rely on all sources of available supply including underrepresented groups.

To support both new entrants and international migrants, employers will need to develop in-house training programs to provide new workers with necessary skills while working closely with university and college training programs to ensure comprehensive training is provided to meet needs.

Graph 5.5 – Proportion of Additional Labour Supply from New Domestic Entrants and International Migrants



Source: C4SE POMS Forecast

5.4 Rankings

The LMI model uses the demand and supply measures outlined in Sections 5.1, 5.2 and 5.3 for specific occupations and consolidates them into a market ranking. The demand and supply measures are calculated for all industries as the model assumes that the supply of workers can come from any industry. For example, an electrician from oil and gas extraction can be employed in the electricity sector. Using these measures, the model develops three rankings, which include the demand rank, supply rank and unemployment gap rank. The demand rank focuses on 'demand pressure' as measured by the number of job openings for an occupation divided by the size of the occupation's labour force in the previous year, which is similar to the labour force growth rate for the occupation. If the demand growth for an occupation is high – relative to that of the occupation – then it will receive a higher rank as it will likely require relatively more effort to find the workers. The supply measure focuses on migration and is measured as the ratio of required net in-migration and the occupation's labour force in the previous year. Occupations where supply requirements are largely met through migration may be at risk if these requirements are not accommodated through additional immigration or if Canadian workers do not wish or are not available to move to the locations in question. Unemployment rate gap rank is the difference between an occupation's actual and normal unemployment rate.

A weighted average of the three rankings has been used to calculate an overall rank related to labour market tightness for selected occupations across all industries. These rankings are presented in Table 5.6.

Table 5.6 – Labour Market Rankings Defined

Rankings and Descriptions	
1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market**

Rankings and Descriptions	
	The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

Graphs 5.8a-e in Section 5.4.1 (below) provide the rankings for individual occupations. Overall, the model shows that between 2017 and 2022, the majority of occupations will experience balanced markets or markets with slight excess supply from 2017 to 2022. Balanced markets imply normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal, organizations may have to rely on migrants to meet supply, but this situation is not different from what they have faced in the past. The unemployment rate gap is very small which means that the actual unemployment rate for occupations is roughly equal to or slightly higher than the typical long-term unemployment rate. Slight excess supply indicates a situation where there are slightly more workers available than expected to meet demand. Demand pressure is lower than usual; there is less reliance than expected on migrants to fill jobs. The unemployment rate is slightly higher than the expected rate, making it easier than normal to find workers.

Some occupations will have slight excess of demand for periods over the forecast horizon which results from a decrease in the size of the labour force or increase in number of job openings, low actual unemployment rate or reduction in net in-international migration. The labour market rankings for individual occupations are discussed in the following section. Table 5.7 provides the market rankings at a glance.

Table 5.7 –Labour market rankings in Canada by occupation, 2017–2022

1 = excess supply; 5 = excess demand

	2017	2018	2019	2020	2021	2022
Managers and supervisors						
Utilities managers	2	3	4	4	3	3
Supervisors of electricians and electrical powerline workers	2	3	3	3	3	3
Engineering managers	2	4	4	3	3	3
Construction managers	3	3	3	3	2	2
Engineers/engineering technologists						
Electrical and electronics engineers	2	4	3	3	3	3
Mechanical engineers	2	4	4	4	3	3
Civil and other engineers	2	4	4	3	3	3
Electrical and electronics technologists and technicians	3	4	3	3	3	3
Mechanical engineering technologists and technicians	3	4	4	3	3	3
Civil engineering and other technologists and technicians	2	4	4	3	2	2

	2017	2018	2019	2020	2021	2022
Radiation technicians	2	4	4	4	3	3
Trades						
Powerline technicians and cable technicians	2	3	4	4	4	3
Utility arborists	2	3	3	3	3	3
Power systems operators	4	3	3	4	4	4
Power system electricians	2	4	3	3	3	3
Construction electricians	2	3	4	3	3	3
Industrial electricians	3	4	4	4	4	3
Power station operators	4	3	3	4	4	4
Millwrights or industrial mechanics	3	4	4	4	4	3
Electrical mechanics	2	2	4	4	4	4
Welders	2	4	4	4	3	3
Renewable energy and climate change occupations						
Wind technicians	4	3	3	4	4	4
Solar panel installers	3	3	3	3	3	3
Smart grid specialists	4	3	3	4	4	4
Information and communication technology occupations						
Information systems analysts and consultants	4	3	3	4	4	4
Database analysts and data administrators	3	3	4	4	4	4
Software engineers and designers	4	3	3	3	3	4
Computer programmers / interactive media developers	4	3	3	3	3	3
Computer network technicians	3	2	3	4	4	4
Cyber security specialists	4	3	3	4	4	4

Source: C4SE POMS Forecast, EHRC Employer Survey

Rankings by Occupation

Mangers and Supervisors

Managerial occupations that will experience slight excess demand are engineering managers in 2018 and 2019. Relatively low unemployment rates and lower excess supply of qualified workers will result in organizations having difficulty hiring engineering managers in 2018 and 2019. As a result, organizations will have to focus recruitment efforts towards new migrants. However, the supply of workers is expected increase in 2020 and the labour market will become balanced from 2020 to 2022.

Table 5.8a – Labour Market Rankings for Managers and Supervisors

Managers and Supervisors	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Utilities Managers	2	3	4	4	3	3
Supervisors of Electricians/Electrical Powerline Workers	2	3	3	3	3	3
Engineering Managers	2	4	4	3	3	3
Construction Managers	3	3	3	3	2	2

Source: C4SE POMS Forecast

Employer survey findings showed that more than half of the respondents felt it was moderately difficult to hire Supervisors of Electricians & Supervisors of Electrical Power Line Workers and Construction Managers in 2017. For 2022, employers anticipate these occupations will also be moderately difficult to hire for.

Engineers/Engineering Technologists

As shown in Table 5.8b, the majority of engineers and engineering technologists will have slight excess of demand in 2018, with some occupations (e.g. civil and other engineers, civil engineering and other technologists and technicians and radiation technicians) having more prolonged excess demand. Occupations with slight excess demand will have some trouble hiring new workers due to a lower supply of workers resulting from relative low unemployment and fewer new migrant workers.

Table 5.8b – Labour Market Rankings for Engineers/Engineering Technologists

Engineers/Engineering Technologists	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Electrical and Electronics Engineers	2	4	3	3	3	3
Mechanical Engineers	2	4	4	4	3	3
Civil and Other Engineers	2	4	4	3	3	3
Electrical and Electronics Technologists & Technicians	3	4	3	3	3	3
Mechanical Engineering Technologists & Technicians	3	4	4	3	3	3
Civil Engineering and Other Technologists & Technicians	2	4	4	3	2	2
Radiation Technicians	2	4	4	4	3	3

Source: C4SE POMS Forecast

The majority of employers reported having no difficulty in hiring engineers and engineering technologists in 2017 and do not anticipate that these occupations will be difficult to hire for in 2022.

Skilled Trades

A few trade occupations, specifically power system operators and industrial electricians will experience slight excess demand from 2017 to 2022. For power system operators (i.e. NOC 9241), which includes power station operators, wind technicians and smart grid specialists) experienced slight excess demand in 2017 and is also expected to experience slight excess demand in 2022.

Industrial electricians will experience slight excess demand in 2018. During 2017, 2018 and 2022 organizations will have challenges hiring new power system operators and industrial electricians and would have to put more emphasis on accessing international workers. The remaining occupations will experience balanced or labour markets with slight excess supply implying that recruiting and hiring new workers from the current labour supply will not be difficult.

Table 5.8c – Labour Market Rankings for Trades

Trades	2017	2018	2019	2020	2021	2022
Powerline Technicians and Cable Technicians	2	3	4	4	4	3
Utility Arborists	2	3	3	3	3	3
Power Systems Operators	4	3	3	4	4	4
Power System Electricians	2	4	3	3	3	3
Construction Electricians	2	3	4	3	3	3
Industrial Electricians	3	4	4	4	4	3
Power Station Operators* (see Power Systems Operators)	4	3	3	4	4	4
Millwrights or Industrial Mechanics	3	4	4	4	4	3
Electrical Mechanics	2	2	4	4	4	4
Welders	2	4	4	4	3	3

Source: C4SE POMS Forecast
* Occupations which are included in the same NOC code.

Over half of employer survey respondents stated they had moderate difficulty in hiring Power Systems Operators, Power Systems Electricians, Power Station Operators in 2017. Further, more than 10% of respondents reported hiring Power Systems Operators was extremely difficult. In 2022, employers anticipate that these occupations will also be moderately difficult to hire for.

Renewable Energy and Climate Change Occupations

As noted in Table 5.8d, wind technicians and smart grid specialists are included in NOC 9241. As such, the labour markets for these occupations are also expected to experience slight excess demand in 2017 and 2022. Solar panel installers will have balanced markets from 2017 to 2019 and will experience slight excess supply from 2020 to 2022 implying that organizations will not have to rely heavily on migrants to fill jobs due to higher than normal unemployment for these workers.

Table 5.8d – Labour Market Rankings for Renewable Energy and Climate Change Occupations

Renewable energy and climate change occupations	2017	2018	2019	2020	2021	2022
Wind technicians	4	3	3	4	4	4
Solar panel installers	3	3	3	3	3	3
Smart grid specialists	4	3	3	4	4	4

Source: C4SE POMS Forecast
* Occupations which are included in the same NOC code.

Over half of the employers surveyed indicated that Solar PV Installers and Smart Grid Specialists were moderately hard to hire, while over 10% of respondents stated that Smart Grid Specialists were extremely difficult to hire.

1.1.1.1 Information and Communication Technology Occupations

Information and communication technology occupations will experience labour markets with slight excess supply or balanced markets from 2018 to 2022. Finding workers for these occupations will be easier than normal or normal for organizations. As noted previously, given that industry is critical to the operation of the entire Canadian economy, it is essential that the system be well-protected from cyber-security and/or other online threats.

Table 5.8e – Labour Market Rankings for Information and Communication Technology Occupations

Information and communication technology occupations	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Information systems analysts and consultants	4	3	3	4	4	4
Database analysts and data administrators	3	3	4	4	4	4
Software engineers and designers	4	3	3	3	3	4
Computer programmers/interactive media developers	4	3	3	3	3	3
Computer network technicians	3	2	3	4	4	4
Cyber security specialists	4	3	3	4	4	4

Source: C4SE POMS Forecast

According to employer survey results, renewable occupations were reported as the most difficult to hire for in 2017. The introduction of new technologies, coupled with a lack of clarity concerning skill requirements, make it difficult to find appropriate staff. Employers anticipate difficulty hiring for these occupations in 2022 as well.

ENDNOTES: SECTION 5

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SECTION 5: RECOMMENDATIONS AND CONCLUSIONS

To meet the labour challenges to come in the years ahead, the electricity industry and educational institutions will need to address issues of cross-training, pressure in specific occupations, professional skills development, the aging workforce, diversity and the transformational impact of technology.

6.1 Cross-training is essential

Cross-training provides workers with a broad array of skills and experiences outside of their regular work, increasing their flexibility and versatility. For example, engineers with backgrounds in mechatronics have a more holistic understanding of projects, particularly renewable energy projects, and tradespeople with multiple tickets or skills can respond more effectively to operational problems. While the industry is beginning to recognize the benefits of cross-training its employees, efforts are most commonly focused on management.

Recommendations

1) Increase research and stakeholder engagement to determine which occupations would benefit most from cross-training as well as the opportunities, challenges and barriers that may exist to implementing cross-training (particularly in the trades). Barriers such as traditional role definitions and collective agreements must be addressed.
2) Facilitate partnerships between employers and unions to determine opportunities and highlight the benefits of cross-training among workers.
3) Work with unions to understand and address the language in collective agreements with a view to enabling tradespersons to enhance their skills and train cross-functionally.
4) Engage employers and work with educators and trainers to develop courses and curricula that provide electricity workers with access to a range of cross-trained skills. Cross-training opportunities should be designed to be accessible to experienced workers currently in the electricity industry (e.g., modular course design, remote and asynchronous learning).

6.2 Some occupations are facing pressure

Despite the relatively flat retirement and voluntary separation rates, employers are reporting difficulties in recruiting for certain occupations, particularly managers and ICT professionals. As senior management begins to retire, the pressure to find replacements with the needed skills and experience will increase. At the same time, hiring in ICT, especially cyber security, faces stiff competition from other industries. Employers do not have the knowledge to conduct in-house training in cyber security and are therefore reliant on contracted positions and new workers with the appropriate skills. Furthermore, much of the technology used in the electricity industry relies on legacy systems and platforms. As younger ICT workers focus on cutting-edge technology, it will be challenging to find workers with the knowledge of and experience with the industry's legacy technology.

Recommendations

1) Investigate the capacity of the contractor workforce to meet the needs of some in-demand occupations, particularly IT and short-term projects.
2) Analyze sectors of overlapping occupations and the methods they have used to successfully meet workforce challenges. Analysis would include assessment of recruitment strategies, tactics and best practices.
3) Provide internal training programs to cross-train and develop the needed skills with existing workers.

6.3 Professional, non-technical skills cannot be neglected

While continuing to acknowledge the importance of technical skills, employers have begun to explicitly inform educational institutions of the importance of professional skills (e.g., communication, critical thinking, team building, time management) for new workers. Currently, workers are getting most of their professional skills training on the job, so the development of these skills tends to be ad hoc and reactive. Educators have been promoting the development of professional skills; however, employers continue to emphasize the need for further professional skills development of new entrants.

The evolving nature of technology and industry regulations is also placing more emphasis on workers' ability to reskill and upskill throughout their careers.

Recommendations

1) Collaborate with educators and employers to identify the core professional skills needed for this sector and provide leadership in implementing skills development for both new and existing employees.
2) Work with training institutions to help change curricula to incorporate the skills needed in a modern workplace.
3) Work with educators to develop a variety of work-integrated learning programs to promote the development of professional and non-technical skills in new graduates.
4) Develop an employer toolkit to train managers on best practices for onboarding new hires.
5) Develop an employee toolkit for new hires to help them develop, monitor and evaluate the progress of their professional skills development.
6) Develop recruitment processes and tools to help identify professional skills in new entrants to the industry.

6.4 Aging and retirement will present challenges for specific occupations

Although workers are staying at work longer than anticipated and projections indicate a need for fewer workers in the future, aging and retirement will adversely affect specific occupations in the electricity industry. Managers, solar panel installers, industrial mechanics, and welders and millwrights are all expected to have higher than average retirement rates from 2019 to 2022. As senior workers leave the sector, succession plans are needed to ensure their knowledge and skills are not lost.

Recommendations

1) Develop succession plans for non-management workers in identified critical occupations.
2) Provide flexible work arrangements for employees transitioning to retirement to ensure the transfer of knowledge and skills to other workers.
3) Implement deliberate plans to promote the slow transition to retirement for senior workers, providing time for knowledge transfer and the training of replacements.
4) Develop and implement a process to identify and address potential skills gaps in individual organizations.
5) Build redundancy in skills across workers to ensure critical positions have appropriate coverage.
6) Develop a toolkit to assist employers with succession planning.
7) Develop knowledge-sharing workshops or roundtables to allow employers to share best practices relating to knowledge transfer and succession planning.

6.5 Diversity, equity and representation must be improved

Hiring in the electricity industry is not keeping pace with the changing Canadian demographic landscape, with the proportion of women, Indigenous people and internationally trained workers continuing to remain well below the average for the Canadian workforce. Newcomers to Canada and persons with disabilities also represent pipelines for skilled talent that the electricity sector would do well to consider.

The expansion of green energy generation may offer opportunities to improve the diversity balance in the sector, particularly for Canada's youth. Young women and Indigenous youth are often interested in environmental issues and may be prepared to consider careers that promise an opportunity to build a greener future.

Recommendations

1) Continue to lead the development of training resources to emphasize the importance of a diverse workforce that builds on key strengths and opportunities for business growth.
2) Continue to establish partnerships with organizations, building on the momentum of other successful initiatives (such as the Leadership Accord) to further diversify the workforce and capture demonstrable progress.
3) Create programming to support the development of an inclusive and barrier-free workforce.
4) Work with employers, educators and unions to develop messaging to engage young people in the sector.
5) Focus on attracting and recruiting younger workers as part of a long-term workforce plan.

6.6 Technology, digitalization and innovation are transforming the industry

Smart grids, renewable electricity generation, automation, carbon capture and storage, and the integration of EVs and energy storage options are transforming the electricity industry. Technological innovation is reshaping and reinventing the skills and occupations required to support the electrical grid. To benefit from green technologies, employers need to hire new staff with the required skills and education. This is currently a challenge, however, as the standards being used are often inconsistent and change constantly. The industry will need to rethink and reshape traditional occupational standards and skills profiles.

As both energy regulations and technology become more complicated, there is also an increased need for regulatory specialists and cyber security professionals to ensure compliance and security requirements are met. There will be strong competition across sectors for employees with these skill sets. Many employers are currently relying on contractors with the requisite knowledge and experience for this work.

Recommendations

1) Identify transferable skills within renewable energy that could be expanded into future business lines.
2) Develop new, updated and consistent national standards for the skills required for new and changing roles within those potential business lines.
3) Work with post-secondary institutions to update curricula and train the next generation of workers to fill critical occupations over the coming decade. Programs should be developed to ensure a talent pipeline of new employees while at the same time enabling existing employees to upskill with a minimal workplace impact.

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2.1 National LMI Advisory Committee

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Julia Aitken
Electricity Human Resources Canada

Myola Alvares
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Niall Tait
Carleton University

Melissa Young
National Electrical Trade Council

APPENDIX A: LIST OF STUDY PARTICIPANTS

We would like to acknowledge the generous time and support of the employers, educational institutions and other key stakeholders who participated in this study.

EMPLOYERS	
Acuren Group Inc.	Hatch Energy
Alberta Electric System Operator (AESO)	Hydro 2000 Inc.
Alectra Utilities	Hydro ECI Inc.
AltaLink Management Ltd.**	Hydro Hawkesbury
Applied Engineering Solutions	Hydro One
ATCO Electric*	Hydro Ottawa**
ATCO Power	Hydro-Québec**
Atikokan Hydro Inc.	Independent Electricity System Operator (IESO)
ATTAWAPISKAT POWER CORP	IROQUOIS FALLS POWER CORP
BC Hydro**	K-Line Group of Companies
Belair Power & Production Equipment Inc.	Lakeland REA Ltd.
Belledune Generation Station	Liburdi Turbine Services (Lidya Energie Societe)
Boralex Inc.	Maritime Electric*
Bowark Energy Ltd.	Manitoba Hydro
Brantford Power Inc.	Milton Hydro Distribution (Maxim Power Corp)
Brookfield Renewable Power	Espanola Regional Hydro Distribution Corporation
Bruce Power	Natural Power
Burlington Hydro	NB Power**
Atlantic Power (Calstock Power Plant)	Newfoundland Power Inc.**
Cameco Corp.	Newfoundland and Labrador Hydro (Nalcor Energy)
Capital Power Corporation **	Newmarket - Tay Power Distribution Ltd.
Chapleau Public Utilities Corporation	Niagara Peninsula Energy Inc.
City of New Westminster	Oakville Hydro Electricity Distribution Inc.
City of Swift Current Light & Power	Ontario Power Generation**
Cooperative Embrun Hydro Inc	Ottawa River Power Corp
Cornwall Electric (Fortis Ontario)	Paul Reitzel Industrial
Cubit Power Systems	PUC Services Inc.

EMPLOYERS	
Dapp Power Ltd.	Qulliq Energy Corp
DPM Energy	Reid Wylde Engineering Ltd.
ENMAX Corporation**	Rio Tinto
EnWin Utilities Ltd.	Roberts Onsite Inc.
Eolectric	Rocky Rural Electrification Association Ltd.
EPCOR	S&C Electric Canada Ltd
Erth Business Technologies Inc.	SaskPower
Yukon Energy*	Sensus Metering Systems Inc.
Festival Hydro Inc.	Siemens Gamesa Renewable Energy Limited
Fortis Alberta Inc.**	Sioux Lookout Hydro Inc
FortisBC Energy Inc.	Thunder Bay Hydro Electricity Distribution Inc.
Gezhtoojig Employment and Training	TransAlta Corporation**
ZE Powergroup	TransCanada
Greater Sudbury Hydro Inc.	Veridan
Green Power Labs Inc.	Wasaga Distribution Inc.
Guelph Hydro Electric Systems Inc.	Welland Hydro Electric System Corp.**
Halton Hills Hydro Inc	Wellington North Power Inc.
Ghost Pine Wind Farm LP (NextEra Energy Canadian Operating Services Inc.)	Western Pacific Enterprises

Educational Institutions	
Algonquin College**	McMaster University
Assiniboine Community College	Medicine Hat College
Brandon University	New Brunswick Community College*
Cambrian College of Applied Arts and Technology*	Northern Lights College
Carlton University**	Nova Scotia Community College
CEGEP Vanier College	Okanagan College
Centennial College	PWU Training Inc.
College Communautaire de Nouveau Brunswick	Red Deer College*
College of New Caledonia	Red River College

Educational Institutions	
College of the North Atlantic	Relay Education (TREC Education)
Colleges and Institutes Canada*	Southern Alberta Institute of Technology (SAIT)**
Ecole Polytechnique de Montreal	St. Lawrence College
Fanshawe College	Thompson Rivers University
Georgian College**	University of Alberta
Grande Prairie Regional College	University of Calgary*
Humber College	University of Manitoba**
Keyano College	University of Ontario Institute of Technology
Lakeland College**	University of Toronto
Lambton College*	University of Windsor
Lethbridge Community College	Yukon College

Other Organizations	
CanWEA*	Office to Advance Women Apprentices (OAWA)*
Indigenous Works*	Canadian Union of Skilled Workers*
Métis Nation of Ontario*	Electrical Contractors Association of Ontario*
Women in Renewable Energy (WiRE)*	Power Workers' Union

Legend

No asterisk – Participated in survey
* – Participated in a key informant interview
** – Participated in both the survey and a key informant interview

APPENDIX B: INDUSTRY DEFINITIONS AND DATA SOURCES

Definitions

Electricity Human Resources Canada (EHRC) uses data and information that adhere to EHRC's definition of the electricity industry. This includes sector-level data based on the North American Industry Classification System (NAICS), and occupational data according to the National Occupational Classification (NOC) system.

These two standardized frameworks are summarized below:

North American Industry Classification System (NAICS) Canada 2017 Version 1.0
The NAICS assigns a code number that describes economic and business activity at the industry level. Under NAICS, assignment to a specific industry is based on primary activity, enabling the grouping together of establishments with similar activities.

EHRC has aligned its definition of the industry to a specific NAICS Code 2211: Electric Power Generation, Transmission and Distribution Description. This industry group comprises employers primarily engaged in generating, transmitting, and/or distributing electric power. Establishments in this industry group may perform one or more of the following activities: (1) operate generation facilities that produce electric energy; (2) operate transmission systems that convey the electricity from the generation facility to the distribution system; and (3) operate distribution systems that convey electric power received from the generation facility or the transmission system to the final consumer. This group also includes those growing renewable energy sector, retailers and their contractors and consultants.

National Occupational Classification (NOC) System
Occupational analysis in this report also follows the NOC system to report on labour market activity. The NOC is a standardized framework for categorizing occupations. Statistics Canada uses the NOC code system to provide information on labour market and employment outcomes across industries and sub-sectors. Occupations are each assigned a NOC code consisting of 1 to 4 digits, and a corresponding occupational title.

From the NOC System, EHRC identified 26 occupations (including managers, engineers, technicians and trades) which were considered the most relevant to the industry in managing, maintaining and operating the facilities within Canada's changing energy landscape. It is important to note that this list of occupations was refined and expanded from the 2011 study which originally included 19 occupations. The refined and expanded set of occupations includes the integration of such occupations as cybersecurity and smart grid specialists, utility arborists, wind technicians/, wind station operators and solar PV installers and divides powerline technicians and cable powerline technicians into two separate occupations. Similar to the 2011 LMI study, this current. The study also provides data on 12 construction occupations which support the industry infrastructure.

Key occupations and NOC code classification for this study include:

- #0211 Engineering managers
- #0711 Construction managers
- #0912 Utilities managers
- #2131 Civil engineers
- #2132 Mechanical engineers
- #2133 Electrical and electronics engineers
- #2171 Information systems analysts and consultants (includes cyber security)

- #2172 Database analysts and data administrators
- #2173 Software engineers and designers
- #2174 Computer programmers and interactive media developers
- #2231 Civil engineering technologists and technicians
- #2232 Mechanical engineering technologists and technicians
- #2241 Electrical and electronics engineering technologists and technicians
- #2261 Non-destructive testers and inspection technicians
- #2262 Engineering inspectors and regulatory officers
- #2281 Computer network technicians
- #7202 Contractors and supervisors, electrical trades and telecommunications occupations
- #7241 Electricians
- #7243 Power system electricians
- #7244 Electrical power line and cable workers
- #7311 Construction millwrights and industrial mechanics
- #7441 Residential and commercial installers and servicers (includes solar PV Installers)
- #7522 Public works maintenance equipment operators and related workers (includes utility arborists)
- #9241 Power engineers and power systems operators (includes power system and power station operators, smart grid specialists, wind technicians, wind station operators)

Table C1 – Occupations Included in the Report by Occupational Group

Grouping	Occupation Name in Survey	NOC Code	Additional Occupation Names (also known as)	Notes
Managers/Supervisors	Utilities Managers	912	• Operations Managers • Electric Power Plant Managers	
	Engineering Managers	211	• Senior Project Managers • (in engineering fields)	
	Construction Managers	711		Include senior project managers in related fields in this category
	Supervisors of Electricians/ Supervisors of Electrical Power Line Workers	7202	• Foreperson or Subforperson • Powerline Technician Foreperson or Subforperson	
Engineers/Engineering Technologists	Electrical and Electronics Engineers	2133		
	Mechanical Engineers	2132		Include nuclear engineers in this category
	Civil and Other Engineers	2131		Include data for all engineers in this category, with the exception of those noted above (electrical and electronics engineers; mechanical engineers)
	Technologists and Technicians	2241	• Instrumentation Technicians • Metering Technicians • Protection and Control Technicians • Electronics Design Technologists Electricity Distribution Network Technologists	

Grouping	Occupation Name in Survey	NOC Code	Additional Occupation Names (also known as)	Notes
	Mechanical Engineering Technologists and Technicians	2232		
	Civil Engineering and Other Technologists and Technicians	2231		Include all technicians and technologists in this category, with the exception of those noted above (Electrical and Electronics Engineering Technologists and Technicians; Radiation Technologists; Mechanical Engineering Technologists and Technicians)
	Radiation Technicians	2261		
Trades	Electrical Power Line Workers	7244	• Power Line Technicians • Trouble Technicians	
	Cable Workers	7244	• Cable Splicers • Power Cable Technician	
	Utility Arborists	7522		
	Power Systems Operators	9241	• Apprentice Power Dispatcher	
	Power System Electricians	7243	• Electricians • Power Electricians • Industrial or Construction Electricians	
	Construction Electricians	7241		Includes electricians that are Solar Photovoltaic (PV) Systems Certified SPVC), as well as employees that install electric vehicle charging infrastructure

Grouping	Occupation Name in Survey	NOC Code	Additional Occupation Names (also known as)	Notes
	Industrial Electricians	7242		Includes mine electricians, plant electricians and plant maintenance electricians
	Power Station Operators	9241	• Diesel Station Operator • Electrical Station Operator • Nuclear Station Operator	
	Millwrights or Industrial Mechanics	7311		Includes mechanics, millwrights, plant equipment mechanics
	Electrical Mechanics	7333		Includes winders and repairers
	Welders	7237		Includes machine operators who operate previously set up production welding, brazing and soldering equipment
Renewable Energy and Climate Change Occupations	Wind Technicians	9241	• Wind Station Operators	
	Solar Panel Installers	7441		
	Smart Grid Specialists	9241		
Information and Communication Technology Occupations	Information Systems Analysts and Consultants	2171		Includes database analysts; data administrators; software engineers and designers; computer programmers; interactive media developers; computer network technicians
	Database Analysts and Data Administrators	2172		
	Software Engineers and Designers	2173		
	Computer Programmers and Interactive Media Developers	2174		
	Computer Network Technicians	2281		Includes supervisors of computer network technicians
	Cyber Security Specialists	2171		

Table C2 – Description of Occupations Included in Report

Occupation Name in Survey	Job Descriptions and Other Common Names for the Occupation
	Engineers/Engineering Technologists
Electrical and Electronics Engineers	Design, plan, research, evaluate and test electrical and electronic equipment and systems. Employees in this occupation may also be known as design or process control engineers. (NOC 2133: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2133)
Mechanical Engineers	Research, design and develop machinery and systems for power generation, heating, ventilating and air conditioning, transportation, processing and manufacturing. They also perform duties related to the evaluation, installation, operation and maintenance of mechanical systems. This NOC also includes nuclear engineers. (NOC 2132: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2132)
Civil and Other Engineers	Plan, design, develop and manage projects for the construction or repair of buildings, powerhouses, earth structures, roads, airports, railways, rapid transit facilities, bridges, tunnels, water distribution and sanitation. Civil engineers may also specialize in foundation analysis, building and structural inspection, surveying, geomatics and municipal planning. (NOC 2131: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2131) *Include data for all engineers in this category, with the exception of those noted above (Electrical and Electronics Engineers; Mechanical Engineers).*
Electrical and Electronics Engineering Technologists and Technicians	Provide technical support and services in the design, development, testing, production and operation of electrical and electronic equipment and systems. Also known as electronics design technologists, electricity distribution network technologists. Employees in this occupation may also be known as instrumentation technicians, metering technicians, protection and control technicians, electronics design technologists or electricity distribution network technologists. (NOC 2241: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2241)
Mechanical Engineering Technologists and Technicians	Provide technical support and services in the design, development, testing and maintenance of machines, components, tools, heating and ventilation systems, power generation and power conversion plants, and manufacturing plants and equipment. (NOC 2232: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2232)
Civil Engineering and Other Technologists and Technicians	Provide technical support and services to scientists, engineers and other professionals, may develop engineering designs and drawings from preliminary concepts and sketches, conduct or supervise inspection and testing of construction materials. (NOC 2231: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2231) *Include all technicians and technologists in this category, with the exception of those noted above (Electrical and Electronics Engineering Technologists and Technicians; Radiation Technologists; Mechanical Engineering Technologists and Technicians.)*

Occupation Name in Survey	Job Descriptions and Other Common Names for the Occupation
Radiation Technician	Non-destructive testers and inspection technicians operate radiographic, ultrasonic, liquid penetrant, magnetic particle, eddy current and similar testing equipment to detect discontinuities in objects of various compositions and materials. (NOC 2261: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2261)
Trades	
Electrical Power Line Workers	Construct, maintain and repair overhead and underground electrical power transmission and distribution systems. Also known as Power Line Technicians, Trouble Technicians. (NOC 7244: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7244) This is a designated Red Seal trade.
Cable Workers	Construct, maintain and repair overhead and underground electrical power transmission and distribution systems. Also known as Cable Splicers or Power Cable Technician. (NOC 7244: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7244)
Utility Arborists	Clear vegetation close to power lines, inspect the condition of utility poles and locate underground utility lines and pipes. (NOC 7522: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7522)
Power Systems Operators	Monitor and operate switchboards and related equipment in electrical control centres to control the distribution of electrical power in transmission networks. They are responsible for coordinating and scheduling power loads and line voltages to meet demands during daily operations, system outages and repairs. Also known as Apprentice Power Dispatcher. (NOC 9241: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=9241)
Power System Electricians	Install, maintain, test and repair electrical power generation, transmission and distribution system equipment and apparatus. Also known as electricians/power electricians/ industrial or construction electricians. (NOC 7243: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7243)
Power Station Operators	Operate reactors, turbines, boilers, generators and other related equipment in electrical generating stations and substations. Also known as Diesel Station Operator, Electrical Station Operator, Nuclear Station Operator. (NOC 9241: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=9241)
Construction Electricians	Lay out, assemble, install, test, troubleshoot and repair electrical wiring, fixtures, control devices and related equipment in buildings and other structures. Includes electricians that are Solar Photovoltaic (PV) Systems Certified SPVC), as well as employees that install electric vehicle charging infrastructure. (NOC 7241: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7241) This is a designated Red Seal trade.

Occupation Name in Survey	Job Descriptions and Other Common Names for the Occupation
Industrial Electricians	Install, maintain, test, troubleshoot and repair industrial electrical equipment and associated electrical and electronic controls. Includes mine electricians, plant electricians and plant maintenance electricians. (NOC 7242: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7242)
Millwrights or Industrial Mechanics	Install, maintain, troubleshoot and repair stationary industrial machinery and mechanical equipment. This category includes mechanics, millwrights, plant equipment mechanics. (NOC 7311: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7311) This is a designated Red Seal trade.
Electrical Mechanics	Maintain, test, rebuild and repair electric motors, transformers, switchgear and other electrical apparatus. This category includes winders and repairers. (NOC 7333: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7333) This is a designated Red Seal trade.
Welders	Operate welding equipment to weld ferrous and non-ferrous metals. This unit group also includes machine operators who operate previously set up production welding, brazing and soldering equipment. (NOC 7237: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7237) This is a designated Red Seal trade.
Renewable Energy and Climate Change Occupations	
Wind Technicians	Operate and maintain reactors, turbines, boilers, generators, stationary engines and auxiliary equipment to generate electrical power and to provide heat, light, refrigeration and other utility services. Power systems operators monitor and operate switchboards and related equipment in electrical control centres to control the distribution of electrical power in transmission networks. Also known as Wind Station Operators. (NOC 9241: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=9241)
Smart Grid Specialists	Operate and maintain reactors, turbines, boilers, generators, stationary engines and auxiliary equipment to generate electrical power and to provide heat, light, refrigeration and other utility services for commercial, institutional and industrial plants and facilities. Power systems operators monitor and operate switchboards and related equipment in electrical control centres to control the distribution of electrical power in transmission networks. (NOC 9241: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=9241)
Solar Panel Installers	Install and service a wide variety of interior and exterior prefabricated products such as solar panels on residential and commercial properties. (NOC 7441: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=7441)
Information and Communication Technology Occupations	

Occupation Name in Survey	Job Descriptions and Other Common Names for the Occupation
Information Systems Analysts and Consultants	Develop and implement information systems development plans, policies and procedures, and provide advice on a wide range of information systems issues. Aspects of this occupational category would also include: control systems, systems architecture, enterprise, security. (NOC 2171: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2171) *Include database analysts and data administrators, software engineers and designers, computer programmers and interactive media developers and computer network technicians.*
Database Analysts and Data Administrators	Database analysts design, develop and administer data management solutions using database management software. Data administrators develop and implement data administration policy, standards and models. (NOC 2172: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2172)
Software Engineers and Designers	Research, design, evaluate, integrate and maintain software applications, technical environments, operating systems, embedded software, information warehouses and telecommunications software. (NOC 2173: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2173)
Computer Programmers and Interactive Media Developers	Computer programmers write, modify, integrate and test computer code for microcomputer and mainframe software applications, data processing applications, operating systems-level software and communications software. Interactive media developers write, modify, integrate and test computer code for Internet applications, computer-based training software, computer games, film, video and other interactive media. (NOC 2174: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2174)
Computer Network Technicians	Establish, operate, maintain, and co-ordinate the use of local and wide area networks (LANs and WANs), mainframe networks, hardware, software and related computer equipment. They set up and maintain Internet and Intranet Web sites and Web-server hardware and software, and monitor and optimize network connectivity and performance. Supervisors of computer network technicians are included in this group. (NOC 2281: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2281)
Cyber Security Specialists	Analyze systems requirements, develop and implement information systems development plans, policies and procedures, and provide advice on a wide range of information systems issues. (NOC 2171: http://noc.esdc.gc.ca/English/noc/QuickSearch.aspx?ver=16&val65=2171)

APPENDIX C: RESEARCH METHODOLOGY

The use of multiple lines of evidence ensures that this report is comprehensive, robust and in line with the highly regarded earlier studies. Malatest reviewed and proposed alterations to the methodology for the national LMI study. Data collection tools and communication materials that were reviewed and updated included:

- Survey communications;
- Survey questionnaires (review and update of 2011 instruments);
- Key informant interview communications;
- Key informant interview guides; and
- Professional translation of documents into French.

DATA COLLECTION ACTIVITIES

Literature Review and Environmental Scan

At the outset of the project, Malatest worked with EHRC to develop a preliminary source list for both an environmental scan of provincial, national and international information regarding the current labour market resources of the electricity industry, as well as a for literature review of external business drivers and key factors that affect labour supply and demand in the industry, such as technology changes; demographic changes; energy policy and projections of energy demand; labour mobility; and sources of supply, including underrepresented groups such as women and Indigenous people.

Key Data Sources

The initial list of data sources included 114 documents ranging from academic and grey literature, along with regulatory guidelines, frameworks and strategies; this initial source list was reviewed and revised on an ongoing basis, to ensure that information included remained current throughout the course of the project.

Malatest also collected statistical data from a variety of public and private sources, to provide key information on variables of interest including demographic characteristics (e.g. age, education, diversity) and economic and behavioural factors (e.g. commodity prices, gross domestic product, employment).

Data sources that were central to the analysis include the following:

Census (Statistics Canada):

The census provides a wide range of information on Canada's population, including topics related to labour market activities. While it is a relatively more detailed source of data, the census is produced once every five years. The most recent census was produced in 2016. EHRC requested customized data from Statistics Canada in order to deliver analyses

Labour Force Survey (LFS) (Statistics Canada):

The LFS covers topics related to labour market activities in Canada for the population 15 years of age and over (e.g. employment, unemployment, labour force participation). This survey is conducted monthly and therefore provides the timeliest data (that are also publicly available). Data are often at a broader 2-digit NAICS rather than the preferred 4-digit level (e.g. NAICS 22 instead of NAICS 2211)

Registered Apprenticeship Information System (RAIS)

RAIS is an annual survey that has been conducted by Statistics Canada since 1974. The purpose of the survey is to gather information from provinces and territories on individuals who receive training or certification within a trade where apprenticeship training is being offered.

The survey compiles data on the number of registered apprentices taking in-class and on-the-job training in trades that are either Red Seal or non-Red Seal and where apprenticeship training is either compulsory or voluntary. It also compiles data on the number of provincial and interprovincial certificates granted to apprentices or trade qualifiers (challengers).

Other Data Sources:
EHRC uses a variety of other sources throughout this analysis and where appropriate, including data from: BuildForce Canada; Engineers Canada; Canadian Council of Directors of Apprenticeship/Red Seal; Generation Energy Council; Bloomberg New Energy Finance; and Natural Resources Canada.

Surveys of Industry Stakeholders and Educational Institutions
Malatest reviewed and revised the 2011 LMI study questionnaires:

- National survey of industry stakeholders
- Education institutions

Although modifications were made to the survey instruments to address changing occupations and circumstances within the industry, question wording was kept close to the original instruments to promote comparisons with previous reports.

After review and revisions of the 2011 LMI study questionnaires, Malatest developed two new surveys:

1. EHRC Survey of Electricity Employers; and
2. EHRC Survey of Post-Secondary Institutions.

Survey Sample
Malatest received the 2011 survey sample, provided by EHRC, which was updated as necessary. The sample included contact information for 350 employers and 179 educational stakeholders.

Survey Programming
Both surveys were programmed into Malatest's Computer Assisted Telephone/Web Interface for online and telephone administration. Both surveys were also internally tested. Following internal testing, both surveys were field tested prior to full administration.

Survey Administration
Both surveys utilized a census-approach with the following target industry stakeholder groups:

- Electricity sector employers (large and small hydro; renewables including wind, solar, geothermal; generation, distribution and transmission utilities; small- to medium-sized businesses, industry associations)
- Contractors (construction/engineers/electrical)
- Designated groups (women, Indigenous peoples, minority groups and people with disabilities)

Administration of the surveys included:

- Initiate contact with potential respondents
- Support mixed-mode survey administration (online, telephone, paper-based)
- Undertake response enhancement techniques, to maximize response rate

To improve response rates for the EHRC Survey of Electricity Employers, a short version of the survey was prepared. The main difference between the short version of the survey and the full version was that respondents were not asked to provide numbers for each individual electricity sector occupation. Instead respondents were asked to provide data at that level of the occupational groups. For example, rather than provide retirement numbers for each type of manager (utility, construction, engineering, supervisors), respondents were asked to provide retirement numbers for managers overall.

In total, 90 industry stakeholders took part in the EHRC Survey of Electricity Employers (6 participated in the short version of the survey) and 34 stakeholders participated in the EHRC Survey of Post-Secondary Education Institutions.

Key Informant Interviews

Malatest developed two interview guides for key informant interviews with:

- employer/union organizations (demand-side); and
- educational institutions (supply-side).

Conducting Interviews

Names and contact details for key informants were selected through a review of the survey of employers and educational institutions

Malatest contacted and scheduled interviews, which included 15 interviews with employers, 12 with educational institution representatives and seven (7) with other stakeholders including one union, four diversity-based organizations and diversity groups (n=5) and two industry associations.

LABOUR MARKET ASSESSMENTS

C4SE Provincial Economic Modeling System

The Centre for Spatial Economics (C4SE) was engaged by EHRC to provide findings from their forecast modeling system.

C4SE maintains a modeling system that consists of a set of provincial macroeconomic models. The models are linked together through trade, financial markets and inter-provincial migration. They are multi-sector models, which incorporates the purchasing patterns from Statistics Canada's input output tables.

The C4SE Provincial Economic Modeling System was designed to incorporate information on major capital projects in all industries for each province. The major project inventory contains specific information about each project, including the constriction costs and number of construction and operation jobs associated with the project. Major project investment assumptions are utilized to determine the direction, magnitude and timing of investment in the forecast and are a major forecast driver within the provinces. The pattern of investment and electricity demand is used to calculate employment growth by population.

For the purposes of this study, C4SE will focus on projects in the electricity generation, transmission and distribution industry which also includes renewable energy projects. These projects are reviewed and updated regularly as changes are announced. The Provincial Economic Modeling System produces forecasts of real GDP, consumer spending, exports/imports, employment, personal income, unit labor costs, as well as government revenues/budgetary balances, as well as many other important macroeconomic variables.

Provincial Occupations Models (POMS) Labour Market Intelligence Models

The POMS Labour Market Intelligence models bring together the macroeconomic and demographic information from the Provincial Economic Models to generate forecast of labour demand and supply. Labour demand forecasts are generated provincially for over 70 NAICS industries by 500 4-digit NOC categories. Labour force supply is determined by the local population, its composition by age and sex, labour force participation rates by age and sex, immigration, emigration and interprovincial migration. C4SE will conduct forecasting for the identified NOC occupations.

POMS can conduct occupation demand and supply projections for each province and role them up to produce projections for Canada as a whole. It is used to produce occupation outlooks consistent with the SECINC provincial macroeconomic outlooks.

In POMS, workforce supply and demand are interdependent — supply responds to changes in demand and changes in supply can affect demand. Almost all the other approaches undertaken in occupational modelling assume that workforce supply is an input to their workforce outlooks. That is, they assume that the demand and supply for the workforce are independent of each other. This approach allows them to show large persistent imbalances between supply and demand that are inconsistent with the way the world works. In the real world, such large imbalances would cause wages, prices, and other economic variables such interest rates, participation rates, and the exchange rate to adjust to reduce these imbalances.

The occupation projections made using POMS reflect a "requirements" approach for both demand and supply. This approach starts with the macroeconomic models where workforce demand and supply adjust over time to balance aggregate labour markets. An important part of this adjustment is an "optimal" immigration approach where the federal government is the residual source of workforce supply. The macroeconomic models employ the latest federal immigration policy targets in the short term and when targets are available, and in the longer term, the models adjust immigration levels to appropriate levels to assist the national labour market in maintaining a relatively healthy balance. Under this approach, there are no persistent large imbalances at the aggregate level of the economy across the country. Nevertheless, there may be temporary shortages or surpluses for some occupations over the economic cycle that will need to be considered in workforce planning.

In the POMS there is an outlook for demand requirements and the required supply to meet these demand requirements. The demand requirements are changes in employment, people retiring from the workforce, and people dying. The sources of supply to meet these requirements are young people entering the workforce after finishing school or changing jobs, both international and interprovincial net in-migrants, and other sources such as people changing occupations and deciding to enter the labour force because of more job opportunities and higher wages.

While there are no major and forever lasting labour market imbalances in the POMS outlooks, POMS does employ a labour market tightness ranking approach that considers the fact that the supply requirements computed may not be achieved. It attempts to identify occupations that may be difficult for organizations to find in the future. Occupations with relatively strong demand growth, for example, may be more difficult to find than those where demand growth is weaker. Moreover, occupations where supply requirements are largely met through migration may be at risk if the federal government does not accommodate these requirements through additional immigration or Canadian workers do not wish or are not available to move to the location in question. There may also be some tightness issues over economic cycles and for specific occupations. This tightness is incorporated in the ranking approach.

APPENDIX D: REGIONAL OUTLOOKS

Workforce in Motion

Labour Market Intelligence Study

Factsheet for

Alberta

2017–2022

electricity HUMAN RESOURCES CANADA
RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

NEW REALITIES, NEW DIRECTIONS

Photo credit: Alberta Independent Electricity System Operator

Trends include: global efforts to reduce greenhouse gas emissions, technological innovations (like smart grids and micro-grids), and automation, which are changing how electricity is delivered, stored and traded. These trends and others will determine the skills and occupations that will be in demand in the years ahead.

A recent labour market intelligence (LMI) study by Electricity Human Resources Canada (EHRC) looked at how the changes underway will affect Canada's electricity workforce in the coming years. This factsheet presents the outlook of that study for Alberta.

Download the national LMI report, *Workforce in Motion: 2017–2022 Labour Market Intelligence Study*, at electricityhr.ca/workforce-in-motion.

The sector today

EHRC's LMI study looked at how electricity is generated across Canada and measured overall age distribution, percentage of women and level of educational attainment among the almost 14,000 workers in Alberta's electricity industry.

Existing electrical capacity by fuel type

Nearly half of Alberta's electricity is generated by coal, and another third is generated by natural gas. In comparison, energy production in the rest of the country is largely dominated by hydro.

Existing Electrical Capacity by Type

FIGURE A4.1 Alberta

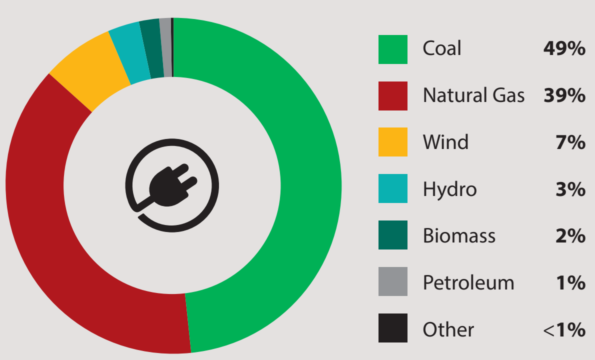
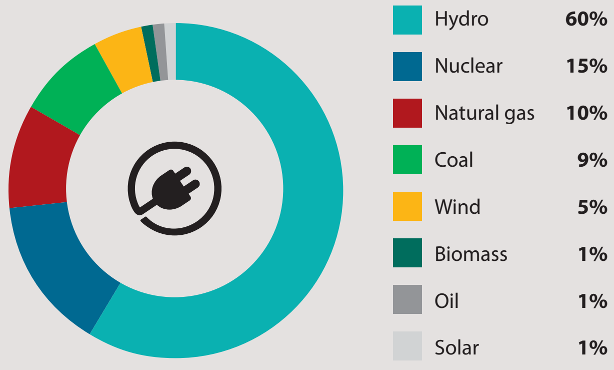


FIGURE 2.2 Canada



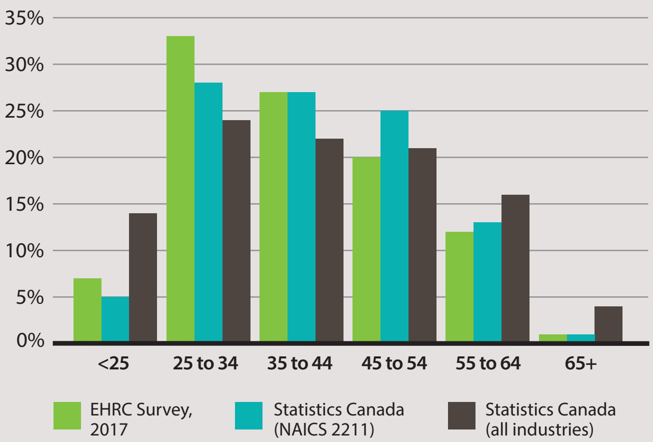
Source: National Resources Canada Electrity Fact. 2016.

Age distribution

Electricity workers in Alberta are younger than the national workforce. Around 60% of Alberta's electricity workforce is under the age of 45 compared to 50% nationally.

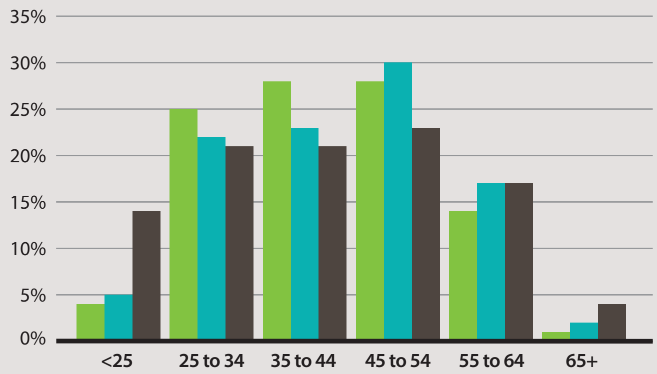
Overall Age Distribution

FIGURE A4.2 Alberta



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.5 Canada

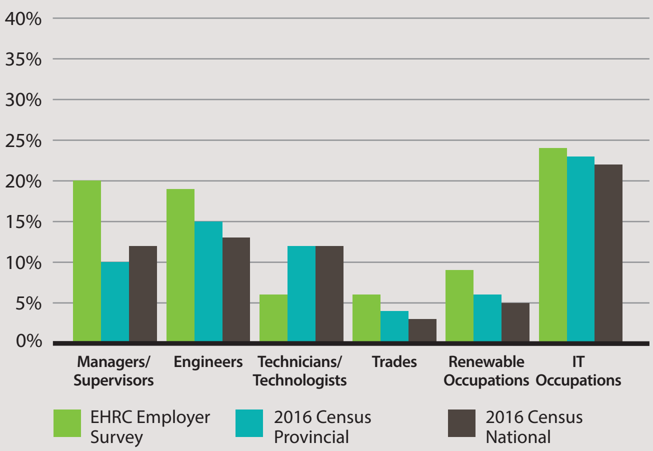


Percentage of women in the workforce

The proportion of women working in Alberta's electricity industry is similar to the national picture. However, Alberta has a higher proportion of women in management compared to what was reported by employers nationwide.

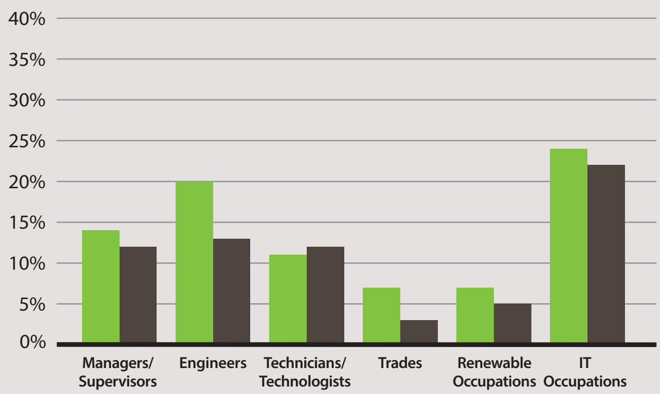
Percent of women in the workforce

FIGURE A4.3 Alberta



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.3 Canada



Level of educational attainment

Educational attainment distributions for Alberta and Canada are similar across all occupational classes.

Educational Attainment by Occupational Class

FIGURE A4.4 Alberta

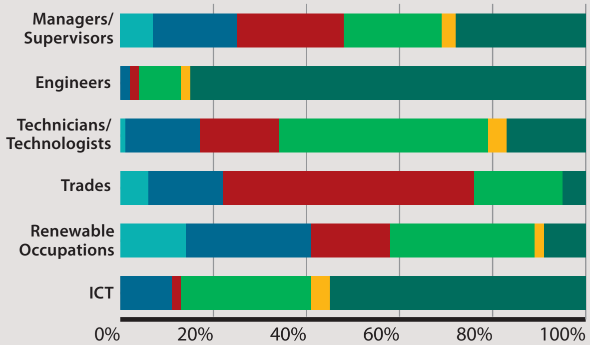
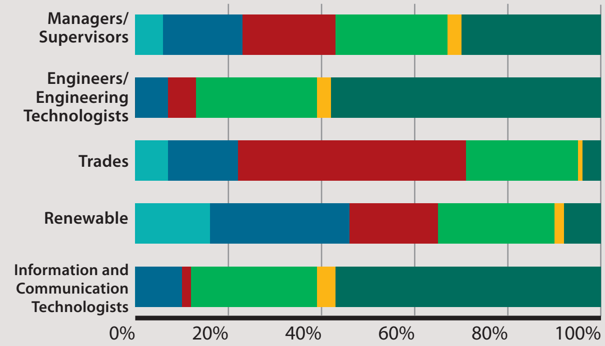


FIGURE 3.7 Canada



- No certificate, diploma or degree
- Secondary (high) school diploma or equivalency certificate
- Apprenticeship or trades certificate or diploma
- College, CEGEP or other non-university certificate or diploma
- College, CEGEP or other non-university certificate or diploma
- University certificate, diploma or degree at bachelor level or above

Source: Statistics Canada

"With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities—but they will demand highly specialized personnel with entirely new skill sets."

Looking Ahead

EHRC's LMI study generated forecasts and projections that can help the sector prepare for the impacts of the changes underway.

Supply and demand for occupations

The forecast data for Alberta's electricity sector suggests it will grow at a substantially higher rate than Canada's electricity sector overall.

TABLE 1 **Alberta's current and forecasted employment by occupation, 2017 and 2022**

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	131	145	10.69%	2.09%
Construction managers	74	81	9.46%	1.85%
Utilities managers	599	661	10.35%	2.02%
Civil engineers	158	174	10.13%	1.98%
Mechanical engineers	252	278	10.32%	2.02%
Electrical and electronics engineers	999	1,101	10.21%	2.00%
Information systems analysts and consultants	363	400	10.19%	1.99%
Database analysts and data administrators	53	58	9.43%	1.84%
Software engineers and designers	21	23	9.52%	1.90%
Computer programmers and interactive media developers	53	58	9.43%	1.84%
Civil engineering technologists and technicians	58	64	10.34%	2.02%
Mechanical engineering technologists and technicians	37	41	10.81%	2.09%
Electrical and electronics engineering technologists and technicians	315	348	10.48%	2.05%
Engineering inspectors and regulatory officers	32	35	9.38%	1.84%
Computer network technicians	79	87	10.13%	1.99%
Contractors and supervisors, electrical trades and telecommunications occupations	163	180	10.43%	2.04%
Power system electricians	410	452	10.24%	2.00%
Electrical powerline and cable workers	1,109	1,223	10.28%	2.01%
Construction millwrights and industrial mechanics	216	238	10.19%	1.99%
Residential and commercial installers and servicers	11	12	9.09%	1.82%
Public works maintenance equipment operators and related workers	74	81	9.46%	1.85%
Power engineers and power systems operators	936	1,031	10.15%	1.98%
Electricity sector occupations	**6,143**	**6,771**	**10.22%**	**1.98%**
Other occupations	**7,757**	**8,548**	**10.20%**	**1.98%**
Total	**13,900**	**15,319**	**10.21%**	**2.00%**

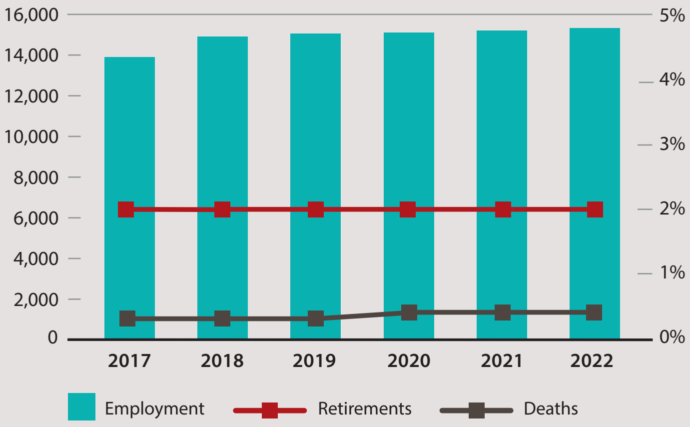
Source: C4SE POMS Forecast

Retirement

A consistent proportion of 2% of Alberta's electricity workforce is projected to retire each year from 2017 to 2022. This is slightly lower than the retirement projections for Canada overall.

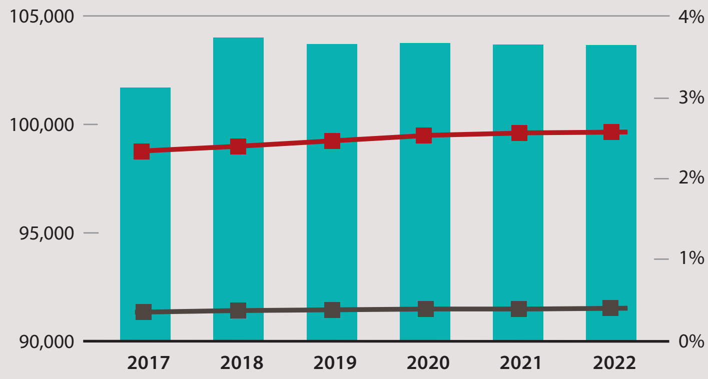
Retirement Projections for the Electricity Industry Workforce

FIGURE A4.6 Alberta



Source: C4SE POM Forecast

FIGURE 5.2 Canada

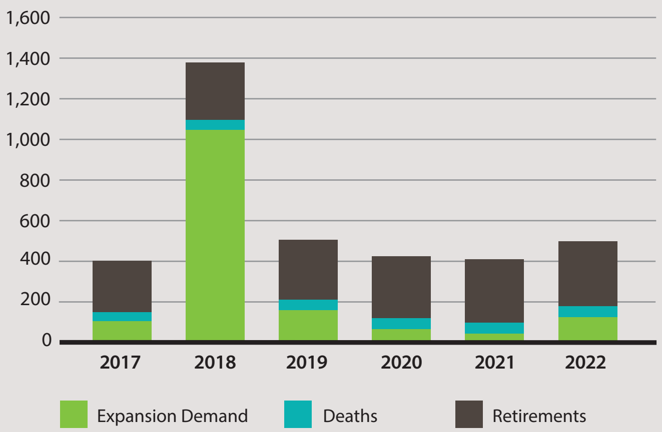


Total recruitment requirements

Recruitment requirements for the sector are influenced by expansion, death and retirement. The data for Alberta suggests that while its recruitment requirements due to expansion will be higher from 2019 to 2022 than most of the country's, the majority of the province's recruitment requirements will still come from retirements.

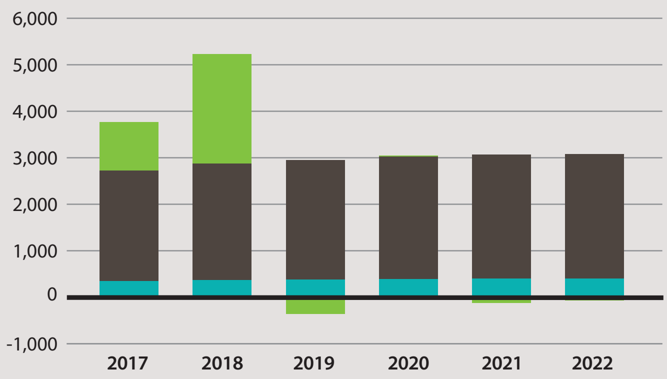
Retirement Projections for the Electricity Industry Workforce

FIGURE A4.7 Alberta



Source: C4SE POM Forecast

FIGURE 5.3 Canada



"As the sector becomes more sophisticated, demand will increase for employees able to work in an ever-changing, diverse, interconnected and high-tech electricity sector."

About the rankings

The LMI model uses demand and supply measures for specific occupations and consolidates them into a market ranking. The model assumes the supply of workers can come from any industry (e.g., an electrician from oil and gas extraction could be employed in electricity). Accordingly, demand and supply measures are calculated for all industries.

Labour market rankings

The labour markets for electricity sector occupations in Alberta will be mainly balanced or showing slight excess of supply until 2022.

See the legend under Table 2 on the following page for explanations of the different rankings.

1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

Get more labour market insights into Canada's electricity and renewables sector along with EHRC's recommendations for meeting labour challenges. Download *Workforce in Motion: 2017–2022 Labour Market Intelligence Study* at electricityhr.ca/workforce-in-motion today.

TABLE 2 Labour market rankings for Alberta, 2017–2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	3	3	4	3	2	3
Construction managers	3	2	3	2	2	2
Utilities managers	3	2	3	3	2	3
Civil engineers	2	4	4	3	3	3
Mechanical engineers	2	4	4	3	2	2
Electrical and electronics engineers	2	4	3	3	3	3
Information systems analysts and consultants	3	2	2	2	3	3
Database analysts and data administrators	3	2	3	3	3	3
Software engineers and designers	3	2	2	2	2	2
Computer programmers and interactive media developers	3	2	2	2	2	2
Civil engineering technologists and technicians	2	4	4	3	3	2
Mechanical engineering technologists and technicians	2	4	4	3	2	2
Electrical and electronics engineering technologists and technicians	2	3	4	3	3	3
Non-destructive testers and inspection technicians	2	4	4	3	2	2
Engineering inspectors and regulatory officers	3	3	4	3	3	3
Computer network technicians	3	2	2	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	2	2	3	2	2	2
Power system electricians	2	3	3	2	2	2
Electrical powerline and cable workers	3	3	3	2	2	2
Construction millwrights and industrial mechanics	3	3	4	3	3	2
Residential and commercial installers and servicers	2	3	3	2	2	2
Public works maintenance Equipment operators and related workers	4	3	3	3	3	3
Power engineers and power systems operators	3	3	4	4	2	2

Source: C4SE POMS Forecast

Workforce in Motion

Labour Market Intelligence Study

Factsheet for Atlantic Provinces

2017–2022

electricity HUMAN RESOURCES CANADA

RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

NEW REALITIES, NEW DIRECTIONS

Trends include: global efforts to reduce greenhouse gas emissions, technological innovations (like smart grids and micro-grids), and automation, which are changing how electricity is delivered, stored and traded. These trends and others will determine the skills and occupations that will be in demand in the years ahead.

A recent labour market intelligence (LMI) study by Electricity Human Resources Canada (EHRC) looked at how the changes underway will affect Canada's electricity workforce in the coming years. This factsheet presents the outlook of that study for the Atlantic provinces.

Download the national LMI report, *Workforce in Motion: 2017–2022 Labour Market Intelligence Study*, at electricityhr.ca/workforce-in-motion.

The sector today

EHRC's LMI study looked at how electricity is generated across Canada and measured overall age distribution, percentage of women and level of educational attainment among the more than 8,000 workers in Atlantic Canada's electricity industry.

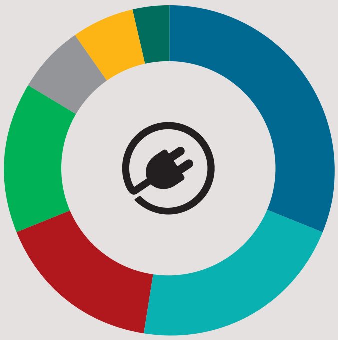
Existing electrical capacity by fuel type

Electricity generation methods varies widely across the Atlantic provinces. New Brunswick's generation capacity is quite diverse, with significant amounts of power coming from nuclear, hydro, natural gas and coal. Prince Edward Island relies almost exclusively on wind energy, and Newfoundland and Labrador almost exclusively on hydro. Nearly half of Nova Scotia's electricity comes from coal. In comparison, energy production in the rest of the country is largely dominated by hydro.

"With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities—but they will demand highly specialized personnel with entirely new skill sets."

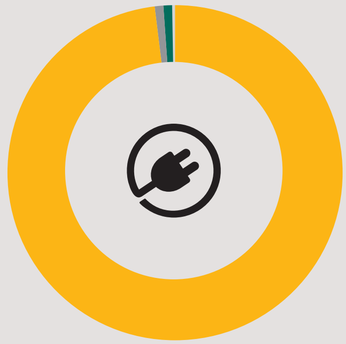
Existing Electrical Capacity by Type

FIGURE A6.1 New Brunswick



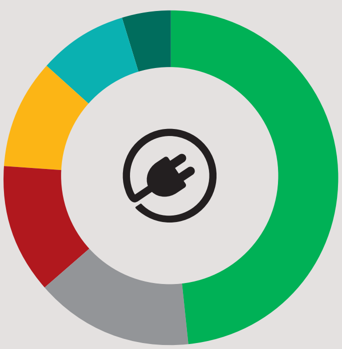
Nuclear	**31%**
Hydro	**22%**
Natural Gas	**16%**
Coal	**15%**
Petroleum	**7%**
Wind	**6%**
Biomass	**4%**

FIGURE A6.2 Prince Edward Island



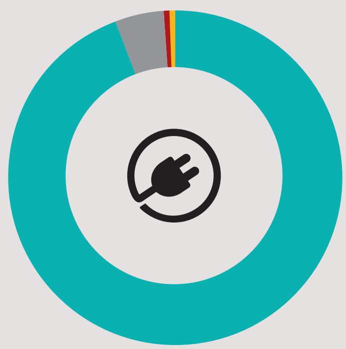
Wind	**98%**
Petroleum	**1%**
Biomass	**<1%**
Solar	**<1%**

FIGURE A6.3 Nova Scotia



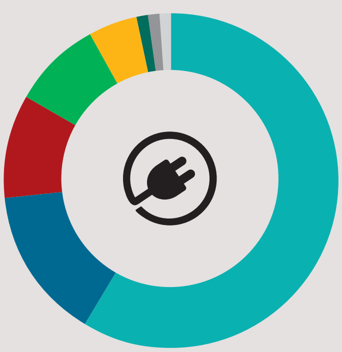
Coal	**49%**
Petroleum	**15%**
Natural Gas	**13%**
Wind	**10%**
Hydro	**9%**
Biomass	**5%**
Solar	**<1%**

FIGURE A6.4 Newfoundland and Labrador



Hydro	**94%**
Petroleum	**5%**
Natural Gas	**<1%**
Wind	**<1%**

FIGURE 2.2 Canada



Hydro	**60%**
Nuclear	**15%**
Natural gas	**10%**
Coal	**9%**
Wind	**5%**
Biomass	**1%**
Oil	**1%**
Solar	**1%**

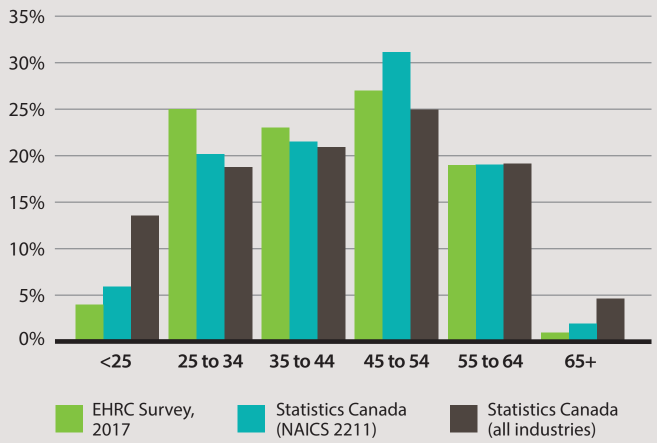
Source: Natural Resources Canada Electricity Facts, 2016

Age distribution

The age profile of workers in Atlantic Canada's electricity sector is similar to Canada's overall. With fewer workers under the age of 25 than all other industries, the Atlantic provinces' distribution suggests the same need for younger workers seen nationally.

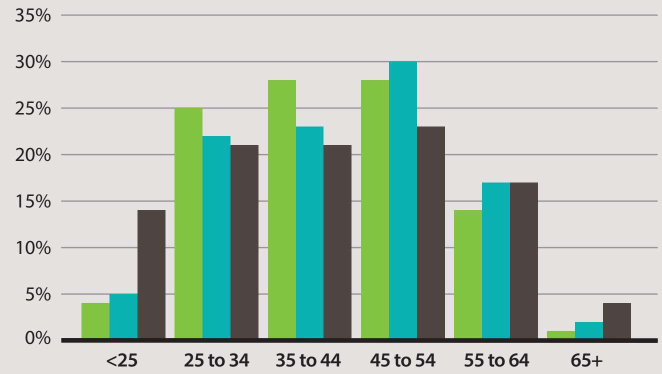
Overall Age Distribution

FIGURE A6.5 Atlantic provinces



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.5 Canada

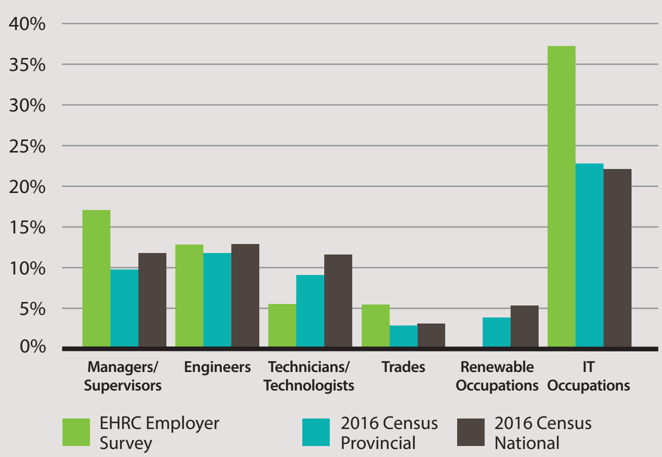


Percentage of women in the workforce

The proportion of women working in Atlantic Canada's electricity industry is similar to the national picture. However, the Atlantic provinces have a smaller proportion of women working as engineers, technicians and technologists, and a greater proportion of women in ICT, compared to what was reported by employers nationwide.

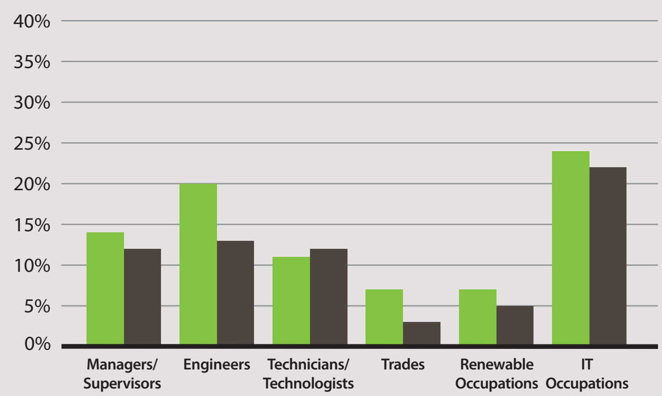
Percent of women in the workforce

FIGURE A6.6 Atlantic provinces



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.3 Canada

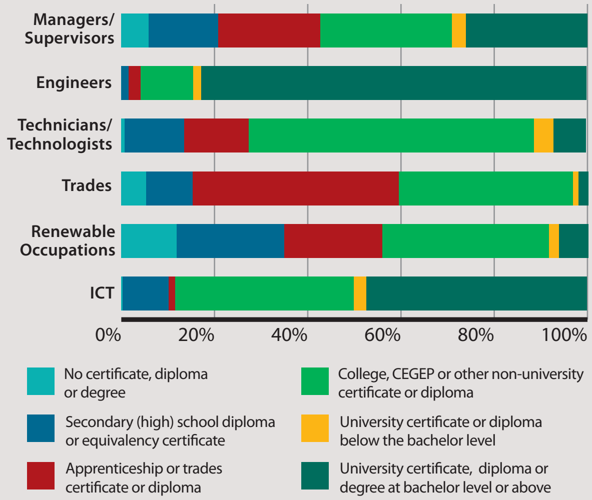


Level of educational attainment

Educational attainment distributions for the Atlantic provinces and Canada overall are similar across all occupational classes.

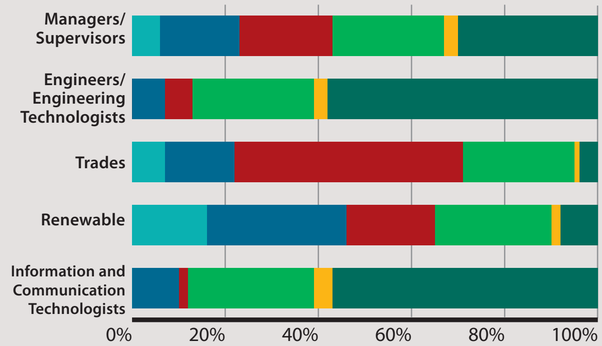
Educational Attainment by Occupational Class

FIGURE A6.7 Atlantic provinces



Source: Statistics Canada

FIGURE 3.7 Canada



Looking Ahead

EHRC's LMI study generated forecasts and projections that can help the sector prepare for the impacts of the changes underway.

Supply and demand for occupations

The forecast data suggests the electricity sectors in New Brunswick, Prince Edward Island and Nova Scotia will all contract, while Newfoundland and Labrador's sector will grow at a higher rate than Canada's electricity sector overall.

TABLE 1 New Brunswick's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	21	19	-9.52%	-1.95%
Utilities managers	42	37	-11.90%	-2.47%
Civil engineers	16	14	-12.50%	-2.58%
Mechanical engineers	79	70	11.39%	-2.35%
Electrical and electronics engineers	163	144	-11.66%	-2.42%
Information systems analysts and consultants	37	33	-10.81%	-2.21%
Database analysts and data administrators	10	9	-10.00%	-2.00%
Software engineers and designers	10	9	-10.00%	-2.00%
Computer programmers and interactive media developers	47	42	-10.64%	-2.20%

Continued on the next page

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Mechanical engineering technologists and technicians	21	19	-9.52%	-1.95%
Electrical and electronics engineering technologists and technicians	89	79	-11.24%	-2.33%
Engineering inspectors and regulatory officers	10	9	-10.00%	-2.00%
Contractors and supervisors, electrical trades and telecommunications occupations	31	28	-9.68%	-1.98%
Power system electricians	79	70	-11.39%	-2.35%
Electrical powerline and cable workers	262	233	-11.07%	-2.30%
Construction millwrights and industrial mechanics	110	98	-10.91%	-2.26%
Residential and commercial installers and servicers	10	9	-10.00%	-2.00%
Public works maintenance equipment operators and related workers	10	9	-10.00%	-2.00%
Power engineers and power systems operators	388	344	-11.34%	-2.35%
Electricity sector occupations	**1,435**	**1,275**	**-11.15%**	**-2.31%**
Other occupations	**1,665**	**1,476**	**-11.35%**	**-2.35%**
Total	**3,100**	**2,751**	**-11.26%**	**-2.33%**

Source: C4SE POMS Forecast

TABLE 2 Prince Edward Island's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	6	5	-16.67%	-3.33%
Civil engineers	6	5	-16.67%	-3.33%
Electrical and electronics engineers	11	11	0.00%	0.15%
Electrical and electronics engineering technologists and technicians	6	5	-16.67%	-3.33%
Electrical powerline and cable workers	14	14	0.00%	0.10%
Power engineers and power systems operators	11	11	0.00%	0.15%
Electricity sector occupations	**54**	**51**	**-5.56%**	**-1.05%**
Other occupations	**46**	**45**	**-2.17%**	**-0.39%**
Total	**100**	**96**	**-4.00%**	**-0.80%**

Source: C4SE POMS Forecast

TABLE 3 Nova Scotia's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	52	48	-7.69%	-1.57%
Construction managers	15	14	-6.67%	-1.33%
Utilities managers	67	62	-7.46%	-1.51%
Civil engineers	45	41	-8.89%	-1.82%
Mechanical engineers	45	41	-8.89%	-1.82%
Electrical and electronics engineers	105	97	-7.62%	-1.56%
Information systems analysts and consultants	52	48	-7.69%	-1.57%
Mechanical engineering technologists and technicians	15	14	-6.67%	-1.33%
Electrical and electronics engineering technologists and technicians	127	117	-7.87%	-1.61%

Continued on the next page

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering inspectors and regulatory officers	15	14	-6.67%	-1.33%
Computer network technicians	15	14	-6.67%	-1.33%
Contractors and supervisors, electrical trades and telecommunications occupations	45	41	-8.89%	-1.82%
Power system electricians	30	28	-6.67%	-1.33%
Electrical powerline and cable workers	232	214	-7.76%	-1.59%
Construction millwrights and industrial mechanics	60	55	-8.33%	-1.71%
Power engineers and power systems operators	427	393	-7.96%	-1.63%
Electricity sector occupations	**1,347**	**1,241**	**-7.87%**	**-1.61%**
Other occupations	**1,753**	**1,614**	**-7.93%**	**-1.62%**
Total	**3,100**	**2,855**		

Source: C4SE POMS Forecast

TABLE 4 Newfoundland and Labrador's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	22	24	9.09%	1.78%
Construction managers	11	12	9.09%	1.82%
Utilities managers	70	78	11.43%	2.21%
Civil engineers	43	48	11.63%	2.24%
Mechanical engineers	43	48	11.63%	2.24%
Electrical and electronics engineers	114	126	10.53%	2.04%
Information systems analysts and consultants	27	30	11.11%	2.14%
Database analysts and data administrators	11	12	9.09%	1.82%
Software engineers and designers	11	12	9.09%	1.82%
Computer programmers and interactive media developers	11	12	9.09%	1.82%
Civil engineering technologists and technicians	11	12	9.09%	1.82%
Electrical and electronics engineering technologists and technicians	162	180	11.11%	2.15%
Engineering inspectors and regulatory officers	11	12	9.09%	1.82%
Computer network technicians	27	30	11.11%	2.14%
Contractors and supervisors, electrical trades and telecommunications occupations	32	36	12.50%	2.41%
Power system electricians	103	114	10.68%	2.07%
Electrical powerline and cable workers	259	288	11.20%	2.16%
Construction millwrights and industrial mechanics	70	78	11.43%	2.21%
Public works maintenance equipment operators and related workers	11	12	9.09%	1.82%
Power engineers and power systems operators	205	228	11.22%	2.17%
Electricity sector occupations	**1,254**	**1,392**	**11.00%**	**2.13%**
Other occupations	**1,346**	**1,493**	**10.92%**	**2.12%**
Total	**2,600**	**2,885**	**10.96%**	**2.12%**

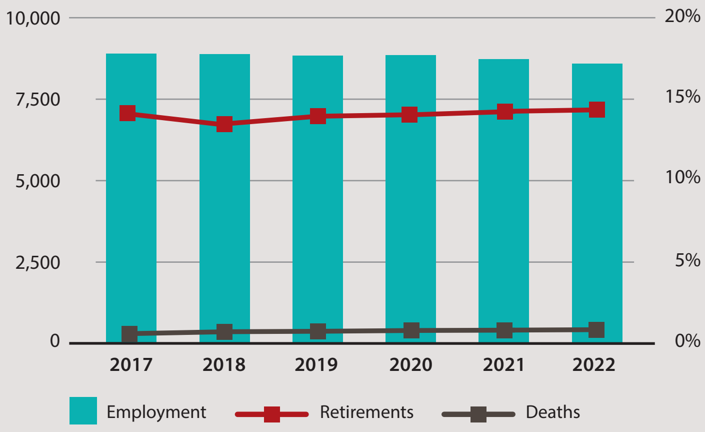
Source: C4SE POMS Forecast

Retirement

Retirement is projected to be higher in Atlantic Canada than anywhere else in the country, with almost 15% of the workforce set to retire by 2022.

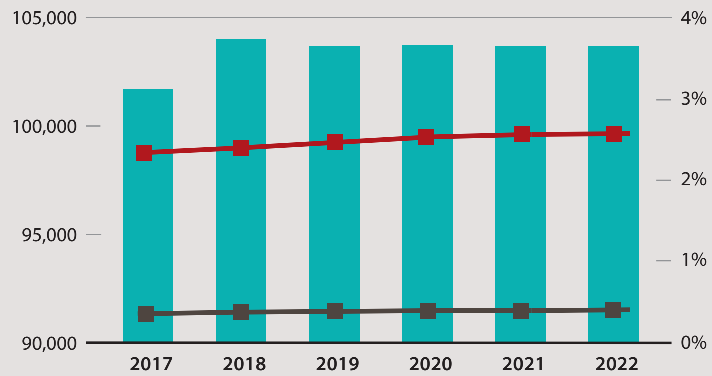
Retirement Projections for the Electricity Industry Workforce

FIGURE A6.12 Atlantic provinces



Source: C4SE POM Forecast

FIGURE 5.2 Canada

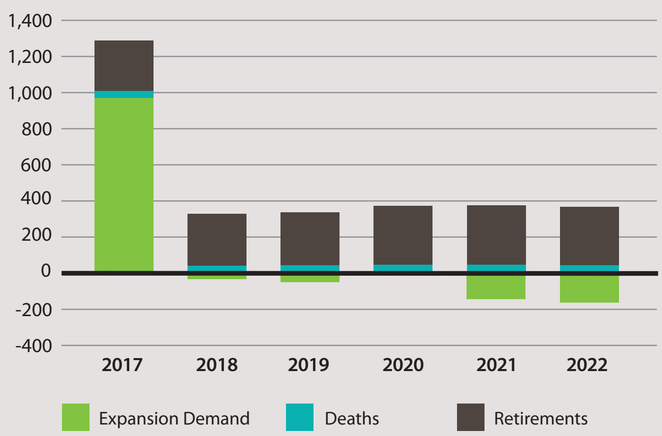


Total recruitment requirements

Recruitment requirements for the sector are influenced by expansion, death and retirement. The data for the Atlantic provinces suggests much of the recruitment requirement from 2019 to 2022 will be due to retirements, which is similar to the picture for Canada overall.

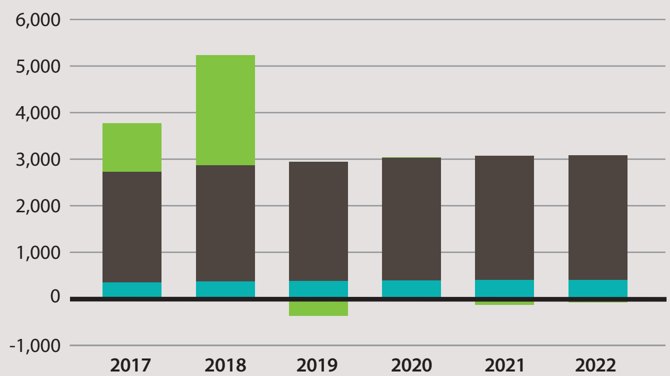
Total Recruitment Requirements: Electricity Sector Occupations, 2017–2022

FIGURE A6.13 Atlantic provinces



Source: C4SE POM Forecast

FIGURE 5.3 Canada



“As the sector becomes more sophisticated, demand will increase for employees able to work in an ever-changing, diverse, interconnected and high-tech electricity sector.“

About the rankings

The LMI model uses demand and supply measures for specific occupations and consolidates them into a market ranking. The model assumes the supply of workers can come from any industry (e.g., an electrician from oil and gas extraction could be employed in electricity). Accordingly, demand and supply measures are calculated for all industries.

Labour market rankings

The labour markets for most electricity sector occupations in Atlantic Canada will be mainly balanced or showing slight excess of supply until 2022. A few occupations in each province will experience periods of slight or high excess demand.

See the legend under Table 8 on page 10 for explanations of the different rankings.

1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

Get more labour market insights into Canada’s electricity and renewables sector along with EHRC’s recommendations for meeting labour challenges. Download *Workforce in Motion: 2017–2022 Labour Market Intelligence Study* at electricityhr.ca/workforce-in-motion today.

TABLE 5 Labour market rankings for New Brunswick, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	2	3	3	3	3	3
Construction managers	2	3	3	3	3	3
Utilities managers	2	3	3	3	3	3
Civil engineers	3	4	4	3	2	2
Mechanical engineers	2	4	3	2	2	2
Electrical and electronics engineers	2	3	3	3	2	2
Information systems analysts and consultants	3	2	2	3	3	3
Database analysts and data administrators	3	3	3	3	3	3
Software engineers and designers	3	2	2	2	2	2
Computer programmers and interactive media developers	3	2	2	2	2	2
Civil engineering technologists and technicians	2	4	4	2	2	2
Mechanical engineering technologists and technicians	2	3	3	3	2	2
Electrical and electronics engineering technologists and technicians	3	3	3	4	3	3
Non-destructive testers and inspection technicians	2	4	4	2	2	2
Engineering inspectors and regulatory officers	3	3	3	4	4	4
Computer network technicians	2	2	2	2	2	2
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	3	3	4	3
Power system electricians	3	3	4	3	2	3
Electrical powerline and cable workers	3	3	4	3	3	3
Construction millwrights and industrial mechanics	3	3	3	3	3	3
Residential and commercial installers and servicers	3	3	3	3	3	3
Public works maintenance Equipment operators and related workers	3	3	4	3	3	3
Power engineers and power systems operators	3	3	3	3	3	3

Source: C4SE POMS Forecast

TABLE 6 Labour market rankings for Prince Edward Island, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	2	3	3	2	2	2
Construction managers	3	4	4	3	3	3
Utilities managers	NA	NA	NA	NA	NA	NA
Civil engineers	3	3	3	3	3	4
Mechanical engineers	3	3	2	2	2	2
Electrical and electronics engineers	2	3	3	3	2	2
Information systems analysts and consultants	3	3	3	3	3	3
Database analysts and data administrators	3	3	3	3	3	3
Software engineers and designers	2	3	3	2	2	2

Continued on the next page

Occupation	2017	2018	2019	2020	2021	2022
Computer programmers and interactive media developers	2	3	2	3	3	3
Civil engineering technologists and technicians	3	2	2	3	3	3
Mechanical engineering technologists and technicians	3	3	2	2	2	2
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	2	3	2	2	2	2
Engineering inspectors and regulatory officers	5	3	3	3	3	3
Computer network technicians	3	2	2	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	3	3	3	3
Power system electricians	NA	NA	NA	NA	NA	NA
Electrical powerline and cable workers	2	3	2	3	3	3
Construction millwrights and industrial mechanics	3	3	3	3	3	3
Residential and commercial installers and servicers	3	4	3	3	3	3
Public works maintenance equipment operators and related workers	3	3	3	4	4	5
Power engineers and power systems operators	2	3	3	3	3	4

Source: C4SE POMS Forecast

TABLE 7 Labour market rankings for Nova Scotia, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	3	3	3	3	3	3
Construction managers	3	3	3	3	3	3
Utilities managers	3	3	3	3	3	3
Civil engineers	4	3	3	3	3	3
Mechanical engineers	3	3	3	3	3	3
Electrical and electronics engineers	4	3	3	3	3	3
Information systems analysts and consultants	3	2	3	3	3	3
Database analysts and data administrators	3	3	3	3	3	3
Software engineers and designers	3	2	3	3	3	3
Computer programmers and interactive media developers	3	2	3	3	3	3
Civil engineering technologists and technicians	3	3	3	3	3	3
Mechanical engineering technologists and technicians	3	3	3	3	3	4
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	3	3	3	3	3	3
Engineering inspectors and regulatory officers	3	3	3	3	4	4
Computer network technicians	3	3	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	3	3	3	3

Continued on the next page

Occupation	2017	2018	2019	2020	2021	2022
Power system electricians	5	3	3	3	2	2
Electrical powerline and cable workers	5	3	3	3	2	2
Construction millwrights and industrial mechanics	2	4	3	3	3	3
Residential and commercial installers and servicers	3	3	3	3	3	3
Public works maintenance Equipment operators and related workers	2	3	3	3	3	3
Power engineers and power systems operators	5	3	3	3	3	3

Source: C4SE POMS Forecast

TABLE 8 Labour market rankings for Newfoundland and Labrador, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	3	3	3	3	3	3
Construction managers	3	3	2	2	3	3
Utilities managers	3	3	3	3	4	4
Civil engineers	3	3	3	3	2	2
Mechanical engineers	2	3	3	3	2	3
Electrical and electronics engineers	3	3	3	3	3	3
Information systems analysts and consultants	3	3	3	3	3	3
Database analysts and data administrators	2	3	3	3	2	2
Software engineers and designers	4	3	3	3	2	2
Computer programmers and interactive media developers	3	3	3	3	2	2
Civil engineering technologists and technicians	2	3	3	3	2	2
Mechanical engineering technologists and technicians	3	3	3	3	2	2
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	2	3	3	3	2	2
Engineering inspectors and regulatory officers	3	3	3	3	3	3
Computer network technicians	3	3	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	2	2	3	3
Power system electricians	3	2	3	2	3	3
Electrical powerline and cable workers	3	2	2	3	3	3
Construction millwrights and industrial mechanics	2	3	3	3	3	3
Residential and commercial installers and servicers	3	3	3	3	2	2
Public works maintenance Equipment operators and related workers	3	3	3	3	3	3
Power engineers and power systems operators	3	3	3	3	4	4

Source: C4SE POMS Forecast

Workforce in Motion

Labour Market Intelligence Study

Factsheet for **British Columbia**

2017–2022

electricity HUMAN RESOURCES CANADA
RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

NEW REALITIES, NEW DIRECTIONS

Trends include: global efforts to reduce greenhouse gas emissions, technological innovations (like smart grids and micro-grids), and automation, which are changing how electricity is delivered, stored and traded. These trends and others will determine the skills and occupations that will be in demand in the years ahead.

A recent labour market intelligence (LMI) study by Electricity Human Resources Canada (EHRC) looked at how the changes underway will affect Canada's electricity workforce in the coming years. This factsheet presents the outlook of that study for British Columbia.

Download the national LMI report, *Workforce in Motion: 2017–2022 Labour Market Intelligence Study*, at electricityhr.ca/workforce-in-motion.

The sector today

EHRC's LMI study looked at how electricity is generated across Canada and measured overall age distribution, percentage of women and level of educational attainment among the almost 9,000 workers in British Columbia's electricity industry.

Existing electrical capacity by fuel type

The vast majority (89%) of British Columbia's electricity is produced through hydro generation. This is an even higher proportion than that seen in the rest of the country.

Existing Electrical Capacity by Type

FIGURE A3.1 British Columbia

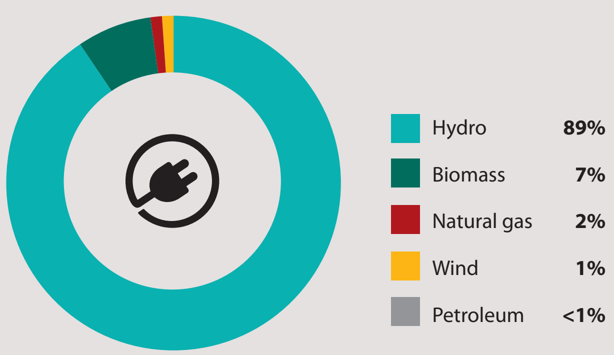
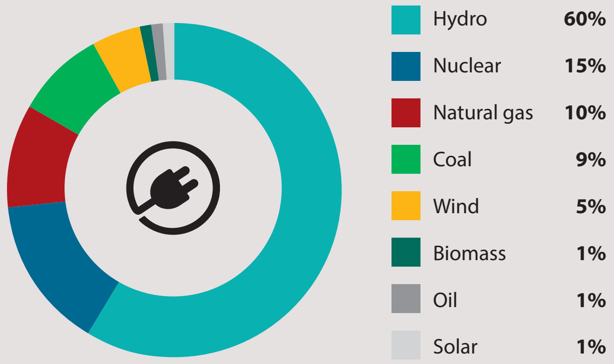


FIGURE 2.2 Canada



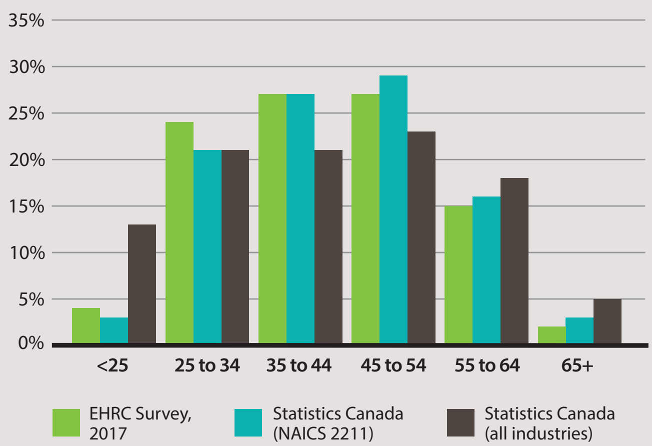
Source: Natural Resources Canada Electricity Facts, 2016

Age distribution

The age profile of workers in British Columbia's electricity sector is almost identical to Canada's overall. With fewer workers under the age of 25 than all other industries in the province, British Columbia's distribution suggests the same need for younger workers seen nationally.

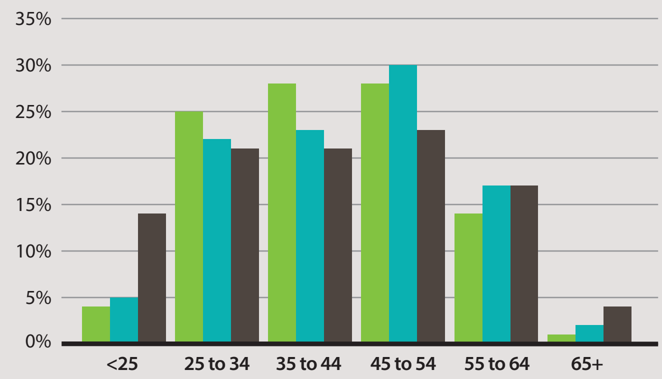
Overall Age Distribution

FIGURE A3.2 British Columbia



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.5 Canada

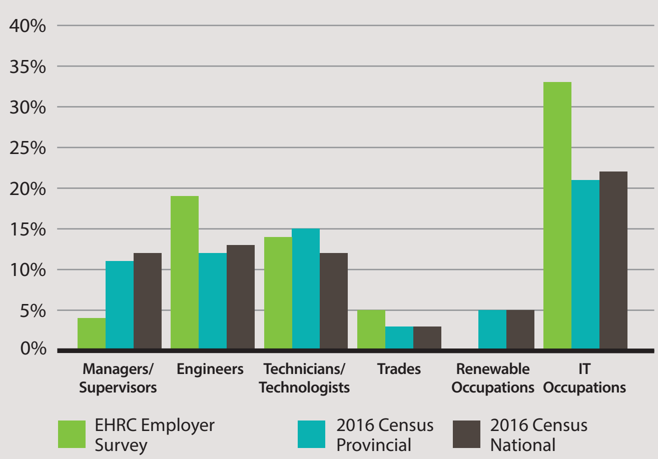


Percentage of women in the workforce

The proportion of women working in British Columbia's electricity industry is similar to the national picture. However, the province has a higher proportion of women in ICT occupations compared to what was reported by employers nationwide.

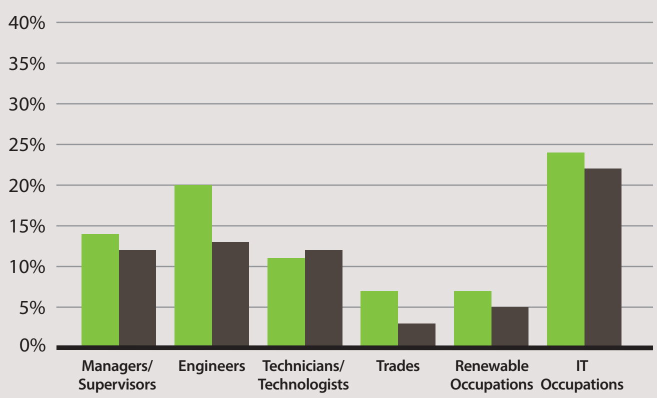
Percent of women in the workforce

FIGURE A3.3 British Columbia



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.3 Canada

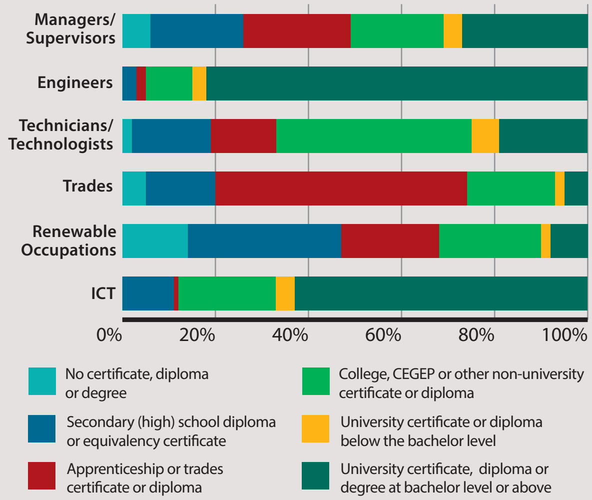


Level of educational attainment

Educational attainment distributions for British Columbia and Canada are similar across all occupational classes.

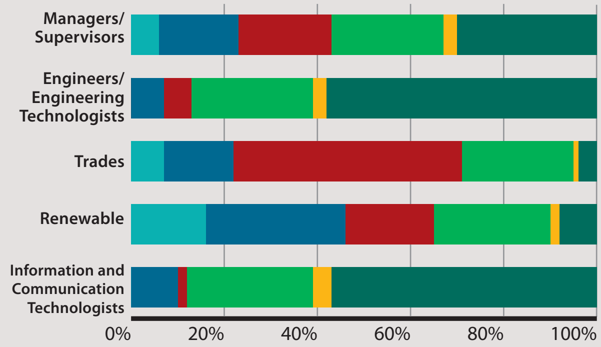
Educational Attainment by Occupational Class

FIGURE A2.4 British Columbia



Source: Statistics Canada

FIGURE 3.7 Canada



"With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities—but they will demand highly specialized personnel with entirely new skill sets."

Looking Ahead

EHRC's LMI study generated forecasts and projections that can help the sector prepare for the impacts of the changes underway.

Supply and demand for occupations

The forecast data for British Columbia's electricity sector suggests it will grow at a higher rate than Canada's electricity sector overall.

TABLE 1 British Columbia's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	81	84	3.70%	0.74%
Construction managers	81	84	3.70%	0.74%
Utilities managers	464	478	3.02%	0.60%
Civil engineers	163	168	3.07%	0.61%
Mechanical engineers	196	202	3.06%	0.61%
Electrical and electronics engineers	598	616	3.01%	0.60%
Information systems analysts and consultants	215	222	3.26%	0.65%
Database analysts and data administrators	29	30	3.45%	0.71%
Software engineers and designers	29	30	3.45%	0.71%
Computer programmers and interactive media developers	14	15	7.14%	1.43%
Civil engineering technologists and technicians	53	54	1.89%	0.38%
Mechanical engineering technologists and technicians	57	59	3.51%	0.70%
Electrical and electronics engineering technologists and technicians	339	350	3.24%	0.65%
Engineering inspectors and regulatory officers	10	10	0.00%	0.00%
Computer network technicians	81	84	3.70%	0.74%
Contractors and supervisors, electrical trades and telecommunications occupations	115	118	2.61%	0.52%
Power system electricians	382	395	3.40%	0.68%
Electrical powerline and cable workers	650	671	3.23%	0.67%
Construction millwrights and industrial mechanics	148	153	3.38%	0.67%
Residential and commercial installers and servicers	10	10	0.00%	0.00%
Public works maintenance equipment operators and related workers	24	25	4.17%	0.83%
Power engineers and power systems operators	416	429	3.13%	0.62%
Electricity sector occupations	**4,155**	**4,287**	**3.18%**	**0.63%**
Other occupations	**4,145**	**4,274**	**3.11%**	**0.62%**
Total	**8,300**	**8,561**	**3.14%**	**0.63%**

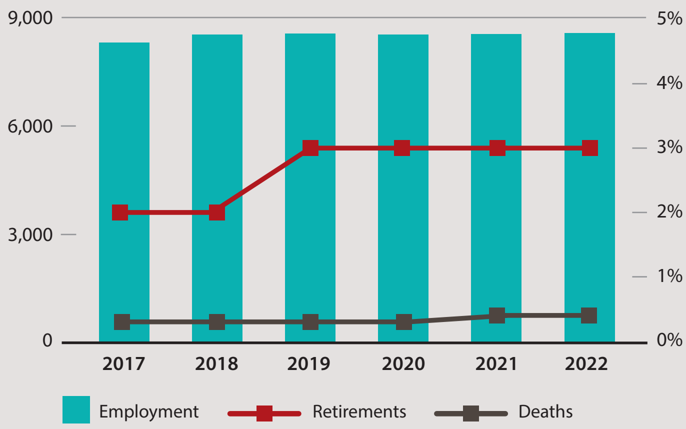
Source: C4SE POMS Forecast

Retirement

A consistent proportion of 2% to 3% of British Columbia's electricity workforce is projected to retire each year from 2017 to 2022. This is similar to the retirement projections for Canada overall.

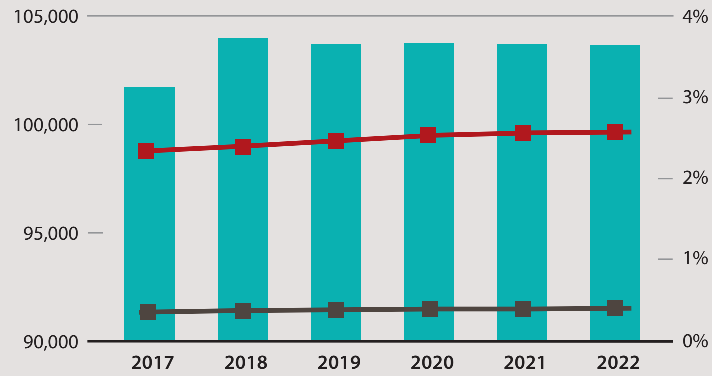
Retirement Projections for the Electricity Industry Workforce

FIGURE A3.6 British Columbia



Source: C4SE POM Forecast

FIGURE 5.2 Canada

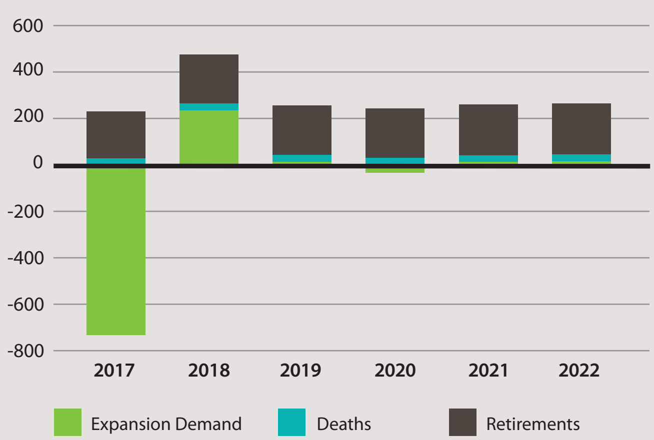


Total recruitment requirements

Recruitment requirements for the sector are influenced by expansion, death and retirement. The data for British Columbia suggests much of the recruitment requirement from 2019 to 2022 will be due to retirements, which is similar to the picture for Canada overall.

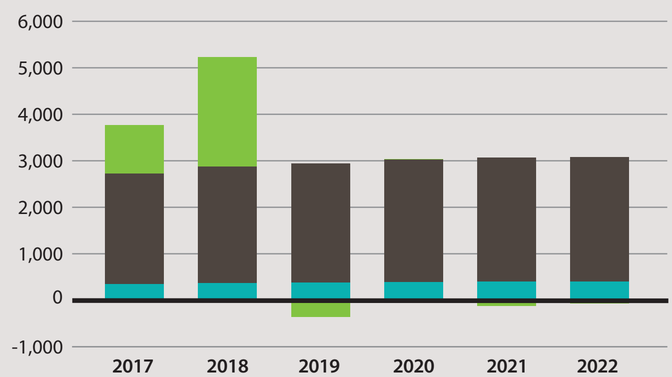
Total Recruitment Requirements: Electricity Sector Occupations, 2017–2022

FIGURE A4.7 British Columbia



Source: C4SE POM Forecast

FIGURE 5.3 Canada



"As the sector becomes more sophisticated, demand will increase for employees able to work in an ever-changing, diverse, interconnected and high-tech electricity sector."

About the rankings

The LMI model uses demand and supply measures for specific occupations and consolidates them into a market ranking. The model assumes the supply of workers can come from any industry (e.g., an electrician from oil and gas extraction could be employed in electricity). Accordingly, demand and supply measures are calculated for all industries.

Labour market rankings

The labour markets for electricity sector occupations in British Columbia will be mainly balanced until 2022. However, some occupations, including civil engineers, testers and inspection technicians, engineering inspectors, and regulatory officers, will show prolonged slight or high excess demand.

See the legend under Table 2 on the following page for explanations of the different rankings.

1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
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TABLE 2 Labour market rankings for British Columbia, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	2	3	3	3	3	3
Construction managers	4	3	3	3	2	2
Utilities managers	2	3	3	3	3	3
Civil engineers	2	4	5	5	3	3
Mechanical engineers	2	3	3	3	2	2
Electrical and electronics engineers	2	3	3	3	3	2
Information systems analysts and consultants	3	3	3	3	3	3
Database analysts and data administrators	3	3	3	3	3	3
Software engineers and designers	2	3	3	3	3	2
Computer programmers and interactive media developers	3	2	3	3	3	2
Civil engineering technologists and technicians	2	3	4	3	3	2
Mechanical engineering technologists and technicians	2	3	3	3	2	2
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	2	4	5	5	3	4
Engineering inspectors and regulatory officers	3	3	5	5	4	4
Computer network technicians	3	3	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	3	3	3	3
Power system electricians	2	3	3	4	3	2
Electrical powerline and cable workers	2	3	3	5	3	2
Construction millwrights and industrial mechanics	2	3	3	2	3	4
Residential and commercial installers and servicers	3	3	2	2	2	2
Public works maintenance Equipment operators and related workers	2	2	3	4	4	3
Power engineers and power systems operators	3	3	3	3	3	4

Source: C4SE POMS Forecast

Workforce in Motion

Labour Market Intelligence Study

Factsheet for Manitoba and Saskatchewan

2017–2022

electricity HUMAN RESOURCES CANADA

RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

NEW REALITIES, NEW DIRECTIONS

Trends include: global efforts to reduce greenhouse gas emissions, technological innovations (like smart grids and micro-grids), and automation, which are changing how electricity is delivered, stored and traded. These trends and others will determine the skills and occupations that will be in demand in the years ahead.

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The sector today

EHRC's LMI study looked at how electricity is generated across Canada and measured overall age distribution, percentage of women and level of educational attainment among the more than 10,200 workers in Manitoba and Saskatchewan's electricity industry.

Existing electrical capacity by fuel type

Almost all of Manitoba's electricity is generated by renewable sources — primarily hydro — with less than 1% generated by fossil fuels. In Saskatchewan, coal accounts for nearly half of the province's electricity generation, and another third is generated by natural gas.

Existing Electrical Capacity by Type

FIGURE A5.1 Manitoba

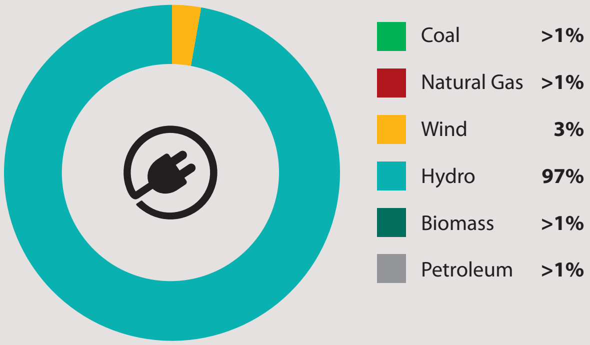


FIGURE A5.2 Saskatchewan

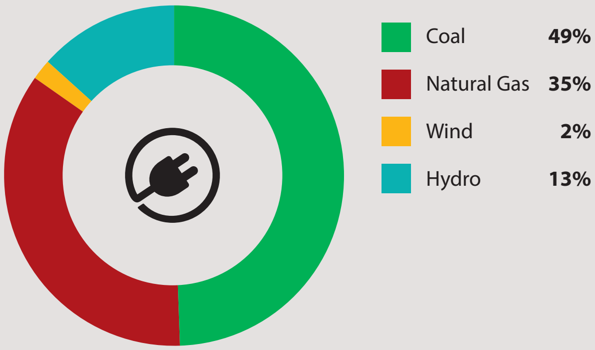
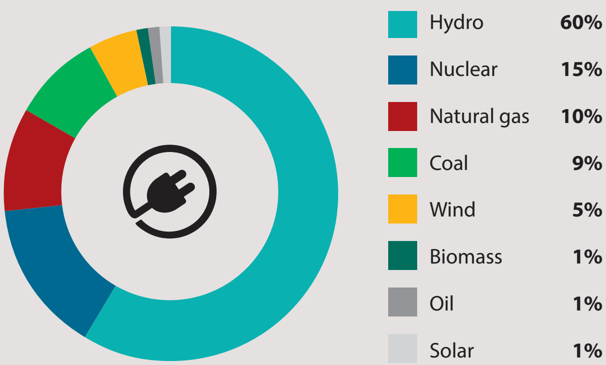


FIGURE 2.2 Canada



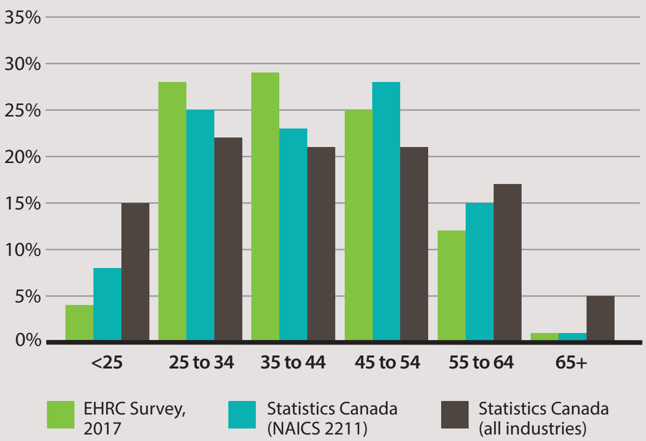
Source: National Resources Canada Electrity Fact, 2016.

Age distribution

The age profile of workers in Manitoba and Saskatchewan's electricity sector is similar to Canada's overall. With fewer workers under the age of 25 than all other industries in both provinces, Manitoba and Saskatchewan's distribution suggests the same need for younger workers seen nationally.

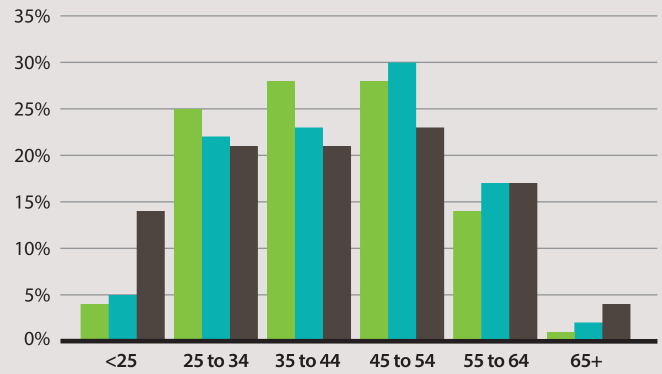
Overall Age Distribution

FIGURE A5.3 Manitoba and Saskatchewan



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.5 Canada

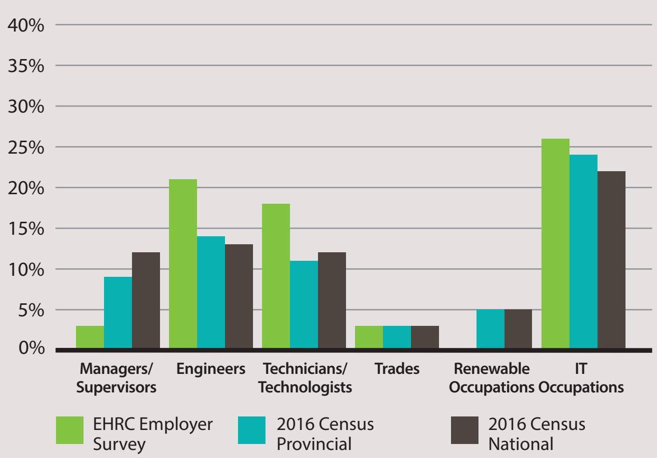


Percentage of women in the workforce

Overall, the proportion of women working in Manitoba and Saskatchewan's electricity industry is similar to the national picture. However, employers in these provinces reported a smaller proportion of women in management as well as higher proportions of women working as engineers and technicians/technologists compared to what was reported by employers nationwide.

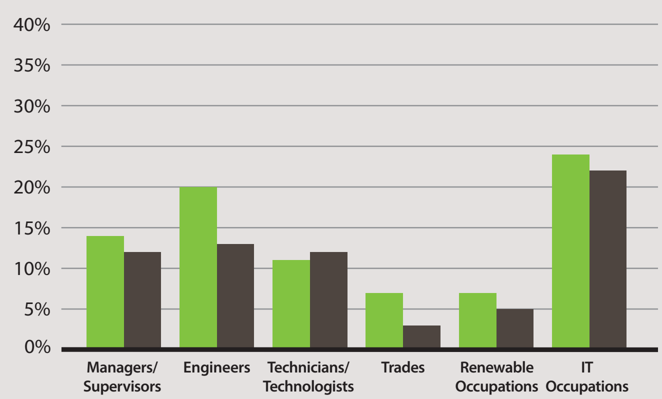
Percent of women in the workforce

FIGURE A5.4 Manitoba and Saskatchewan



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.3 Canada

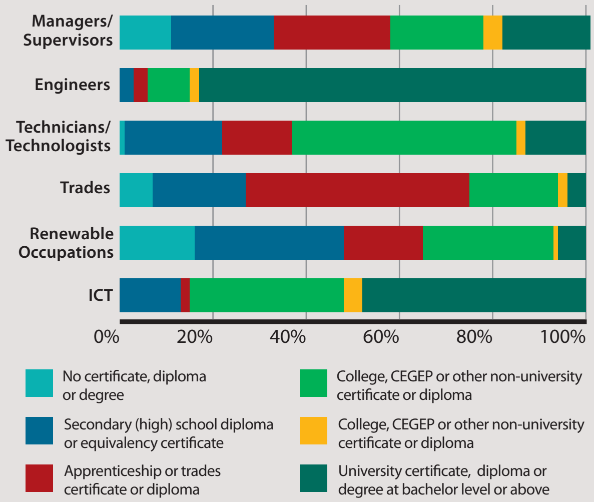


Level of educational attainment

Educational attainment distributions for Manitoba and Saskatchewan are similar to those for the rest of Canada across all occupational classes.

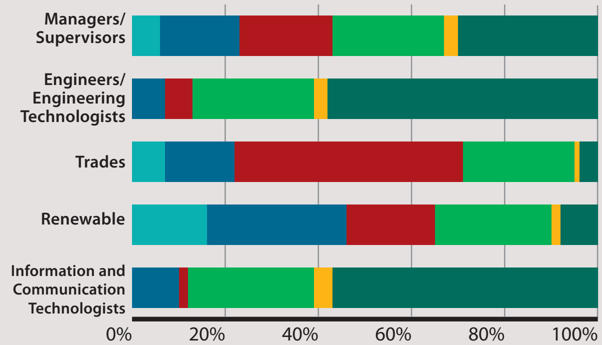
Educational Attainment by Occupational Class

FIGURE A5.5 Manitoba and Saskatchewan



Source: Statistics Canada

FIGURE 3.7 Canada



"With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities—but they will demand highly specialized personnel with entirely new skill sets."

Looking Ahead

EHRC's LMI study generated forecasts and projections that can help the sector prepare for the impacts of the changes underway.

Supply and demand for occupations

The forecast data for Manitoba's electricity sector suggests it will grow slightly faster than the national rate, while Saskatchewan's will contract.

TABLE 1 Manitoba's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	23	23	0.00%	0.00%
Construction managers	11	12	9.09%	1.82%
Utilities managers	192	199	3.65%	0.72%
Civil engineers	232	240	3.45%	0.68%
Mechanical engineers	102	105	2.94%	0.58%
Electrical and electronics engineers	328	339	3.35%	0.66%
Information systems analysts and consultants	102	105	2.94%	0.58%
Database analysts and data administrators	23	23	0.00%	0.00%
Software engineers and designers	11	12	9.09%	1.82%
Computer programmers and interactive media developers	102	105	2.94%	0.58%
Civil engineering technologists and technicians	102	105	2.94%	0.58%
Mechanical engineering technologists and technicians	45	47	4.44%	0.88%
Electrical and electronics engineering technologists and technicians	368	380	3.26%	0.64%
Engineering inspectors and regulatory officers	11	12	9.09%	1.82%
Computer network technicians	57	58	1.75%	0.35%
Contractors and supervisors, electrical trades and telecommunications occupations	90	94	4.44%	0.88%
Power system electricians	288	298	3.47%	0.69%
Electrical powerline and cable workers	639	661	3.44%	0.68%
Construction millwrights and industrial mechanics	119	123	3.36%	0.67%
Residential and commercial installers and servicers	11	12	9.09%	1.82%
Public works maintenance equipment operators and related workers	62	64	3.23%	0.64%
Power engineers and power systems operators	351	363	3.42%	0.68%
Electricity sector occupations	**3,269**	**3,380**	**3.40%**	**0.67%**
Other occupations	**4,231**	**4,375**	**3.40%**	**0.67%**
Total	**7,500**	**7,755**	**3.40%**	**0.67%**

Source: C4SE POMS Forecast

TABLE 2 Saskatchewan's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	32	32	0.00%	0.00%
Construction managers	45	45	0.00%	0.00%
Utilities managers	240	237	-1.25%	-0.25%
Civil engineers	32	32	0.00%	0.00%
Mechanical engineers	65	64	-1.54%	-0.30%
Electrical and electronics engineers	208	205	-1.44%	-0.29%
Information systems analysts and consultants	91	90	-1.10%	-0.22%
Computer programmers and interactive media developers	13	13	0.00%	0.00%
Civil engineering technologists and technicians	19	19	0.00%	0.00%
Mechanical engineering technologists and technicians	13	13	0.00%	0.00%
Electrical and electronics engineering technologists and technicians	169	166	-1.78%	-0.35%
Engineering inspectors and regulatory officers	13	13	0.00%	0.00%
Computer network technicians	19	19	0.00%	0.00%
Contractors and supervisors, electrical trades and telecommunications occupations	39	38	-2.56%	-0.50%
Power system electricians	110	109	-0.91%	-0.18%
Electrical powerline and cable workers	494	486	-1.62%	-0.32%
Construction millwrights and industrial mechanics	156	154	-1.28%	-0.26%
Public works maintenance equipment operators and related workers	19	19	0.00%	0.00%
Power engineers and power systems operators	338	333	-1.48%	-0.29%
Electricity sector occupations	**2,115**	**2,087**	**-1.32%**	**-0.26%**
Other occupations	**2,485**	**2,442**	**-1.73%**	**-0.34%**
Total	**4,600**	**4,529**	**-1.54%**	**-0.31%**

Source: C4SE POMS Forecast

Retirement

Manitoba and Saskatchewan's electricity workforce is projected to retire at a rate of about 5% each year from 2017 to 2022. This is higher than the retirement projections for Canada overall.

Retirement Projections for the Electricity Industry Workforce

FIGURE A5.8 Manitoba and Saskatchewan

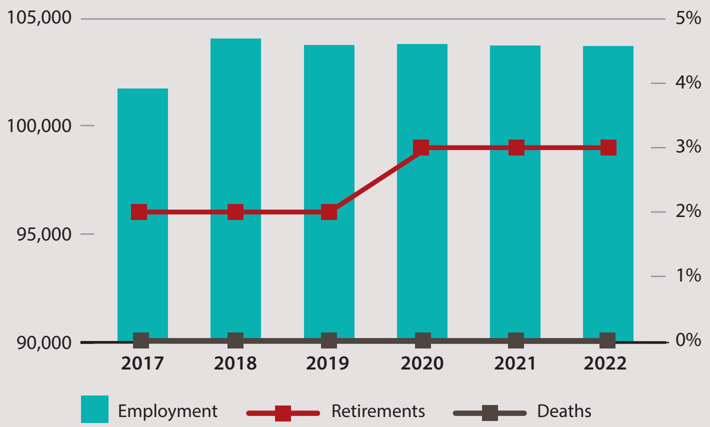
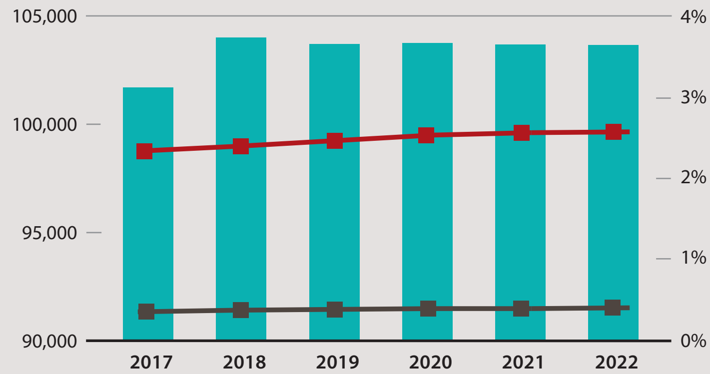


FIGURE 5.2 Canada



Source: C4SE POM Forecast

Total recruitment requirements

Recruitment requirements for the sector are influenced by expansion, death and retirement. The data for Manitoba and Saskatchewan suggests much of the recruitment requirements from 2019 to 2022 will be due to retirements, which is similar to the picture of Canada overall.

Total Recruitment Requirements: Electricity Sector Occupations, 2017–2022

FIGURE A5.9 Manitoba and Saskatchewan

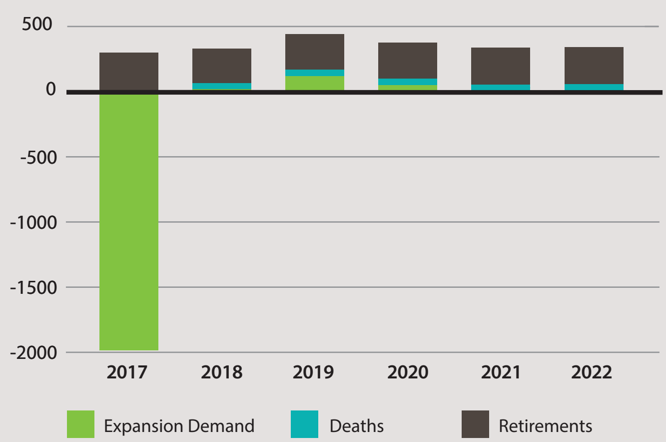
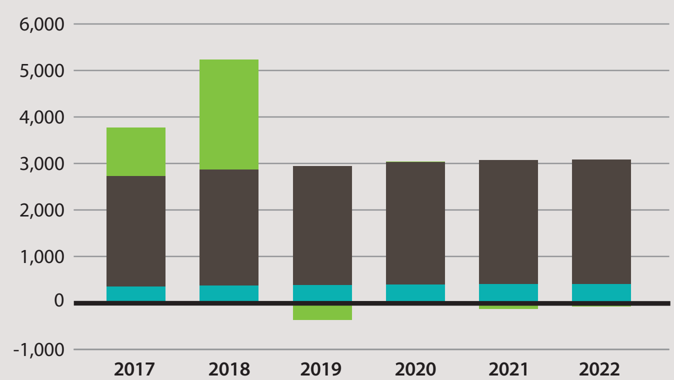


FIGURE 5.3 Canada



Source: C4SE POM Forecast

"As the sector becomes more sophisticated, demand will increase for employees able to work in an ever-changing, diverse, interconnected and high-tech electricity sector."

About the rankings

The LMI model uses demand and supply measures for specific occupations and consolidates them into a market ranking. The model assumes the supply of workers can come from any industry (e.g., an electrician from oil and gas extraction could be employed in electricity). Accordingly, demand and supply measures are calculated for all industries.

Labour market rankings

The labour markets for most electricity sector occupations in Manitoba and Saskatchewan will be mainly balanced or showing slight excess of supply until 2022.

See the legend under Table 2 on the following page for explanations of the different rankings.

1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

Get more labour market insights into Canada's electricity and renewables sector along with EHRC's recommendations for meeting labour challenges. Download *Workforce in Motion: 2017–2022 Labour Market Intelligence Study* at electricityhr.ca/workforce-in-motion today.

TABLE 3 Labour market rankings for Manitoba, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	3	3	3	3	3	3
Construction managers	3	3	3	3	3	3
Utilities managers	2	3	3	3	3	3
Civil engineers	3	3	3	3	2	2
Mechanical engineers	3	3	3	3	3	3
Electrical and electronics engineers	3	3	3	3	3	3
Information systems analysts and consultants	4	3	2	3	3	3
Database analysts and data administrators	3	3	2	3	3	3
Software engineers and designers	5	2	2	2	2	2
Computer programmers and interactive media developers	4	2	2	2	2	2
Civil engineering technologists and technicians	3	3	3	2	2	2
Mechanical engineering technologists and technicians	3	3	2	2	2	3
Electrical and electronics engineering technologists and technicians	2	3	3	3	3	3
Non-destructive testers and inspection technicians	2	3	2	2	3	3
Engineering inspectors and regulatory officers	3	3	3	3	2	3
Computer network technicians	3	3	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	3	3	3	3
Power system electricians	2	3	3	2	2	2
Electrical powerline and cable workers	2	3	3	2	2	2
Construction millwrights and industrial mechanics	3	3	3	3	3	3
Residential and commercial installers and servicers	3	3	3	2	2	3
Public works maintenance Equipment operators and related workers	3	3	3	3	3	3
Power engineers and power systems operators	2	3	4	4	4	4

Source: C4SE POMS Forecast

TABLE 4 Labour market rankings for Saskatchewan, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	2	2	3	3	3	3
Construction managers	2	2	2	2	3	4
Utilities managers	2	2	3	3	3	3
Civil engineers	3	3	3	2	2	3
Mechanical engineers	3	3	3	3	3	2
Electrical and electronics engineers	3	3	3	3	3	2
Information systems analysts and consultants	3	3	3	3	3	3
Database analysts and data administrators	3	3	3	3	3	3
Software engineers and designers	3	2	3	2	2	2
Computer programmers and interactive media developers	3	2	2	2	2	2
Civil engineering technologists and technicians	3	3	3	2	2	2
Mechanical engineering technologists and technicians	3	3	2	2	2	2
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	3	3	3	2	2	2
Engineering inspectors and regulatory officers	3	3	3	3	3	3
Computer network technicians	3	3	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	2	2	3	2	2	4
Power system electricians	2	3	3	3	2	3
Electrical powerline and cable workers	2	3	2	2	2	2
Construction millwrights and industrial mechanics	3	3	3	3	3	3
Residential and commercial installers and servicers	3	2	2	2	2	3
Public works maintenance Equipment operators and related workers	3	3	3	3	3	3
Power engineers and power systems operators	2	3	3	2	2	2

Source: C4SE POMS Forecast

Workforce in Motion

Labour Market Intelligence Study

Factsheet for
Ontario

2017–2022

electricity HUMAN RESOURCES CANADA

RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

NEW REALITIES, NEW DIRECTIONS

Trends include: global efforts to reduce greenhouse gas emissions, technological innovations (like smart grids and micro-grids), and automation, which are changing how electricity is delivered, stored and traded. These trends and others will determine the skills and occupations that will be in demand in the years ahead.

A recent labour market intelligence (LMI) study by Electricity Human Resources Canada (EHRC) looked at how the changes underway will affect Canada's electricity workforce in the coming years. This factsheet presents the outlook of that study for Ontario.

Download the national LMI report, *Workforce in Motion: 2017–2022 Labour Market Intelligence Study*, at electricityhr.ca/workforce-in-motion.

The sector today

EHRC's LMI study looked at how electricity is generated across Canada and measured overall age distribution, percentage of women and level of educational attainment among the more than 40,000 workers in Ontario's electricity industry.

Existing electrical capacity by fuel type

Ontario is one of only two provinces (along with New Brunswick) to generate electricity through nuclear power, which makes up more than half of its existing electrical capacity. Nationally, hydro continues to dominate Canada's renewable energy capacity.

Existing Electrical Capacity by Type

FIGURE A1.1 Ontario

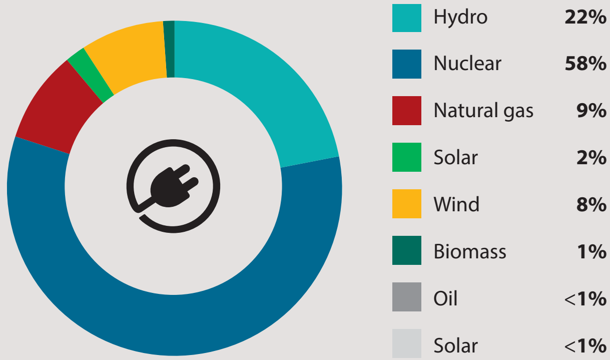
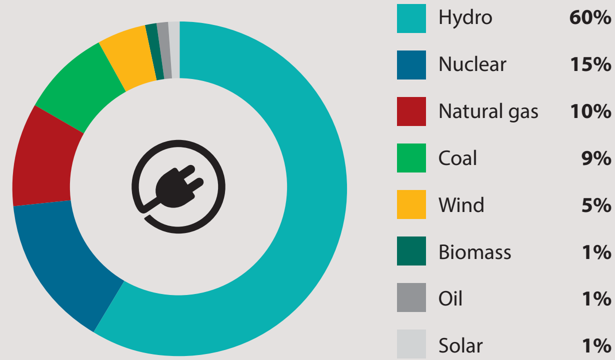


FIGURE 2.2 Canada



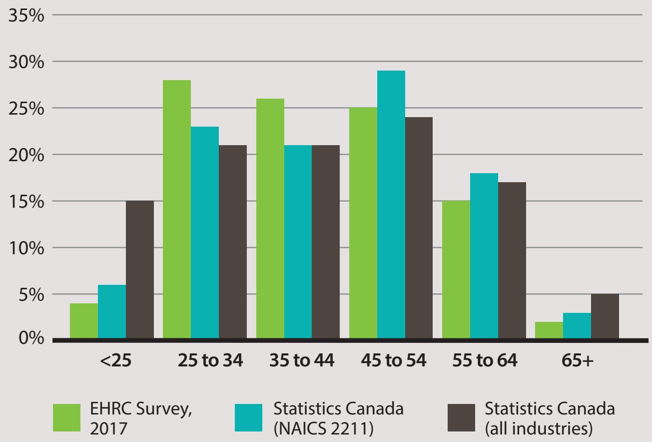
Source: Natural Resources Canada Electricity Facts, 2016

Age distribution

The age profile of workers in Ontario's electricity sector is similar to Canada's overall. With fewer workers under the age of 25 than all other industries in the province, Ontario's distribution suggests the same need for younger workers seen nationally.

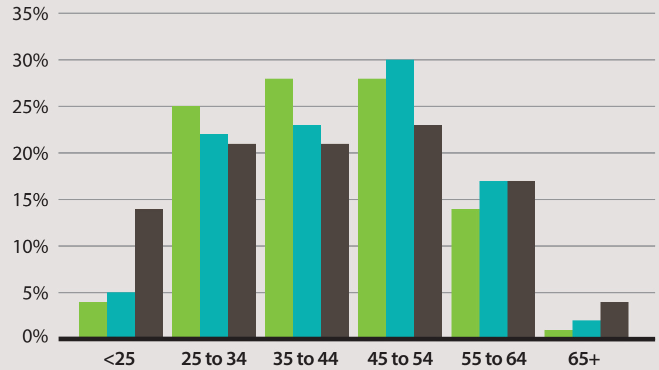
Overall Age Distribution

FIGURE A1.2 Ontario



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.5 Canada

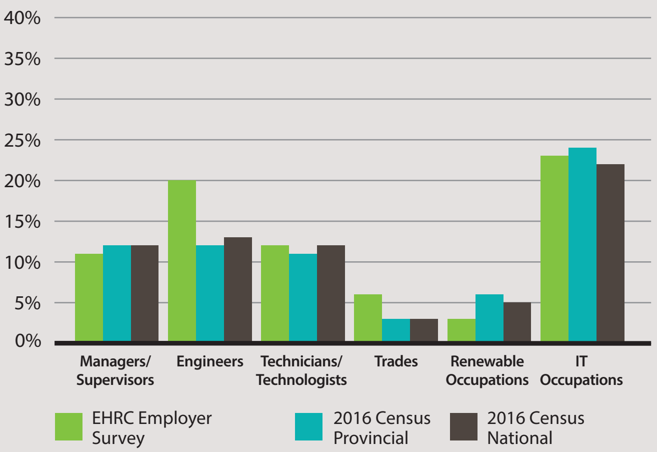


Percentage of women in the workforce

The proportion of women working in Ontario's electricity industry is similar to the national picture. Accordingly, there is need to increase the number of women working in the sector in Ontario.

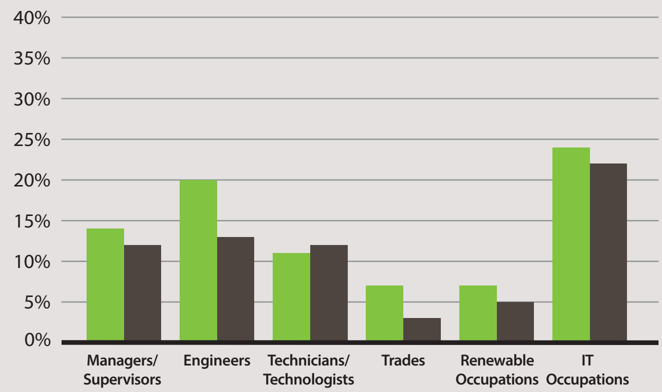
Percent of women in the workforce

FIGURE A1.3 Ontario



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.3 Canada

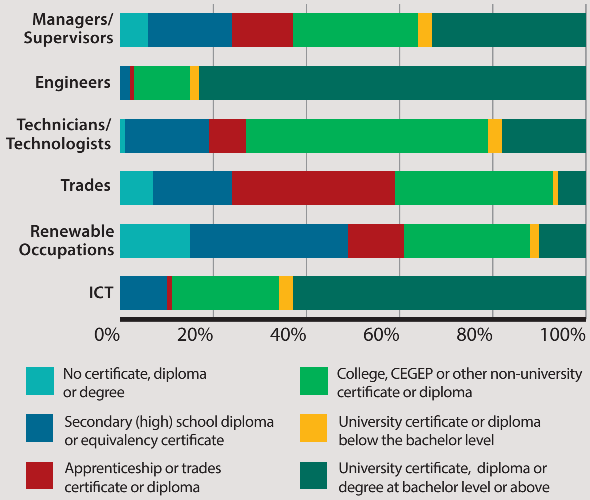


Level of educational attainment

Educational attainment distributions for Ontario and Canada are similar. A key difference is the proportion of workers with a university degree: 82% in Ontario versus 59% in Canada overall.

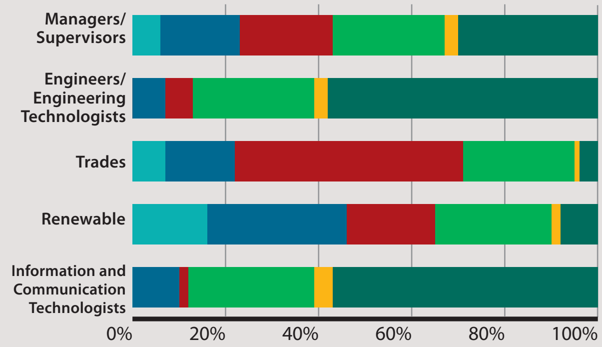
Educational Attainment by Occupational Class

FIGURE A1.4 Ontario



Source: Statistics Canada

FIGURE 3.7 Canada



"With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities—but they will demand highly specialized personnel with entirely new skill sets."

Looking Ahead

EHRC's LMI study generated forecasts and projections that can help the sector prepare for the impacts of the changes underway.

Supply and demand for occupations

The forecast data for Ontario's electricity sector suggests it will grow at approximately half the growth rate for Canada's electricity sector overall.

TABLE 1 Ontario's current and forecasted employment by occupation, 2017 and 2022

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	378	381	0.79%	0.18%
Construction managers	131	132	0.76%	0.17%
Utilities managers	1,371	1,383	0.88%	0.20%
Civil engineers	291	293	0.69%	0.16%
Mechanical engineers	1,337	1,349	0.90%	0.20%
Electrical and electronics engineers	1,647	1,661	0.85%	0.19%
Information systems analysts and consultants	625	630	0.80%	0.18%
Database analysts and data administrators	58	59	1.72%	0.37%
Software engineers and designers	82	83	1.22%	0.27%
Computer programmers and interactive media developers	97	98	1.03%	0.23%
Civil engineering technologists and technicians	199	200	0.50%	0.12%
Mechanical engineering technologists and technicians	663	669	0.90%	0.20%
Electrical and electronics engineering technologists and technicians	1,487	1,500	0.87%	0.20%
Non-destructive testers and inspection technicians	87	88	1.15%	0.26%
Engineering inspectors and regulatory officers	19	20	5.26%	1.05%
Computer network technicians	184	186	1.09%	0.24%
Contractors and supervisors, electrical trades and telecommunications occupations	494	498	0.81%	0.18%
Power system electricians	1,230	1,241	0.89%	0.20%
Electrical power line and cable workers	2,620	2,644	0.92%	0.20%
Construction millwrights and industrial mechanics	1,041	1,051	0.96%	0.21%
Residential and commercial installers and servicers	145	147	1.38%	0.29%
Public works maintenance Equipment operators and related workers	538	542	0.74%	0.17%
Power engineers and power systems operators	3,763	3,797	0.90%	0.20%
Electricity sector occupations	**18,487**	**18,652**	**0.89%**	**0.20%**
Other occupations	**19,313**	**19,487**	**0.90%**	**0.20%**
Total	**37,800**	**38,139**	**0.90%**	**0.20%**

Source: C4SE POMS Forecast

Retirement

A consistent proportion of 2% to 3% of Ontario's electricity workforce is projected to retire each year from 2017 to 2022. This is similar to the retirement projections for Canada overall.

Retirement Projections for the Electricity Industry Workforce

FIGURE A1.6 Ontario

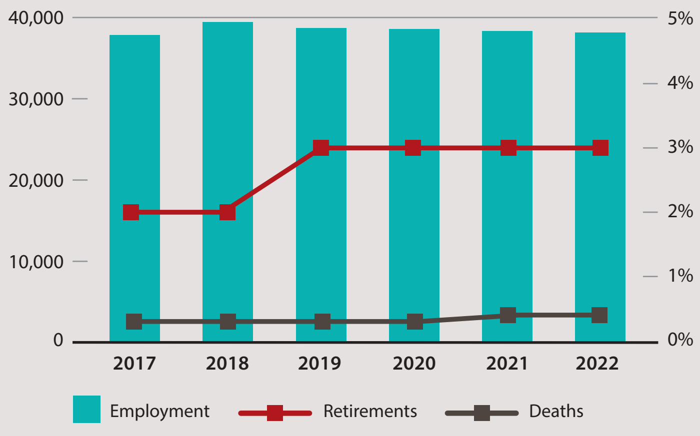
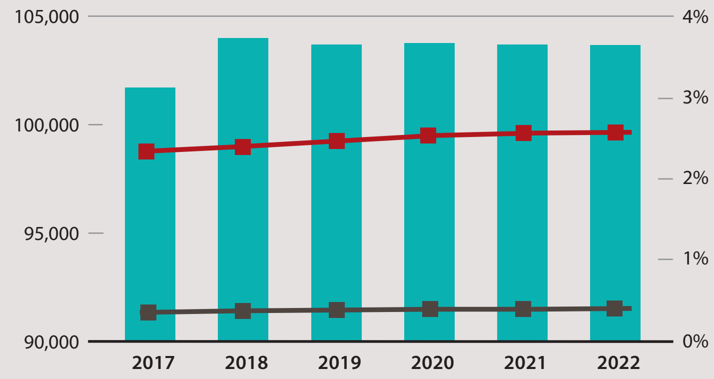


FIGURE 5.2 Canada



Source: C4SE POM Forecast

Total recruitment requirements

Recruitment requirements for the sector are influenced by expansion, death and retirement. The data for Ontario suggests much of the recruitment requirements from 2019 to 2022 will be due to retirements, which is similar to the picture for Canada overall.

Total Recruitment Requirements: Electricity Sector Occupations, 2017–2022

FIGURE A1.7 Ontario

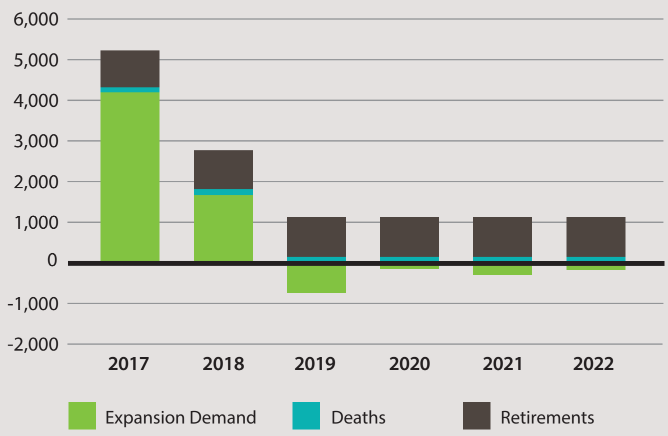
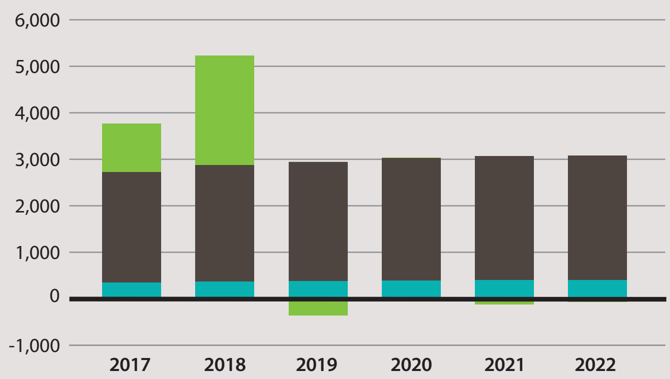


FIGURE 5.3 Canada



Source: C4SE POM Forecast

"As the sector becomes more sophisticated, demand will increase for employees able to work in an ever-changing, diverse, interconnected and high-tech electricity sector."

About the rankings

The LMI model uses demand and supply measures for specific occupations and consolidates them into a market ranking. The model assumes the supply of workers can come from any industry (e.g., an electrician from oil and gas extraction could be employed in electricity). Accordingly, demand and supply measures are calculated for all industries.

Labour market rankings

The labour markets for electricity sector occupations in Ontario will be mainly balanced or show a slight excess of supply. Engineers (civil, mechanical electrical), information systems analysis, inspection technicians, regulatory officers, power systems electricians and power line cable workers will show slight or high excess of demand prior to 2021.

See the legend under Table 2 on the following page for explanations of the different rankings.

1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

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TABLE 2 Labour market rankings for Ontario, 2017 to 2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	3	3	3	3	3	3
Construction managers	3	3	2	2	2	2
Utilities managers	2	3	2	3	3	3
Civil engineers	2	5	4	4	3	3
Mechanical engineers	3	4	3	3	3	3
Electrical and electronics engineers	3	4	3	3	3	3
Information systems analysts and consultants	4	2	3	3	3	3
Database analysts and data administrators	3	2	3	3	3	3
Software engineers and designers	4	2	2	2	3	3
Computer programmers and interactive media developers	4	2	2	2	3	3
Civil engineering technologists and technicians	2	3	3	3	3	2
Mechanical engineering technologists and technicians	3	3	3	3	2	2
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	2	4	4	3	3	3
Engineering inspectors and regulatory officers	3	3	4	3	3	3
Computer network technicians	3	2	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	2	2	2	2
Power system electricians	4	4	2	2	2	2
Electrical power line and cable workers	4	4	2	2	2	2
Construction millwrights and industrial mechanics	3	3	3	3	3	3
Residential and commercial installers and servicers	3	3	2	2	2	3
Public works maintenance Equipment operators and related workers	2	3	3	3	3	3
Power engineers and power systems operators	4	4	2	3	3	3

Source: C4SE POMS Forecast

Workforce in Motion

Labour Market Intelligence Study

Factsheet for Quebec

2017–2022

electricity HUMAN RESOURCES CANADA
RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

Canada

NEW REALITIES, NEW DIRECTIONS

Trends include: global efforts to reduce greenhouse gas emissions, technological innovations (like smart grids and micro-grids), and automation, which are changing how electricity is delivered, stored and traded. These trends and others will determine the skills and occupations that will be in demand in the years ahead.

A recent labour market intelligence (LMI) study by Electricity Human Resources Canada (EHRC) looked at how the changes underway will affect Canada's electricity workforce in the coming years. This factsheet presents the outlook of that study for Quebec.

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The sector today

EHRC's LMI study looked at how electricity is generated across Canada and measured overall age distribution, percentage of women and level of educational attainment among the almost 25,000 workers in Quebec's electricity industry.

Existing electrical capacity by fuel type

The vast majority (95%) of Quebec's electricity is produced through hydro generation. This is an even higher proportion than that seen in the rest of the country.

Existing Electrical Capacity by Type

FIGURE A2.1 Quebec

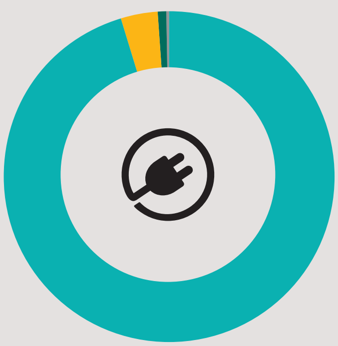
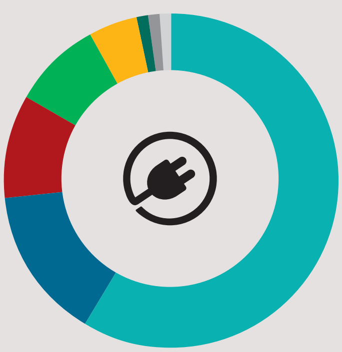


FIGURE 2.2 Canada



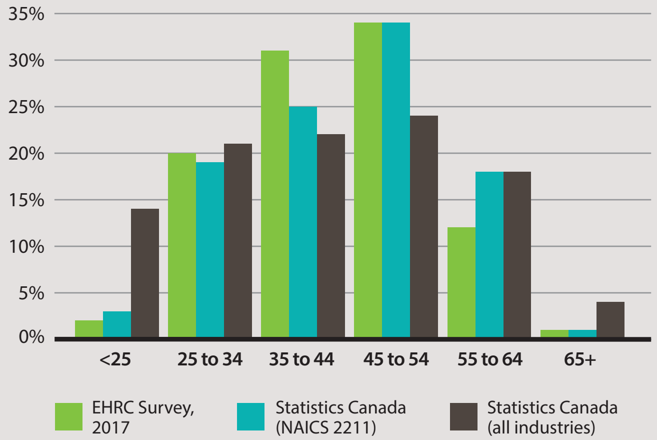
Source: Natural Resources Canada Electricity Facts, 2016

Age distribution

Electricity workers in Quebec are slightly older than the national workforce. The proportion of workers between the ages of 45 and 52 is higher than the national average, while the average of workers under the age of 25 is almost half the national rate and considerably lower than all other industries in the province. This suggests an even greater need for younger workers than across Canada overall.

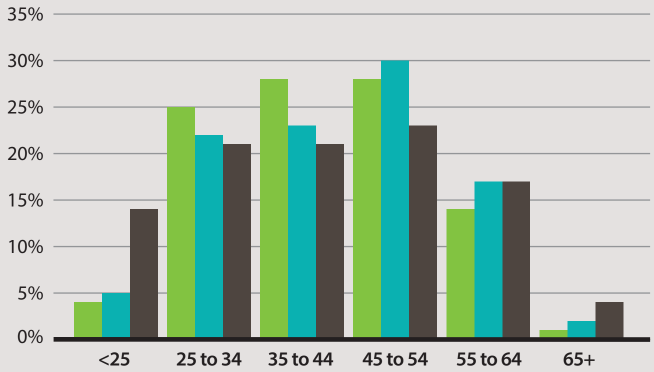
Overall Age Distribution uebec

FIGURE A2.2 Quebec



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.5 Canada

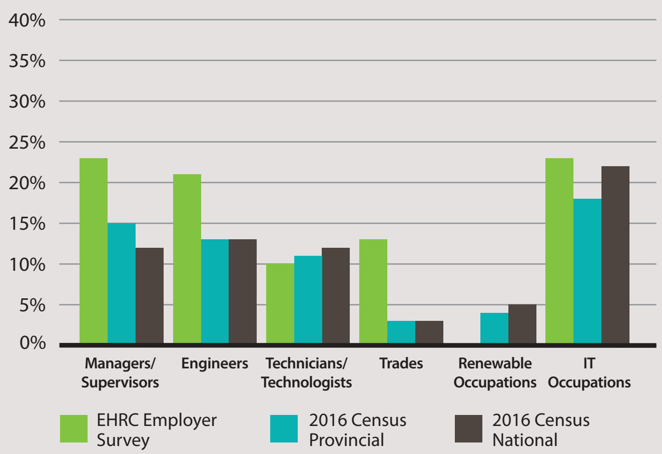


Percentage of women in the workforce

The representation of women in Quebec's electricity workforce is more robust than in the rest of Canada. Employer-reported data showed at least comparable female representation across all occupation groups — and almost twice the national proportion of women among managers and supervisors as well as a much higher proportion of women in the trades.

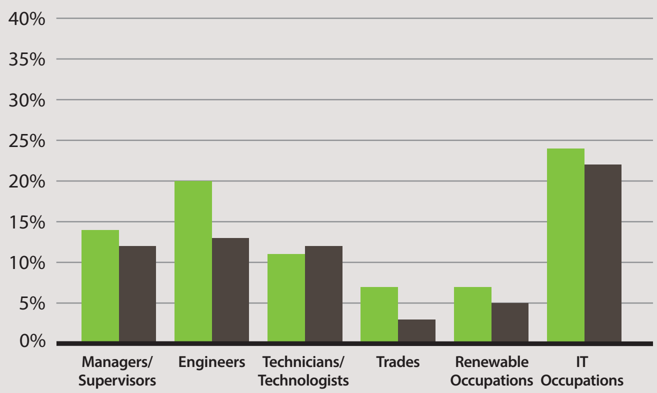
Percent of women in the workforce

FIGURE A2.3 Quebec



Source: EHRC Employer Survey, 2017; Statistics Canada

FIGURE 3.3 Canada

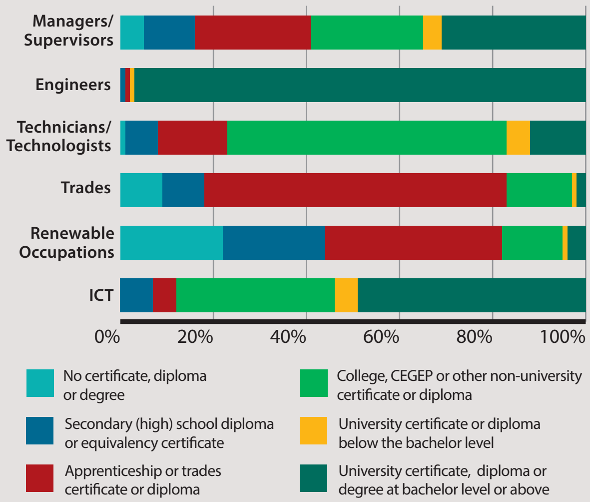


Level of educational attainment

Educational attainment distributions for Quebec and Canada are similar. A key difference is the proportion of engineers with a university degree: 92% in Quebec versus 85% in Canada overall.

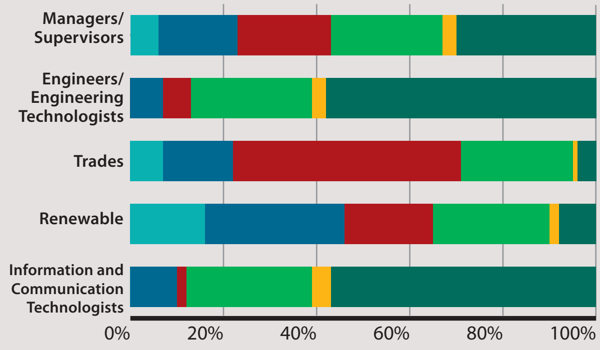
Educational Attainment by Occupational Class

FIGURE A2.4 Quebec



Source: Statistics Canada

FIGURE 3.7 Canada



"With rising investment in the sector and a shift toward renewable energy sources, there will be plenty of new opportunities—but they will demand highly specialized personnel with entirely new skill sets."

Looking Ahead

EHRC's LMI study generated forecasts and projections that can help the sector prepare for the impacts of the changes underway.

Supply and demand for occupations

The forecast data for Quebec's electricity sector suggests it will grow at a substantially lower rate than Canada's electricity sector overall.

TABLE 1 **Quebec's current and forecasted employment by occupation, 2017 and 2022**

Description	2017	2022	% growth 2018–2022	Average annual growth rate
Engineering managers	74	74	0.00%	0.01%
Construction managers	139	139	0.00%	0.01%
Utilities managers	446	448	0.45%	0.10%
Civil engineers	424	426	0.47%	0.10%
Mechanical engineers	303	304	0.33%	0.08%
Electrical and electronics engineers	974	978	0.41%	0.09%
Information systems analysts and consultants	524	526	0.38%	0.08%
Database analysts and data administrators	95	96	1.05%	0.22%
Software engineers and designers	43	43	0.00%	0.01%
Computer programmers and interactive media developers	113	113	0.00%	0.01%
Civil engineering technologists and technicians	290	291	0.34%	0.08%
Mechanical engineering technologists and technicians	104	104	0.00%	0.01%
Electrical and electronics engineering technologists and technicians	1,256	1,260	0.32%	0.07%
Non-destructive testers and inspection technicians	52	52	0.00%	0.01%
Engineering inspectors and regulatory officers	35	35	0.00%	0.02%
Computer network technicians	186	187	0.54%	0.12%
Contractors and supervisors, electrical trades and telecommunications occupations	602	604	0.33%	0.08%
Power system electricians	1,372	1,377	0.36%	0.08%
Electrical powerline and cable workers	1,347	1,351	0.30%	0.07%
Construction millwrights and industrial mechanics	446	448	0.45%	0.10%
Residential and commercial installers and servicers	43	43	0.00%	0.01%
Public works maintenance equipment operators and related workers	13	13	0.00%	0.00%
Power engineers and power systems operators	714	717	0.42%	0.09%
Electricity sector occupations	**9,595**	**9,629**	**0.35%**	**0.08%**
Other occupations	**11,105**	**11,143**	**0.34%**	**0.08%**
Total	**20,700**	**20,772**	**0.35%**	**0.08%**

Source: C4SE POMS Forecast

Retirement

A consistent proportion of 2% to 3% of Quebec's electricity workforce is projected to retire each year from 2017 to 2022. This is similar to the retirement projections for Canada overall.

Retirement Projections for the Electricity Industry Workforce

FIGURE A4.6 Quebec

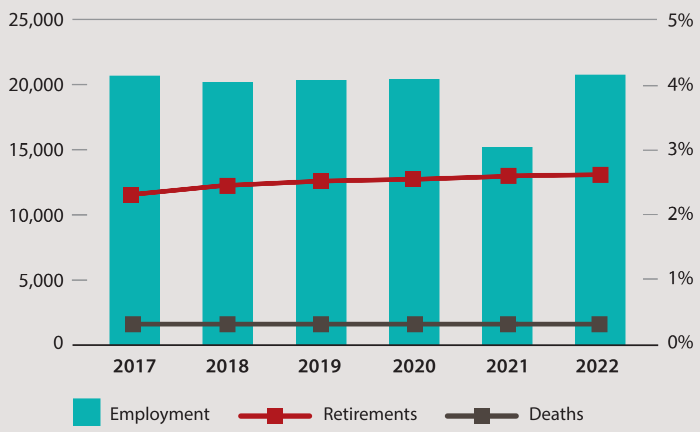
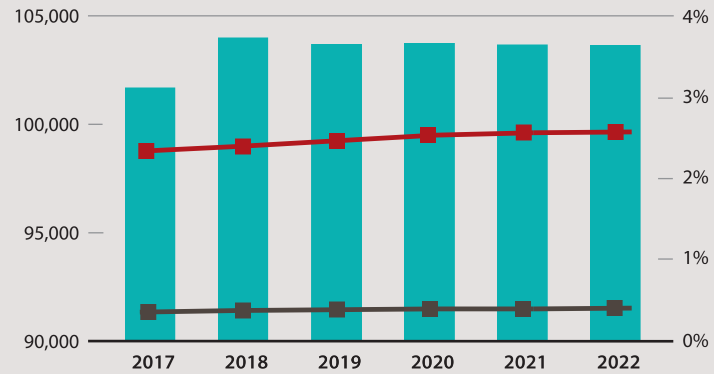


FIGURE 5.2 Canada



Source: C4SE POM Forecast

Total recruitment requirements

Recruitment requirements for the sector are influenced by expansion, death and retirement. The data for Quebec suggests much of the recruitment requirements from 2019 to 2022 will be due to retirements, which is similar to the picture for Canada overall.

Total Recruitment Requirements: Electricity Sector Occupations, 2017–2022

FIGURE A4.7 Quebec

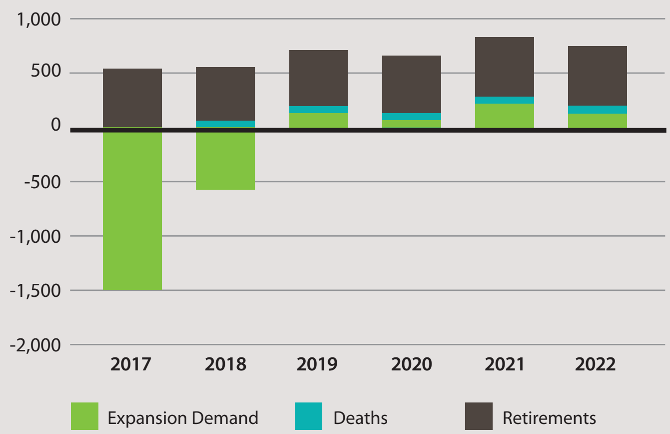
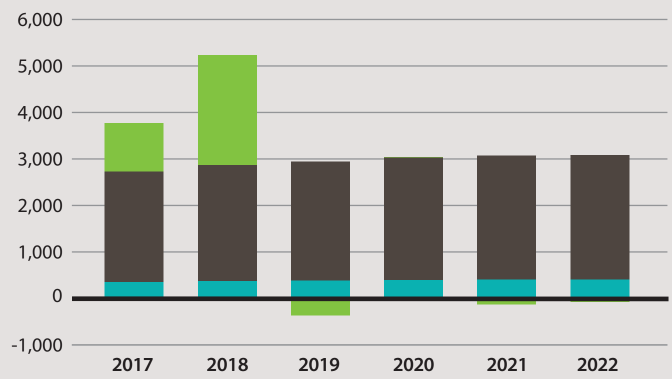


FIGURE 5.3 Canada



Source: C4SE POM Forecast

"As the sector becomes more sophisticated, demand will increase for employees able to work in an ever-changing, diverse, interconnected and high-tech electricity sector."

About the rankings

The LMI model uses demand and supply measures for specific occupations and consolidates them into a market ranking. The model assumes the supply of workers can come from any industry (e.g., an electrician from oil and gas extraction could be employed in electricity). Accordingly, demand and supply measures are calculated for all industries.

Labour market rankings

The labour markets for electricity sector occupations in Quebec will be mainly balanced or show a slight excess of supply. Power engineers and power systems operators will show slight excess of demand in 2020 and 2021.

See the legend under Table 2 on the following page for explanations of the different rankings.

1	**High excess supply** More than sufficient workers are available to meet demand. Demand pressure is much lower than normal, with little to no reliance on migrants to fill jobs. The unemployment rate is noticeably higher than normal. It should be very easy to find workers.
2	**Slight excess of supply** Slightly more workers are available than normal to meet demand. Demand pressure is lower than normal, with less reliance on migrants to fill jobs. The unemployment rate is slightly higher than normal. It should be easier than normal to find workers.
3	**Balanced market** The normal market situation where organizations can rely on their traditional methods for obtaining workers. Demand pressure is normal: organizations may have to compete for workers and rely on migrants to meet supply, but this situation is no different from what they have faced in the past. While they may not be able to fill openings instantly, they should be able to attract workers in a reasonable timeframe. The unemployment rate gap is very small.
4	**Slight excess of demand** Demand pressure is stronger than usual, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is slightly below normal. It could be a little more difficult to find workers.
5	**High excess demand** Demand pressure is quite strong, so organizations must place more emphasis than normal on accessing migrants to meet their worker requirements. The unemployment rate is noticeably below normal. It will be very difficult to find workers.

Get more labour market insights into Canada's electricity and renewables sector along with EHRC's recommendations for meeting labour challenges. Download *Workforce in Motion: 2017–2022 Labour Market Intelligence Study* at electricityhr.ca/workforce-in-motion today.

TABLE 2 Labour market rankings for Quebec, 2017–2022

Occupation	2017	2018	2019	2020	2021	2022
Engineering managers	3	3	3	3	3	3
Construction managers	3	3	3	3	2	3
Utilities managers	3	3	3	3	3	3
Civil engineers	2	5	3	3	2	2
Mechanical engineers	2	3	2	2	2	2
Electrical and electronics engineers	2	3	3	3	3	3
Information systems analysts and consultants	4	3	3	3	3	3
Database analysts and data administrators	3	3	3	3	3	3
Software engineers and designers	3	2	2	2	2	3
Computer programmers and interactive media developers	3	2	2	2	2	2
Civil engineering technologists and technicians	2	3	3	3	2	2
Mechanical engineering technologists and technicians	3	3	2	2	3	2
Electrical and electronics engineering technologists and technicians	3	3	3	3	3	3
Non-destructive testers and inspection technicians	2	3	3	3	3	3
Engineering inspectors and regulatory officers	3	3	3	3	3	3
Computer network technicians	3	3	3	3	3	3
Contractors and supervisors, electrical trades and telecommunications occupations	3	3	3	3	3	3
Power system electricians	2	2	3	3	3	3
Electrical powerline and cable workers	2	2	3	3	3	3
Construction millwrights and industrial mechanics	3	3	2	2	2	2
Residential and commercial installers and servicers	3	3	3	3	2	2
Public works maintenance Equipment operators and related workers	2	3	3	3	3	3
Power engineers and power systems operators	3	3	3	4	4	3

Source: C4SE POMS Forecast