

# Work Transformed

The Impact of Technology

# 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 humanresources needs

Further information on EHRC is available at [electricityhr.ca](http://electricityhr.ca).

*Ce rapport est également disponible en français sous le titre: La transformation du travail – L'incidence de la technologie.* 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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by the Government of Canada's  
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[electricityhr.ca](http://electricityhr.ca)

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# A message from EHRC and PwC Canada

Every industry is feeling the impact of technology on their work and workforce. While innovation can bring tremendous opportunities in efficiency and quality, disruption also brings challenges around upskilling and developing a workforce that can continuously adapt to a rapidly changing environment. For an industry as essential as electricity, we can't afford an interruption in the generation, transmission and distribution of our power supply.

That's why Electricity Human Resources Canada (EHRC), funded in part by the Government of Canada's Sectoral Initiatives Program and with the support of PwC Canada, undertook research to make sure Canada's electricity sector is ready to participate in the digital world. EHRC is the most trusted source of human resources insight, programs and tools to help the Canadian electricity industry. PwC Canada brings more than 110 years of experience from across all industries in Canada to make sure organizations and economies achieve what matters most to them. Together, we're proud to deliver *Work Transformed—The Impact of Technology*, which we see as an essential resource for Canada's electricity sector and its partners.

It's hard to overstate the impact technology will have on electricity in the immediate future. Emerging technologies will change both the size of the sector's labour force and its composition. Modernizing the system will not only improve the way we create and store power—it will also provide jobs for workers who have the right skills and knowledge, combined with the ability to continuously adapt.

Thriving in the digital world is about investing in your people so they can help you write the future. But it has become apparent there's a growing mismatch between the skills people have and digital and data analysis skills needed for the future of work. While some employers may try to embrace new technology through new hires of a younger generation of workers, hiring alone is not the solution. Upskilling is key. It's about identifying the right skills and building strategic plans and programs to power their business. Overall, very few employers have an upskilling plan in place, and nearly a third have no plan at all. As the saying goes: fail to plan, plan to fail.

Preparing people for the digital world is a multi-stakeholder challenge that requires collaboration between employers, educators, unions, and governments. No one organization can do this alone: careful coordination, frequent communication and complimentary delineation of responsibilities are the only way to ensure the workforce of tomorrow has the skills they need to succeed. We firmly believe this report will be invaluable to all parties in forming a skills plan and charting the years to come.

Navigating the future of work won't be easy, but with foresight and planning, we're confident Canada will continue to be a world leader in electricity and economic growth. There's no choice but to adapt and evolve—a challenge this industry will surely rise to meet.

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# Contents

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<b>Executive summary</b>	<b>4</b>
--------------------------	----------

---

<b>Introduction</b>	<b>7</b>
---------------------	----------

---



---

<b>How technology is transforming the electricity sector</b>	<b>8</b>
--	----------

The technologies that are changing the nature of work	9
The factors that are driving technological change	18



---

<b>The impact of technology on workforce size and composition</b>	<b>22</b>
---	-----------

The impact on labour demand	23
The impact on workforce composition	29



---

<b>Skills needed for workers to succeed in an evolving industry</b>	<b>32</b>
---	-----------

The skills needed by tomorrow's electricity workforce	33
The future of training and skills development	37

---

<b>Our recommendations</b>	<b>45</b>
----------------------------	-----------

---

<b>References</b>	<b>49</b>
-------------------	-----------

---

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<b>Appendix A: Table of figures</b>	<b>51</b>
-------------------------------------	-----------

---

<b>Appendix B: Research design</b>	<b>52</b>
------------------------------------	-----------

Research questions	52
Methodology	54
Survey sample	55

---

<b>Appendix C: Acknowledgements</b>	<b>57</b>
-------------------------------------	-----------

National Advisory Committee	57
List of study participants	57





# Executive summary

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New and emerging technologies are driving significant evolution in the way work is done across all sectors of Canada's economy. While much has been said about how these technologies will make *workplaces* more efficient and productive, the potential impact on the Canadian electricity sector's *workforce* has not been extensively explored.

From smart grids and renewable energy to big data and automation, the effects of technological change are already being felt throughout the sector, transforming what we do and how we work. And with even greater disruption expected to come within the next three years, it is vital that electricity sector organizations have an understanding of how these changes will unfold.

That's why Electricity Human Resources Canada (EHRC) conducted this research on how rapid digital and technological innovations will affect the demand for workers in the electricity sector, the composition of the sector's workforce, and the skills profiles and training requirements of future workers in the sector. Equipped with the findings and recommendations emerging from this research, organizations throughout the electricity sector will be better able to anticipate the effects of technological change on their workforce—and better prepare themselves for the future of work.

## Anticipating changes in the labour force

The implications of technological change on the sector are unclear—and there appears to be no real consensus as to the effects on the electricity labour force.

While most of the respondents to our survey (46 per cent) believe labour demand will increase across the sector, more than one-third (35 per cent) disagree, expecting an overall decrease in labour demand. That being so, when looking at the sector's broad occupational groups, it is clear that more workers will be needed to respond to growth in renewable energy, while specialists in information and communication technology (ICT) and engineering will also be in high demand. Similar findings apply when looking specifically at managers and tradespeople. In general, respondents are split as to whether new technologies will cause labour demand to increase, decrease or stay the same. When looking at individual trade occupations, however, an increase in labour demand is anticipated, especially for electricians and electrical powerline workers.

Innovative new technologies will transform not only the size of the sector's labour force but also its composition. While automation and AI may displace some occupations, the wide-scale adoption of new technologies has the potential to transform many others—and could even lead to the creation of entirely new types of jobs, especially in the ICT and renewable energy occupational groups. Digital occupations (such as data analysts, artificial intelligence specialists, and cyber or network security experts) may become more commonplace. Change managers will be required to anticipate, plan for and lead an organization through those changes, and iterate the process moving forward.

## Future skills for an evolving industry

The electricity sector of tomorrow will require workers with strong digital and data-analysis skills.

To effectively use the technologies that are transforming the sector, electricity workers will require new kinds of digital skills and knowledge: computer programming, statistical analysis, big data manipulation and more. Yet most workers in the sector have only slightly or somewhat developed digital skills, with just 18 per cent of the stakeholders we surveyed saying workers' skills were quite or highly developed for sector-specific digital technologies (e.g., smart grids).

While specialized skills will power the sector's workforce, employers are also looking for people who have a combination of skills—especially those who can integrate digital skills with traditional technical knowledge. The preferred skills mix also includes strong personal, interpersonal and professional skills that allow individuals to interact effectively with colleagues and clients in the workplace. To do this effectively, employers and postsecondary/training institutions must share the responsibility of training existing and future electricity sector workers.

## Innovative new technologies

will transform not only the size of the electricity sector's labour force but also its composition.

## The way forward: A proactive option

There is a great deal of disagreement about how the sector should adapt to technological change, especially regarding companies' responsibilities for upskilling and reskilling their employees, and whether employers should be reactive or proactive in the face of disruptive changes.

Employers envision two scenarios for the sector's transition. The first describes a rapid digital transformation, which will increase demand for occupations in vastly different fields than those found in today's workforce. In this scenario, rather than retraining workers, employers expect their workforce will transform through new hires. The alternative sees change happening over a number of years and with a significant period of technological overlap, which will require workers to interact and operate both new and legacy technologies at the same time. This second scenario supports the belief that training existing workers with future skills is not only an employer's responsibility but also makes good business sense.

We believe that maintaining the competitiveness and reliability of Canada's electricity sector in the face of technological change requires a strong investment in and commitment to skill development. Yet our research found very few employers have a training plan in place to fully address their workers' skills needs related to technological change. Nearly one-third have no training plan at all.

Whether their jobs will be displaced or transformed by technology, workers will require some training or upskilling to adapt to new requirements. Companies cannot afford to send their entire workforce back to school, so much of this training will need to be offered through workplace training programs supported by stronger partnerships between postsecondary/training institutions and the workplace.

Employers, educators, regulators, governments and unions all have a role to play in ensuring workers have the skills they need to succeed. As emerging technologies become commonplace, academic and training curricula will need to be adjusted accordingly. To ensure all actors are moving in concert, sector stakeholders should strive to develop a learning ecosystem founded on strong partnerships and common objectives.



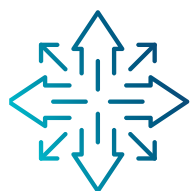


# Introduction

Across every sector of the economy, innovative and disruptive new technologies are poised to dramatically change the way work happens. Advancements in artificial intelligence, automation and more will make workplaces more efficient, productive and collaborative. But how will they affect the workforce? What are the implications on everything from demand for workers to training and skills requirements? These are some of the big questions being asked by employers in Canada's electricity sector.



We at Electricity Human Resources Canada (EHRC) are seeking to answer those questions—and by doing so, give organizations throughout the sector information and guidance to anticipate and prepare for the effects of technological change on their workforces.



This report presents the findings of research that included a comprehensive literature and document review, a national survey of electricity sector stakeholders (including utilities and contractors as well as government, postsecondary education institutions and others), and interviews with key thinkers and leaders in the sector.<sup>1</sup> Those stakeholders and thought leaders shed important light on how rapid digital and technological innovations will likely affect the size and composition of the workforce, the skills profile of electricity sector occupations and the training needs of tomorrow's workers.



<sup>1</sup> See Appendix B for more details about this project's methodology, including the overarching questions guiding our research, our data-collection strategy and a description of our survey sample.

How **technology**  
is **transforming**  
the electricity  
sector





Determining how the electricity workforce is being affected by new and emerging technologies requires an in-depth understanding of what exactly those technologies are—and the factors that are driving their adoption and bringing about such disruptive change across the sector.

## The technologies that are changing the nature of work

During our research, we grouped new and emerging technological innovations into two broad categories:

**1** Those that will affect how companies **do business in all sectors** of the economy

**2** Those that will have a specific impact on **electricity sector operations**

Data analytics, artificial intelligence (AI), automation, drones, the Industrial Internet of Things (IIoT) and 3D printing are among the software and hardware technologies that will affect all industries, not just the electricity sector. (That said, our interest with this particular research project is

in how these innovations will affect the electricity sector specifically.)

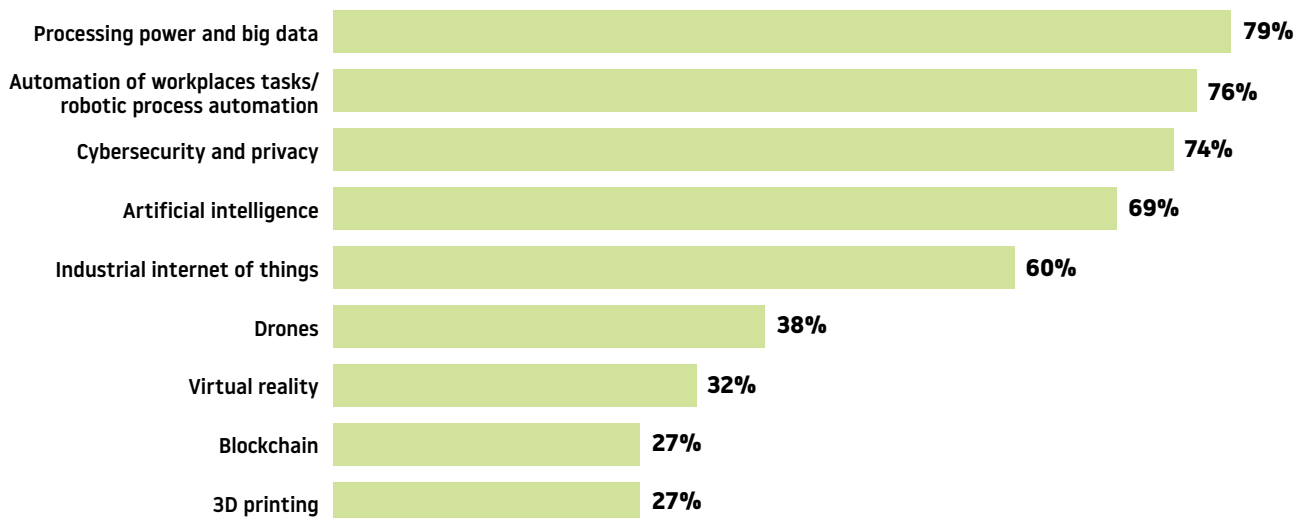
Other innovations, such as smart meters, renewable energy, energy storage, biotechnology and bio-fuels, are unique to the electricity sector—and have the potential to fundamentally transform the way organizations generate, distribute and monitor the consumption of electricity.

### ***Innovations affecting all business***

Although broadly applicable across multiple sectors of the economy, innovations in areas such as computing, networking and robotics will still have a profound impact on the way the electricity sector does business.

As shown in Figure 1, we asked survey respondents to rank the relative potential of several business-level innovations to transform the electricity sector. Big data, automation and cybersecurity topped the list.

**Figure 1.** Technologies with the potential to transform electricity sector business processes



**Note:** Data in this figure represent weighted sums, expressed as a proportion relative to the maximum weighted sum possible for each category (N\*number of items). Higher values correspond to a greater number of respondents ranking the technology as having a high potential for transformation.

### Processing power and big data

A computer's processing power is the speed at which it manipulates data and performs calculations. Exponential increases in both processing power and computer memory capacity have made it possible for organizations in the electricity sector to quickly analyze massive volumes of data, allowing utilities to derive all-new insights on consumer behaviour and system performance.

By analyzing data from across their entire consumer base, for example, utilities can better predict how much electricity will be consumed and when—information that is critical to managing electricity supply and load. This kind of “big data” analysis presents the sector with opportunities to improve the reliability of the electricity supply and the accuracy of energy-demand forecasts.

### Automation of workplace tasks

Automation refers to the use of software that enables machines to perform repetitive, easily repeatable tasks with little to no human interaction. In recent years, converging advances in AI, robotics and computer processing have put an increasing number of occupations at risk of being completely eliminated by automation, especially those in the transportation, manufacturing and construction industries. Occupations that rely heavily on human and social interaction, such as health services and education, are the least likely to be automated (Hawksworth, Berriman, & Goel; 2018).

Automation has the potential to bring substantial economic benefits to the electricity sector. Today, unexpected system disruptions cost the industry an estimated \$10 billion in lost production each year, with roughly 40 per cent of all abnormal events attributed to human error. These issues could be eliminated through the increased use of AI-powered automation, greatly improving the sector's overall efficiency (Annunziata & Bell, 2016).





## Cybersecurity and privacy

As the sector moves toward an interconnected, decentralized energy supply, it will become even more challenging than it already is to maintain the safety and reliability of the electrical grid. One of the main challenges stems from the fact that the legacy technologies still in use today were never meant to be integrated across data-sharing networks like the IIoT. As such, implementing a robust cybersecurity system to protect the smart grid and its data is one of the most pressing concerns for the electricity sector going forward.

## Artificial intelligence

While AI (the simulation of cognitive processes such as learning, reasoning and problem-solving) is not new, a number of factors—including advances in processing power and access to greater quantities of data—have accelerated the pace and scope of its evolution and uptake.

The electricity sector is already taking advantage of AI, with smart grids relying heavily on it to predict electricity price and load. In a microgrid context, where supply and demand are decentralized, AI has the potential to significantly improve the precision of day-ahead forecasts for electricity demands, making decisions based on historical consumption data, weather variables, and daily and weekly variations in usage (Ma & Zhai, 2019).

## Industrial Internet of Things

The IIoT is the interconnected network of smart machines, sensors, instruments and devices that monitor and analyze systems and processes in an industrial or manufacturing environment. The data generated by IIoT devices can be used to coordinate and automate activities across a massive number of nodes, increasing productivity and reducing costs—for example, by tracking equipment performance in real time to enable predictive and remote maintenance.



**The biggest [disruption] that the majority of the industry faces is that it has to go from a hardware focus to a data and a software focus. That's where I find the problem is inside the electricity sector because [we] really don't know how to do that. When you start to look at what having a data and an insight layer in your organization means, and what moving from hardware to software actually does for an organization, that's where I think the biggest disruption to the workforce is going to occur.**

*Key informant*





## Drones

Drones (also known as remotely piloted aircraft systems) are aerial vehicles that are controlled remotely by a pilot on the ground or autonomously by an onboard computer. The increasing sophistication of drone technology has made it a useful tool in the electricity sector. By sending a drone to collect high-quality data, pictures and videos, workers can detect faulty equipment, monitor remote solar and wind farms, and locate downed power lines—without putting their own safety at risk.

## Virtual reality

Virtual reality (VR) provides users with an immersive experience, allowing them to visualize an environment without physically being present in it. Similar to drones, VR has the potential to improve the safety of electricity sector workers as well as students hoping to gain experience in the sector by simulating potentially hazardous scenarios. This approach allows for the delivery of more effective and engaging learning experiences, especially in settings that would be too difficult or dangerous to recreate in reality.

## Blockchain

Blockchain enables the exchange and storage of crucial data with integrity secured through a “distributed ledger that autonomously and transparently keeps a chronological record of transactions” (Olson, 2018). Commonly used to manage Bitcoin transactions, blockchain has emerged as a potentially viable solution for managing transactions within a decentralized electricity supply system. Using blockchain, electricity producers and consumers may no longer need utilities to buy and sell electricity.

**Blockchain brings trust and transparency plus real-time validation, which is why not just us, but a lot of future-minded people in the industry are gravitating toward it. But irrespective of what the underlying technology may be, the whole idea is to create an open-ended marketplace that the suppliers and the consumer can hook up to.**

*Key informant*

## 3D printing

3D printing (also known as additive manufacturing) enables the construction of three-dimensional models and objects by successively adding material layer by layer. From prototype creation to mainstream production, 3D printing has far-reaching implications for the electricity sector. As an extreme example of its potential, the process has been used to print an entire solar field in Australia. It has also been used to print lithium-ion batteries, which could lead to the decentralization of the manufacturing of small-scale energy storage (GlobalData Energy, 2019).

### **Timeline for change on electricity sector business processes**

While some new and emerging technologies are already having a transformative impact on the sector, the full effects of others won't be felt until at least few years down the road.

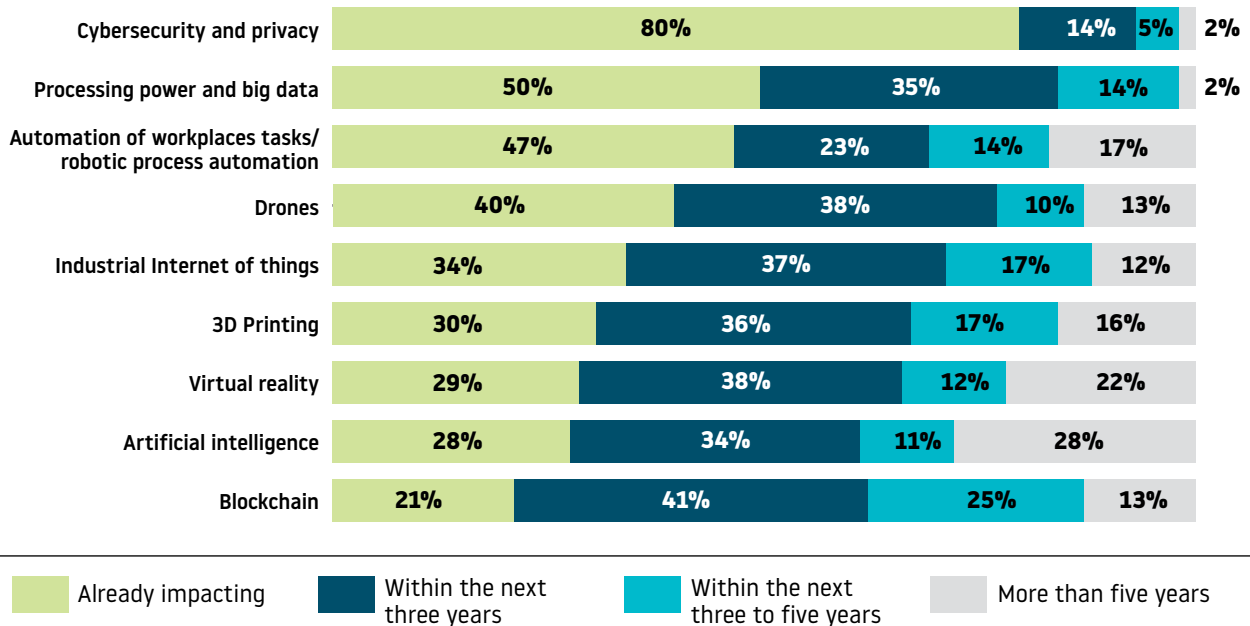
As shown in Figure 2, the vast majority (80 per cent) of our survey respondents believe technologies related to grid security and consumer privacy are already affecting the sector, far beyond any other business-level innovation. Most respondents said the effects of processing power and big data analytics (50 per cent) and the automation of workplace tasks (47 per cent) are also already being felt across the sector.

While 40 per cent of respondents have already started seeing drones change the way their businesses operate, a near equivalent proportion (38 per cent) expects the real impact of drones will only be seen within the next three years.

Finally, most respondents expect the remaining technologies to have an impact within the next three years, though there is some disagreement as to the exact timeline.

These findings indicate that, other than technologies enabling cybersecurity and privacy, the impact timeline for business-level innovations is unclear. That said, respondents not already seeing the impacts of these technologies expect to do so sooner rather than later.

**Figure 2.** Timeline for impact on electricity sector business processes



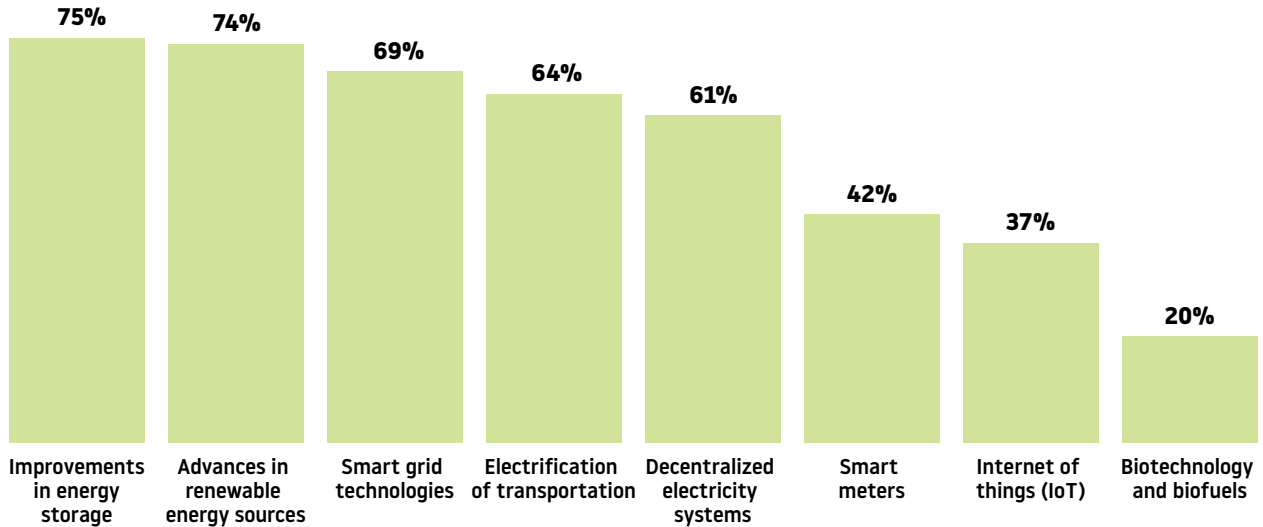
**Note:** For emphasis, the category with the highest proportion of respondents for each technology is not shaded, while all other categories are shaded.

### Innovations specific to the electricity sector

Many emerging digital technologies and innovations have applications that are unique to the electricity sector: smarter, greener technologies that are enabling the adoption of new energy sources and contributing to a greater integration of generation, transmission and distribution systems.

Respondents to our national survey were asked to rank the technologies with the greatest potential to transform the sector's operations. Figure 3 shows that energy storage, renewable energy and smart grid technologies are top of mind.

**Figure 3.** Technologies with the potential to transform electricity sector operations



**Note:** Data in this figure represent weighted sums, expressed as a proportion relative to the maximum weighted sum possible for each category (N\*number of items). Higher values correspond to a greater number of respondents ranking the technology as having a high potential for transformation.

### Energy storage and renewable energy sources

Improvements in energy storage and advances in renewable energy sources are expected to have the most transformative impact on the sector. These two areas are closely related: as energy storage technologies get better, the sector will be able to accelerate its reliance on renewable energy sources.

The contribution of non-hydro renewable energy sources continues to be small relative to the current energy supply mix in Canada. While renewables account for 67 per cent of the country's electricity supply, only seven per cent of that comes from non-hydroelectric sources such as solar, wind and biomass (Natural Resources Canada [NRCan], 2017).

**67%**  
of Canada's  
electricity  
comes from  
renewables

**7%**  
comes from  
non-hydroelectric  
sources

Energy storage will be critical to the wide-scale adoption of non-hydro renewable energy sources. Although the costs of these technologies continue to become more financially viable, the intermittent and highly variable nature of wind, solar and other renewables poses significant challenges for the energy systems that rely on them. Today, wind farms and solar panels can supply energy only when it is available, which may not be when consumers require it.

Storing excess energy to compensate for periods of low production could potentially solve the problems associated with an intermittent and inconsistent energy supply. Innovative solutions in this area continue to emerge, including using batteries from electric vehicles for energy storage and supplying power back to the grid when those batteries are not being used.

### Smart grid technologies

The smart grid is the “next-generation” power grid, integrating a broad array of information and communication technologies (such as smart meters and smart appliances) to enable the exchange of real-time data between electricity suppliers and consumers (Park, Kim, & Kim, 2014; Federal Energy Regulatory Commission, 2016).

In addition to playing an important role in energy-conservation efforts, smart grid technologies have been a driving force in the decentralization and electrification of the energy supply. They are expected to increase the quality and reliability of electric power while also expanding the deployment of renewable energy (Naber et al., 2017).

### Electrification of transportation

There are currently more than 100,000 electric vehicles in Canada, including battery-electric vehicles and plug-in hybrid vehicles. While this number represents just a small proportion of the entire fleet of vehicles in the country, the number of electric vehicles sold across Canada has increased year over year, aided in part by government subsidies and encouraging policies.

**100,000+**  
electric vehicles in Canada...  
and growing

Rapid growth in the number of electric vehicles will radically increase overall demand for electricity; depending on the scale of these vehicles’ uptake, electricity demand is expected to rise from a few terawatt-hours in 2017 to between 118 and 733 terawatt-hours by 2030 (Narayan, 2018). To handle the increase in load requirements, significant modifications and upgrades to the existing grid infrastructure will need to be made.

### Decentralized energy systems

Decentralization refers to the use of smaller, more localized sources of energy generation, storage and distribution. As the price of renewables continues to decline, a greater number of households will be able to generate their own energy—and even sell their excess energy to the grid for use by other consumers. In combination with smart grid technologies, formerly passive consumers of energy are becoming active producers of energy (or “prosumers”) in a decentralized electricity system (John, 2018).

The result is a system where centralized power plants are no longer the sole generators of energy. Current trends are shifting toward a mix of centrally generated (e.g., natural gas, nuclear) and decentralized (e.g., solar, wind) energy sources (General Electric Power, 2019). Ultimately, a decentralized energy system means consumers will be getting their energy from a number of different sources at different times.

## Smart meters

With smart meters, consumers and utilities can see and control, in real time, when, where and how electricity is being used. Seeing how their consumption affects their energy costs is expected to motivate consumers to become more efficient while allowing utilities to better monitor energy consumption patterns. Indeed, this technology is transforming the relationship between energy user and energy provider, with consumers set to become active agents in deciding how much energy they consume and when they consume it.

## The Internet of Things

The process of digitization has made it possible to integrate physical infrastructure with digital infrastructure, resulting in what's known as the Internet of Things (IoT): an interconnected network of physical devices (including personal electronics, vehicles, home appliances and smart meters) that can collect and share data with each other in real time. The communications between IoT devices can help consumers improve the functionality of these devices, optimize their use of electricity and simplify various aspects of their lives. But the IoT also introduces a series of cybersecurity implications, which have led to a significant need for skilled individuals who can ensure the security of grid infrastructure—especially as legacy systems are integrated with more modern technologies.

## Biotechnology and biofuels

Biotechnologies are being used to mimic the processes used by living organisms to generate and store electricity—and in some cases, are directly using living organisms to generate electricity. For example, researchers have explored the potential of microbial solar cells as well as technologies that use photoautotrophic microorganisms or plants to harvest solar energy and generate electrical current, essentially tapping into the electricity generated during photosynthesis (Strik et al., 2011).

Bioenergy is a renewable source of energy derived from living organisms and their by-products. In Canada, biomass includes waste from the forestry and agricultural sectors, animal residue and municipal solid waste that is converted into solid, liquid or gaseous bioenergy, which can then be burned to generate heat/electricity or used in the creation of biofuels such as ethanol or renewable diesel (NRCan, 2016). Currently, biofuels make up roughly six per cent of Canada's total energy supply.

Despite these advances, few stakeholders in our national study believe biofuels and biotechnology will have a disruptive effect on the sector on the same scale as other emerging innovations.





### Timeline for change on electricity sector operations

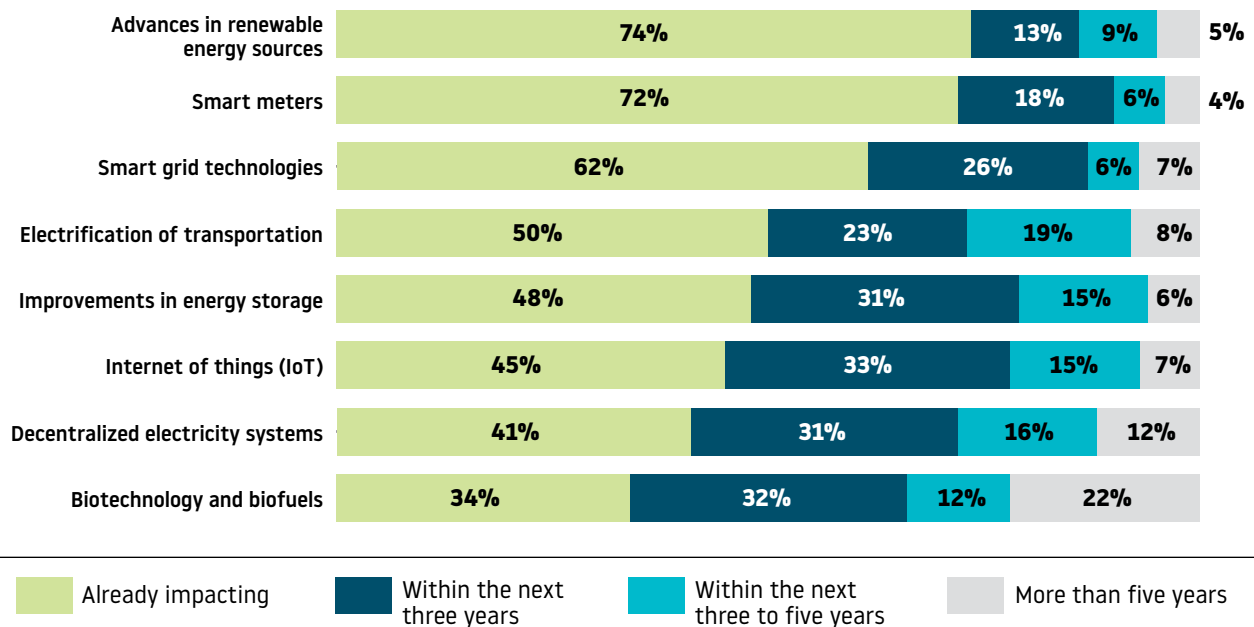
Several of the emerging technologies specific to the electricity sector are already having an impact. A majority of respondents point to renewable energy sources (74 per cent), smart meters (72 per cent) and smart grid technologies (62 per cent) in particular. There is no clear agreement about when the impacts of the electrification of transportation, improvements in energy storage, the IoT and decentralized electricity systems will be felt. While most respondents agree all of these technologies have already affected the sector, between one-quarter and one-third believe the real impact will come within the next three years rather than today.

Finally, there is a great deal of uncertainty about exactly when the impact of biotechnology and biofuels is expected to be seen throughout the sector, with a roughly equivalent proportion of respondents indicating these technologies are already affecting the sector (34 per cent) or will affect it in the next three years

Most respondents agree all of these technologies have already affected the sector, between **one-quarter and one-third** believe the real impact will come within the next three years rather than today.

(32 per cent). The remaining respondents believe the impact of this technology will happen over the longer term, with some expecting changes within the next three to five years (12 per cent) and others believing the impact will occur more than five years down the line (22 per cent).

**Figure 4.** Timeline for impact on electricity sector operations



**Note:** For emphasis, the category with the highest proportion of respondents for each technology is not shaded, while all other categories are shaded.

# The factors that are driving technological change

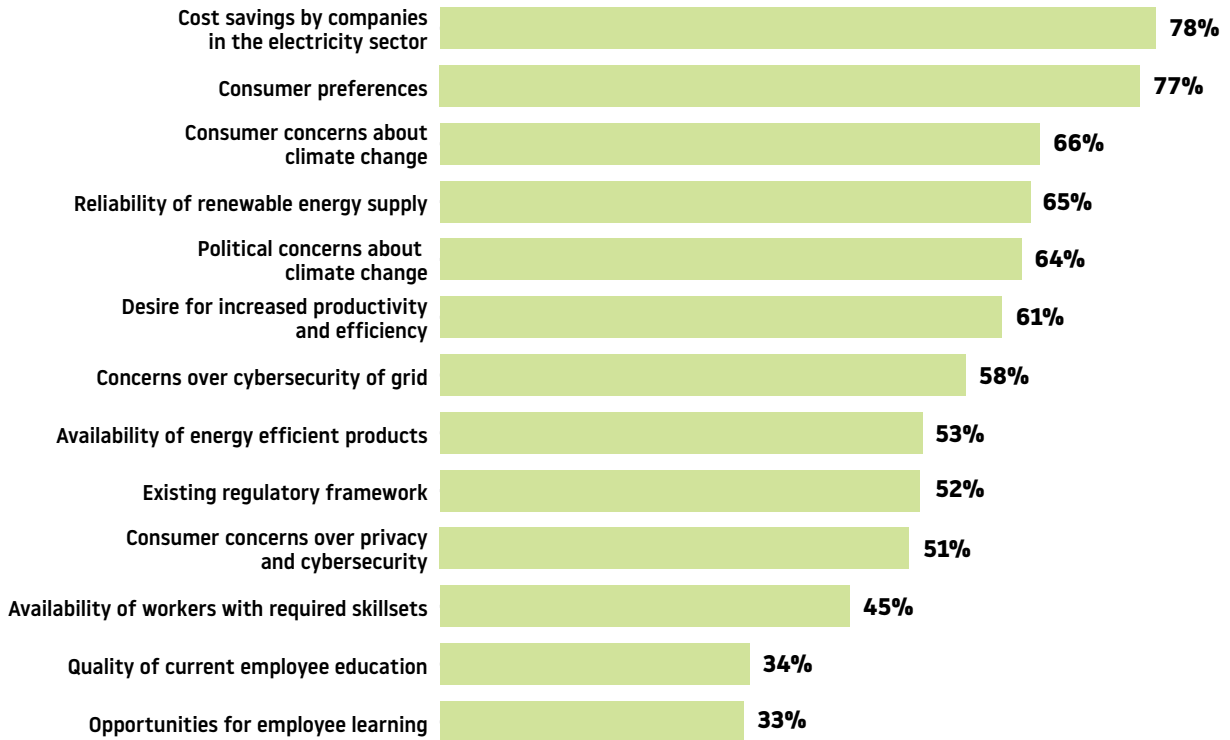
A number of interconnected factors are contributing to the technological changes currently affecting or soon to affect the electricity sector. In general, these changes are motivated largely by the need to improve energy efficiency, sustainability, reliability and accessibility—all of which are key goals in the future of electricity production, distribution and consumption.

As shown in Figure 5, when asked about the relative importance of each potential driver of technological change in the sector, respondents to our national stakeholder survey zeroed in on cost savings and consumer preferences as the primary causes of innovation.

Among the most important drivers of change are the very same innovations already discussed in this report, such as cybersecurity concerns and the availability of energy-efficient products. Other factors driving the pace of technological change relate to the availability of skilled labour and the capacity of postsecondary/training institutions to adequately teach the skills required from a changing workforce. These factors (and how they are affecting the sector) are studied at length later in this report.

On the following pages, we highlight the four factors identified by stakeholders as the most significant drivers of technological change in the electricity sector.

**Figure 5.** Drivers of technological change in the electricity sector



**Note:** Data in this figure represent weighted sums, expressed as a proportion relative to the maximum weighted sum possible for each category (N\*number of items). Higher values correspond to a greater number of respondents identifying the factor as an important driver of change.

## Markets and prices

Market forces and the prices of emerging technologies will be significant drivers of change in the electricity sector, just as they will be across all other parts of Canada's economy.

As prices for solar power, battery storage, wind power, electric vehicles, smart buildings, two-way power flows and other technologies continue to drop precipitously, the market for electricity products will become more and more competitive. In turn, new actors will emerge to help supply and distribute energy through a decentralized grid. The virtuous cycle of higher competition and increasingly lower prices will continue to accelerate the pace of transformation in the sector.



**How do we ensure we are able to be there for our customers with new energy choices? It is about stakeholder engagement, customer insights, data analytics all put together such that there's a win-win scenario and the right opportunities created by which the customer definitely wins.**

*Key informant*

## Consumer preferences and attitudes

As consumer attitudes toward climate change evolve, demand for renewable sources of electricity and energy-efficient products and services could follow, accelerating the pace and scope of change in the electricity sector.

However, consumers may be slow to change. Simply making emerging technologies such as smart meters or electric vehicles available to consumers does not automatically lead to widespread adoption. Even when prices are considered, consumer preferences are influenced by a number of other factors, including personal attitudes, social norms and comfort with change (Gangale, Mengolini, & Onyeji, 2013).



**Individuals may choose to move faster than either policy or price. They may have other reasons, whether it's cool or whether it's the environment or because they want to have control.**

*Key informant*



## Climate change mitigation and decarbonization

“Decarbonization” describes the process of transitioning away from carbon-intensive, greenhouse gas (GHG)-emitting energy sources of electricity toward renewable or non-GHG emitting sources. A push to mitigate the effects of climate change is accelerating the decarbonization of global energy systems, with economies around the world electrifying their transportation, heating and cooling systems.

Canada is one of many national and subnational jurisdictions engaged in decarbonization that is contributing to innovations in energy generation while simultaneously imposing stringent emission standards. The Pan-Canadian Framework on Clean Growth and Climate Change is Canada’s signature policy on decarbonization, providing an opportunity for provincial, territorial and federal governments to collaborate and coordinate their decarbonization strategies.

Many decarbonization activities are already underway in Canada. In 2014, Ontario became the first jurisdiction in North America to fully phase out coal, with other provinces expected to achieve the same goal by 2030. Carbon-pricing initiatives, such as cap-and-trade in Quebec and a national carbon tax, are intended to accelerate Canada’s decarbonization efforts by placing a cost on carbon consumption (Environment and Climate Change Canada, 2017). Additional activities such as low-carbon extraction techniques for Alberta’s oil sands and advanced biofuels for long-haul transportation are also being implemented to tackle high emission levels in those sectors (Bataille, Sawyer, & Melton, 2015).



**Climate change is definitely changing insurance profiles in terms of what’s even insured, what’s not, where you can get insured and where you can’t. Wherever resilience and power outages are becoming an issue due to storms, the issue of grid reliability becomes an economic issue—because power outages lead to economic loss—and that’s going to change the spectrum of costs and that will change people’s willingness to pay.**

*Key informant*

**2014**

Ontario fully phases out coal



**\$100 million**  
government investment  
in smart grid technologies

### Government policies and investments

Canada's electricity sector is highly influenced by government decisions, including policies and regulations that directly affect the sector. Changes in government priorities can have a considerable effect on timelines for change, including the implementation of decarbonization and climate change mitigation plans. A prime example is the recent cancellation of electric vehicle rebates by the Government of Ontario, which led to a 50 per cent decrease in electric vehicle sales in that province (Electric Mobility Canada, 2019).

Public investment is also an important driver of change. For example, the Government of Canada announced an investment of up to \$100 million towards the smart grid component of the Green Infrastructure Phase II Program. As part of this program, utility-led projects will receive funding to demonstrate smart grid technologies and deploy smart grid integrated systems (NRCan, 2018).

Governments across Canada have been investing heavily in renewable energy research, development and demonstration (RD&D), with cumulative investments toward clean energy generation projects totalling more than \$31 billion between 2010 and 2014 (NRCan, 2017). Moving forward, Canada has joined Mission Innovation, an international initiative with 19 other countries and the European Union. As part of this collaboration, Canada will double its investments in clean energy RD&D by 2020 and will increase its annual investments in clean energy to \$775 million (NRCan, 2017).

Despite these commitments, Canada still lags behind other countries that have encouraged both residential and large-scale solar projects. The California Energy Commission, for example, recently adopted new building standards requiring all new residential builds and healthcare facilities to be equipped with smart, solar photovoltaic systems. It also updated its thermal envelope standards for better heat insulation (California Energy Commission, 2018). In Germany, more than 1.5 million photovoltaic systems have been installed in residential households, with solar penetration at eight per cent of the total energy supply (Wittenberg & Matthies, 2016).



**Policy makes all the difference, in the interim, before we observe new technology and emerging solutions becoming mainstream. Within the automotive sector, the electric car will be the mainstream car; the writing is on the wall. Automotive manufacturing is changing now. The question is, do we get there in eight years or will things get expedited? That depends on the policy.**

*Key informant*

**\$775 million**  
annual investments in clean energy



The impact  
of technology  
on **workforce**  
**size** and  
**composition**





New and emerging technologies are doing more than just change the way business is done in the electricity sector. They're also expected to have a huge impact on demand for labour and the makeup of the workforce. It's easy to assume the workforce will shrink due to automation and AI—but that might not actually be the case. In fact, some innovations will even help create entirely new occupations that never existed before.

## The impact on labour demand

One of our primary goals for this research was to understand the potential impact technological change might have on the overall demand for workers across the electricity sector as well as for specific occupations and occupational groups within the sector.

Globally, technological change (and automation in particular) is contributing to a shrinking of the workforce across all sectors of the economy. In Canada, it has been predicted that nearly 10 per cent of Canadian workers risk losing their jobs due to wide-scale adoption of new and emerging technologies (Advisory Council on Economic Growth, 2017).

Some occupations are at a greater risk of being automated than others. Those consisting of repetitive tasks, requiring limited skills and lacking any human interpretation are easiest to automate (Hawksworth, Berriman, & Goel, 2018). Additionally, workers with limited digital skills, particularly older workers, may find it more difficult to adapt to the requirements of a highly digitized work environment.

The electricity sector is not immune to these trends. In the United States, electricity usage is expected to increase between 2016 and 2026, but there will likely be no overall growth in employment by power plant operators, distributors and dispatchers during that same period (United States Bureau of Labor Statistics, 2018). The efficiencies gained through the latest technological innovations can help the sector become more productive with very little change in the size of its workforce.

### ***Labour demand impact by occupational group***

As new technologies transform how the sector generates, distributes and manages the use of electricity, demand for workers across and within occupational groups will change.

We asked survey respondents whether they expect new technologies to decrease, increase or have no effect on labour demand in the electricity overall and in each of the sector's five occupational groups: managers and supervisors, engineers and engineering technologists, tradespeople, renewable energy occupations, and information and communication technology (ICT) occupations.

**10%**  
of Canadian jobs  
are at risk from  
new technologies

An analysis of our survey results suggests the following conclusions:

**1 Disagreement over growth in the sector overall.** There is no clear consensus as to whether labour demand will increase or decrease as a result of technological change. While most respondents (46 per cent) believe labour demand will increase across the sector, more than one-third (35 per cent) disagree, expecting an overall decrease in labour demand.

**2 Increased demand for renewable energy and ICT workers.** There is strong agreement among respondents (67 per cent) that labour demand for workers in renewable energy occupations is likely to increase. A similar result was found for ICT occupations (61 per cent).

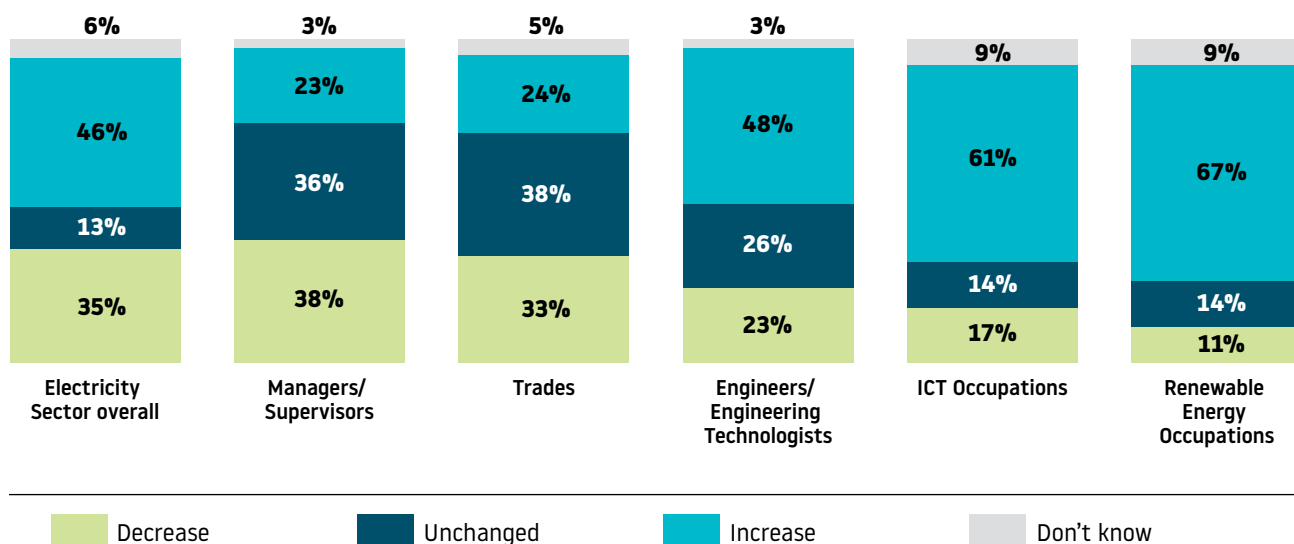
**3 Disagreement over demand for managers and tradespeople.** Respondents were split as to whether technological change will decrease, increase or have no effect on labour demand for managers and tradespeople. Many respondents (38 per cent) believe demand for managers will decrease following the adoption of new

technologies, with about one-third of respondents (33 per cent) saying the same for tradespeople. A near-equal proportion of respondents believes labour demand for managers (36 per cent) and tradespeople (38 per cent) will remain about the same. A smaller yet substantial proportion of stakeholders expect to see an increase in labour demand for both managers (23 per cent) and tradespeople (24 per cent).

**4 Increased but also uncertain demand for engineers.** Nearly half of our survey respondents (48 per cent) expect labour demand for engineers and engineering technologists to increase in tandem with technological change. The other half (49 per cent) believe labour demand will stay the same or decrease for these occupations, indicating substantial disagreement among sector stakeholders as to how many engineers will be needed in the future.

A summary of these findings is presented in Figure 6.

**Figure 6.** Perceived changes in labour demand by electricity sector occupational group



**Note:** The values in this figure indicate the proportion of respondents who selected each category.

## Labour demand impact by occupation

In addition to looking at labour demand by the sector's five occupational groups, we also asked survey respondents about the changes in demand they expect to see for every occupation within those groups. As expected, our analysis of labour demand by occupation is fairly consistent with the results seen for the occupational groups, with our primary findings suggesting the following:

---

**1 Decreased demand across all managerial occupations.** While there is uncertainty about the effects of technological change on managers as a group, stakeholders paint a clear (but grim) portrait of future labour demand at the occupation level. Financial managers and supervisors of electricians and electrical powerline workers are expected to face the most substantial decrease in labour demand following the adoption of new digital technologies.

---

**2 Increased demand for most trade occupations.** Unlike managerial occupations, stakeholders' uncertainty around the future labour demand for tradespeople as a whole becomes clearer and more positive when considering each trade individually. Labour demand could increase for

most trades, especially for electricians (power systems, industrial and construction) and electrical powerline workers.

---

**3 Increased demand for most engineering occupations.** Unsurprisingly, labour demand is expected to increase for most engineering occupations, especially electrical and electronics engineers.

---

**4 Increased demand for all occupations in renewable energy and ICT.** Smart grid specialists are expected to see the most substantial net increase in labour demand among the occupations in these groups, followed by cybersecurity specialists.

The results of our analysis are shown in Figures 7 to 11, with each figure spotlighting occupations in one of the five occupational groups. The values in these figures correspond to the net difference in ranked sums between respondents who expect to see an increase and those who expect to see a decrease in labour demand for each occupation. That means a negative value indicates an expected decrease in labour demand, while a positive value indicates an expected increase in labour demand.

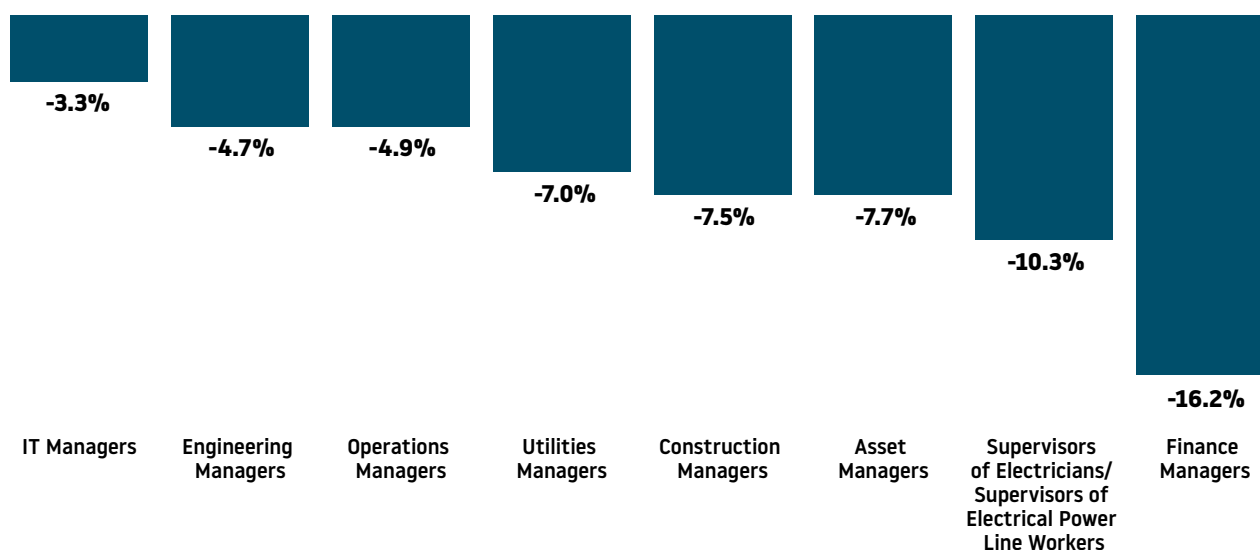
It is important to interpret these findings with caution: while they offer important information regarding electricity sector stakeholders' *perception* of changes in labour demand, they are merely indicative rather than predictive, and should not be interpreted as an accurate forecast of changes.

Business service and cross-cutting occupations play an important role in the day-to-day function of electricity companies. Such occupations include clerical workers, marketing and customer service representatives, human resource officers, lawyers, accountants and other occupations that enable electricity companies to function and grow their business. Because these occupations are not unique to the sector and do not fall into one of its five occupational groups, they were not included in our national survey. As a result, the effects of technological change on labour demand for these occupations cannot be assessed by this research.

That said, businesses in the electricity sector may still be concerned about the extent to which emerging technologies will affect labour demand for these occupations. Recent studies suggest AI and automation could have a powerful displacement effect on these workers (Acemoglu & Restrepo, 2019). But they also contribute to business growth and an increase demand for new, non-automated tasks—meaning AI and automation might actually improve human productivity rather than replace workers.

Indeed, today’s ubiquitous technologies were once emerging technologies that many thought would replace existing office jobs. Spreadsheets, for instance, enabled workers to do similar tasks faster than they previously could; the resulting increase in productivity allowed businesses to expand their operations and hire workers across an array of occupations (Shapiro, 2019). Known as the “reinstatement effect”, the creation of new tasks where labour holds a competitive advantage over automated technology directly counterbalances the displacement effect (Acemoglu & Restrepo, 2019).

**Figure 7.** Net expected changes in labour demand by occupation: Managers



**Note:** Respondents indicated whether they expect to see an increase or a decrease in labour demand for each occupation. Data are calculated using the difference in weighted scores and expressed as a proportion of all respondents.

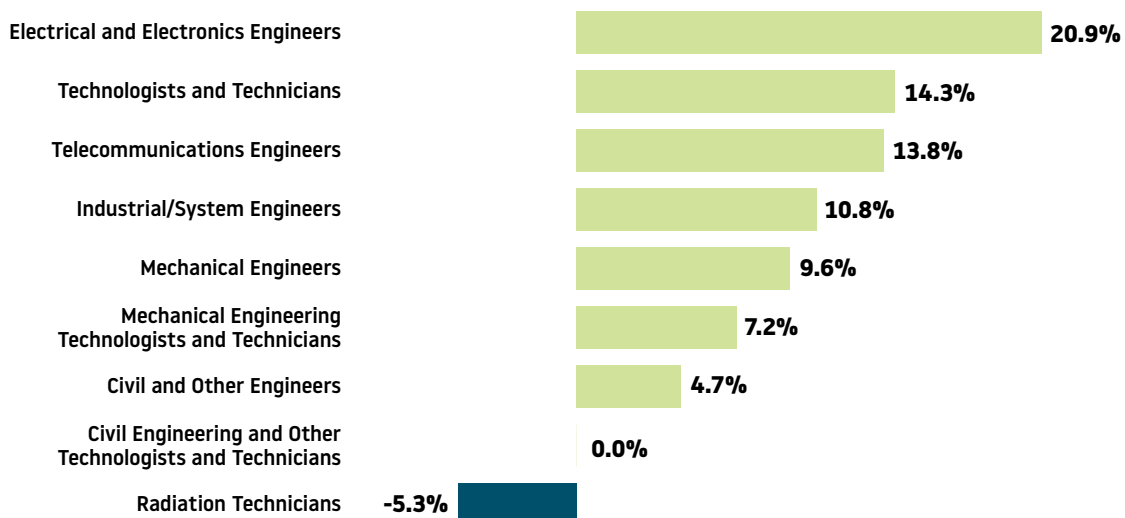
Consistent with our analysis of the occupational groups, demand for managers will decrease following the adoption of digital technologies. The occupation expected to be the least in demand is finance manager, followed by supervisors of electricians and electrical powerline workers. Surprisingly, even with an expected increase of workers in ICT occupations, a small decrease in labour demand is expected for IT managers. Managers may also find their skill requirements change given that ICT competencies are expected to be introduced in a number of occupations that did not previously rely on those skills.

Labour demand is expected to increase for most engineering occupations. Electrical and electronics engineers, technologists and technicians, as well as telecommunications engineers, are expected to see the highest net increase in labour demand. Radiation technician is the only occupation in this group that is expected to see a net decline in labour demand due to technological change.

In contrast to our analysis of the occupational groups, where labour demand for tradespeople is anticipated to remain the same or decrease overall, there is more optimism about the future of labour demand for trades at the occupational level.

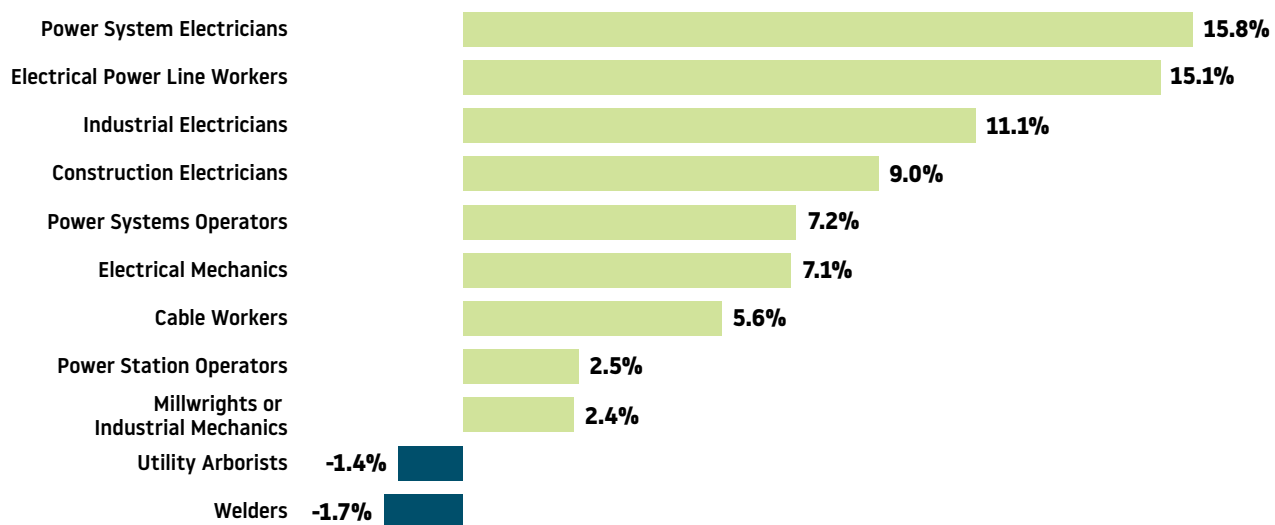


**Figure 8.** Net expected changes in labour demand by occupation: Engineers



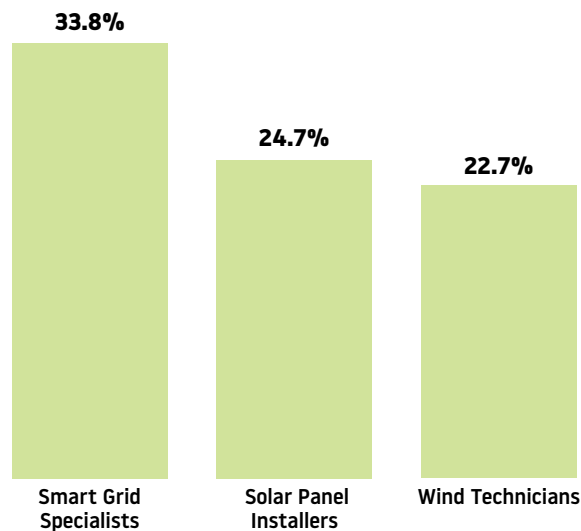
**Note:** Respondents indicated whether they expect to see an increase or a decrease in labour demand for each occupation. Data are calculated using the difference in weighted scores and expressed as a proportion of all respondents.

**Figure 9.** Net expected changes in labour demand by occupation: Trades



**Note:** Respondents indicated whether they expect to see an increase or a decrease in labour demand for each occupation. Data are calculated using the difference in weighted scores and expressed as a proportion of all respondents.

**Figure 10.** Net expected changes in labour demand by occupation: Renewables



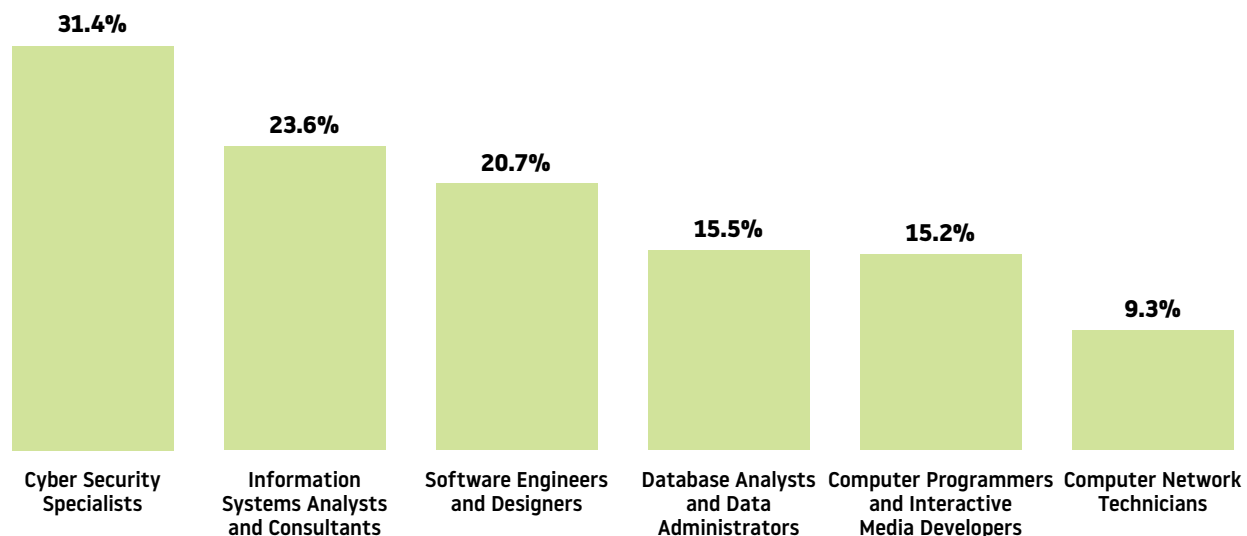
**Note:** Respondents indicated whether they expect to see an increase or a decrease in labour demand for each occupation. Data are calculated using the difference in weighted scores and expressed as a proportion of all respondents.

Our analysis suggests a net positive ranking for most occupations in the trades, indicating that labour demand is expected to increase as a result of technological change, especially for electricians (power systems, industrial and construction) and electrical powerline workers. There are only two occupations in the trades where survey respondents think labour demand will decrease as a result of technology advancements: utility arborists and welders.

Not surprisingly, labour demand for renewable energy occupations is predicted to increase significantly with the adoption of new and emerging technologies. The most significant increase in labour demand will be seen among smart grid specialists, followed by solar panel installers and wind technicians.

In response to this increased labour demand, we are developing national occupational standards, essential skills profiles and physical demands assessments for these three occupations (smart grid specialists, solar panel installers and wind technicians)<sup>2</sup> as well as others related to renewable energy. These documents will provide the industry with detailed, current and validated information on the skills and knowledge requirements, physical requirements and foundational literacy skills necessary to perform these jobs.

**Figure 11.** Net expected changes in labour demand by occupation: ICT



**Note:** Respondents indicated whether they expect to see an increase or a decrease in labour demand for each occupation. Data are calculated using the difference in weighted scores and expressed as a proportion of all respondents.

<sup>2</sup> The industry-approved titles for these occupations include smart grid specialist, photovoltaic (PV) installer and wind turbine technician.

It is interesting to note that, when grouped together, trades occupations are perceived to be less in demand. However, when asked to focus on specific trades, respondents actually perceive the individual occupations as more in demand, highlighting that there is an issue in how trades occupations are perceived by industry stakeholders.

Consistent with the results from our occupational group analysis, labour demand across all ICT occupations is expected to increase going forward. Survey respondents feel the most substantial increase will be seen for cybersecurity specialists, followed by information systems analysts and software engineers.

## The impact on workforce composition

In addition to affecting the *size* of the electricity sector's labour force, technological change is expected to transform its *composition*.

While automation and AI may displace and replace some occupations, wide-scale adoption of new and emerging digital technologies also has the potential to transform and augment many other occupations—for example, by making workers more productive or by eliminating mundane, repetitive or dangerous tasks so they can focus on other aspects of their jobs. These innovations might even generate demand for entirely new and potentially more interesting kinds of jobs within the sector (Dashevsky, 2018).

As part of our research, we asked stakeholders to identify how *existing* occupations will be affected by new and emerging technologies: which occupations are more likely to be transformed or augmented, and what new occupations will be needed as businesses adapt to the latest innovations.

### **Changes to existing occupations**

The impact of technological change is expected to transform the sector's five occupational groups in different ways, as illustrated in Figure 12:

---

**1 Managers and supervisors will see transformation and disruption... or maybe the status quo.** There is considerable disagreement about the extent of technology-driven transformation expected for management occupations. Nearly half of all survey respondents (49 per cent) believe occupations related to worker management and supervision will be disrupted or transformed. More than one-third of respondents (39 per cent) disagree, expecting to see very little change in these occupations.

---

**2 No consistent prediction of change for tradespeople.** While most respondents (39 per cent) believe trade occupations will be transformed following the adoption of new technologies, an almost equivalent proportion (33 per cent) believe these occupations will remain unchanged. One-fifth of respondents (20 per cent) expect to see substantially new trades created. This response pattern indicates that sector stakeholders are unclear about how trade occupations will be transformed by technology.

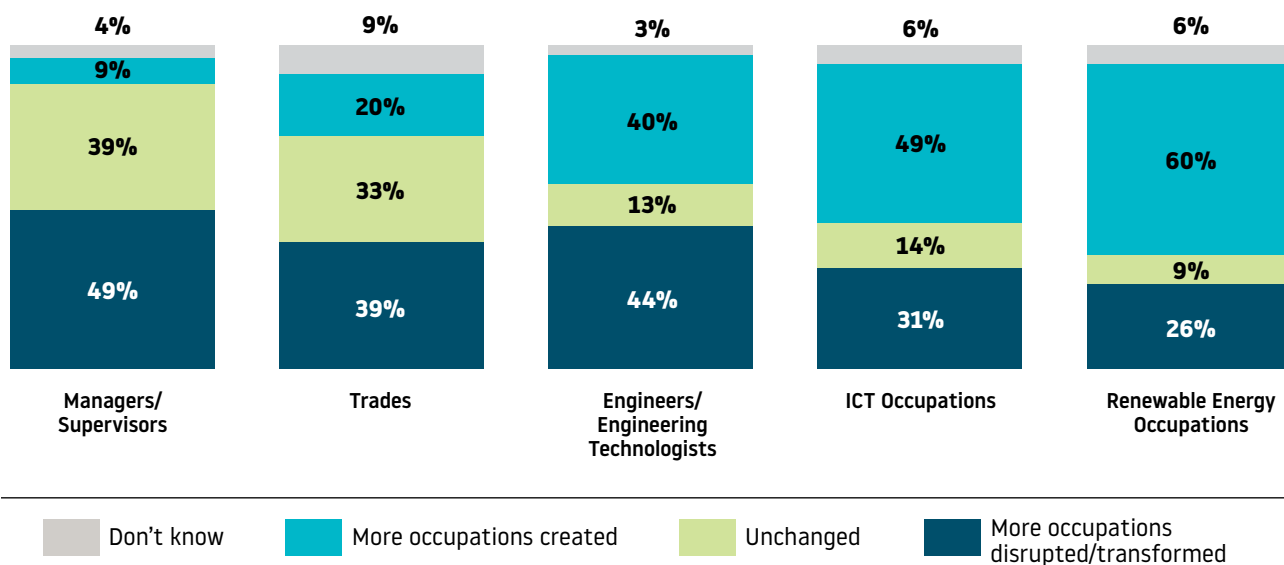
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**3 Transformation and new occupations are expected for engineers.** Few respondents (13 per cent) believe engineering occupations will be unchanged by emerging technologies, with most expecting these occupations to be disrupted or transformed (44 per cent).

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**4 Mostly new occupations are anticipated for renewables and ICT.** The majority of stakeholders agree that new technologies will drive the demand for new occupations within ICT occupations (49 per cent) and renewable energy occupations (60 per cent).

**Figure 12.** Expected changes within existing occupations, by occupational group



**Note:** The values indicate the proportion of respondents who selected each category.

### ***New occupations that will be created***

Most of our survey respondents believe that new and emerging technologies will not only transform existing occupations but also increase demand for occupations not currently utilized in the sector—and even to the creation of all-new occupations.

### **Digital occupations**

Among the new occupations identified by stakeholders, nearly two-thirds (64 per cent) require strong digital, statistical and programming skills. These include big data analysts (25 per cent), AI and machine learning specialists (16 per cent), cyber and network security experts (13 per cent), and robotics and automation specialists (9 per cent). These results are not surprising: a strong emphasis on data-driven occupations is consistent with respondents' expectation that new and emerging digital technologies will be the most disruptive to the sector in the short term.

### **Change managers**

Nearly 10 per cent of respondents identified change and innovation management as a new occupation that will be required for the future. Change management is “the process of continually renewing an organization’s direction, structure and capabilities to serve the ever-changing needs of external and internal customers” (Moran & Brightman, 2001, p. 111). A change manager is the person who can anticipate, plan for and lead an organization through those changes, and iterate the process moving forward.

During our interviews with key sector thought leaders, it became clear that reliance on external consultants to manage change hinders the success of the change process. Businesses should instead empower executives at the highest levels to own the change process. In doing so, they can ensure there is someone inside the company with the responsibility to manage any future changes. Survey respondents also commented on the need for workplaces to transform their culture and processes toward more flexible, adaptable and change-focused approaches. The responsibility for this transformation would be delegated to the change manager.



**We are significantly lacking in change management. Not knowing down the road what we’re going to look like and what skills we’ll need, we need people who are nimble, who have critical thinking skills, who can think on their feet and who can manage through significant change.**

*Key informant*

### Other occupations

Our survey respondents also identified the need for a variety of other occupations that can respond to the impacts of climate change, including infrastructure designers (in particular, smart city designers), energy storage technicians, and environmental modelling experts and meteorologists. The fact that these occupations were mentioned reflects a recognition of the role renewable energy sources that are dependent on weather conditions—notably, solar and wind—will play in the future mix of the electricity supply.

**Table 1.** Expected new occupations needed in the electricity sector

New occupations	%
Data and big data analysts and engineers	25%
Artificial intelligence and machine learning specialists	16%
Cyber and network security experts	13%
Robotics and automation specialists	9%
Change management and innovation officers	9%
Infrastructure planners and smart city designers	5%
Energy storage technicians	5%
Environmental modelling experts and meteorologists	4%
Other technical occupations (e.g., regulatory specialists, technical and technological specialists)	11%

**Note:** Percentages represent the number of respondents who identified a new occupation corresponding to one of the listed categories divided by the total number of respondents who responded to the question.



Skills needed  
for **workers**  
to **succeed** in  
an evolving  
industry





As the sector embraces an ever-increasing number of new and emerging technologies, new sets of skills will be needed to make the most of them. Before thinking about training and skills development, though, organizations first need a firm grasp on which skills will actually be required by the next-generation electricity workforce—and the extent to which those do (or do not) already exist among their employees.

## The skills needed by tomorrow's electricity workforce

In an increasingly digital landscape, electricity workers will require new skills to keep up with industry demands. Our research looked at what those skills might be, which ones are considered most necessary by sector stakeholders, and how well the workforce is prepared for technological change.

### **Overarching skills categories**

Based on our analysis of market trends, employer expectations and technological changes, we have identified three overarching types of skills that will likely be required of future workers in the electricity sector: specialized technical and digital skills, critical business skills and blended skills.

### **Specialized technical and digital skills**

The electricity sector will require an increasing number of workers with specialized skills. The observation in Australia indicates that specialized skills are required to “identify, analyze, develop, support, operate and complement digitalized technologies” (Energy Skills Queensland,

2017, p. 24). As digital technologies reduce the overall number of workers required in certain occupations, the demand for specialized skills is expected to increase, with higher levels of skill and educational qualifications required for even entry-level occupations.

The future of the electricity sector will require workers with strong digital and data-analysis skills. Accordingly, the majority of these specialists are expected to come from enhanced science, technology, engineering and mathematics (STEM) programs, including computer programming, data analytics, statistical analysis, big data manipulation and machine learning (Energy Skills Queensland, 2017).

### **Critical business skills**

The term “critical business skills” refers to a number of personal, interpersonal and professional skills that allow individuals to interact effectively with colleagues and clients in the workplace. These include communication and presentation skills; interpersonal skills such as leadership, management, and teamwork; and thinking skills such as creativity, problem solving and critical thinking.

**Strong digital and data-analysis skills** will be a must for future electricity workers.

Professional skills such as active listening, continuous learning, critical thinking and decision-making, self-awareness, social perceptiveness, time management, speaking, reading comprehension and collaboration are all highly sought after by employers across all sectors. Other skills that are often considered important professional skills include communication, leadership, ethics and professionalism (Electricity Human Resources Canada, 2020a).

As smart grids, smart meters and decentralized energy sources become more prominent, electricity workers will increasingly be required to interact with clients and manage these relationships. Consequently, demand for workers with well-developed critical business skills is only expected to increase (Australian Power Institute, 2015; Lawrence & Hogan, 2015).

### **Blended skills**

Increasingly, employers are looking for people who have a *combination* of skills—and especially those who can integrate digital skills with traditional technical knowledge.

The ideal employee of the future will have the necessary skills to understand the technical requirements of the electricity sector, seamlessly incorporate new digital technologies into their work, recognize both the business and marketing needs of the company, and communicate effectively with clients (Australian Power Institute, 2015; Lawrence & Hogan, 2015).

Employers will be looking for people who can **integrate digital skills** with traditional technical knowledge.

The desire for blended skill sets that combine technical knowledge with human relational and social skills, such as empathy and collaboration, has led some researchers to describe the workforce of tomorrow as the “STEMpathetic workforce” (Schwartz, Stockton, & Monhan; 2017). Indeed, strong socio-behavioural skills are seen as valuable in the labour market as they encourage stronger collaboration and teamwork, and are the least likely to be automated (World Bank, 2019).

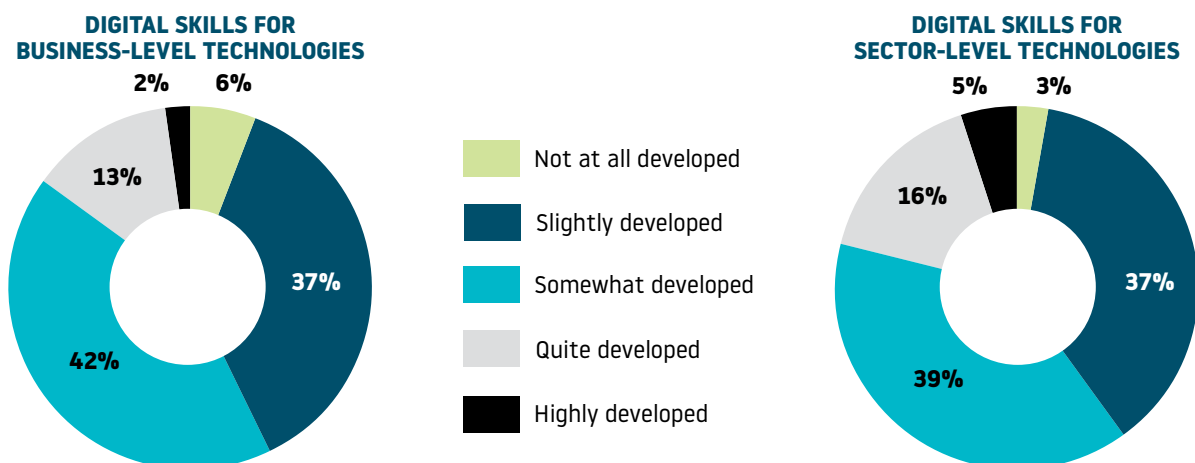
### ***Skills profile of today’s electricity workforce***

We asked our survey respondents to assess the extent to which their current workforce has the digital skills and knowledge needed to use the technological innovations that are transforming businesses in general and the electricity sector specifically.<sup>3</sup> The results suggest that most workers in the sector have digital skills that are either slightly developed or somewhat developed, indicating they might lack the full set of digital skills that will be required as the sector transforms.

Notably, a slightly higher proportion of respondents believe their workers are more likely to have developed digital skills for technologies that are specific to the electricity sector. Respondents said workers have digital skills that are either quite developed (14 per cent) or highly developed (4 per cent) for sector-specific technologies, compared to 13 per cent and 2 per cent, respectively, for more general business-level technologies.

<sup>3</sup> As described earlier in this report, business-level technologies include digital and data-driven innovations, such as AI and big data; as well as hardware technologies, such as drones and virtual reality. Sector-level technologies include green technologies, such as advances in renewable energy and energy storage; and smart technologies, such as smart meters and smart grids.

**Figure 13.** Extent of digital skills and knowledge of current electricity sector workers



**Note:** The values indicate the proportion of respondents who selected each category.

### Stakeholder perspectives on future skills

As part of our survey, respondents were asked to comment in two ways on the types of skills and knowledge that will be required for future workers in the electricity sector:

- 1 Ranking the skills and knowledge from most necessary to least necessary
- 2 Assessing the extent of these skills' development in the sector's current workforce

### Necessary skills for the future workforce

Survey respondents ranked blended skills as the most important for the future of work in the sector (Figure 14). They also ranked technical and applied skills as being highly important for future workers. Their answers (along with the insights gathered through our key informant interviews) made it clear the sector will need workers with cross-functional skills and a blend of technical knowledge and digital skills. Stakeholders agree that data analytics, statistical analysis, big data manipulation and advanced digital skills will all be in high demand. However, the fact

that digital and data analysis skills ranked lower than technical and applied skills suggests the electricity sector continues to place more value on workers who have the technical prerequisites needed to work in the sector.

Least important to our survey respondents were machine learning skills, knowledge of regulatory and legal issues, and specialized knowledge through graduate programs.

### Extent of necessary skills' development in the current workforce

As shown in Figure 15, there is significant disagreement among stakeholders about the extent of development in the most necessary skills and knowledge among the sector's current workforce. With the exception of technical and applied skills, where a majority of respondents (52 per cent) believe these are developed to a large extent across the sector, there is no clear consensus as to the extent of workers' existing skill levels.

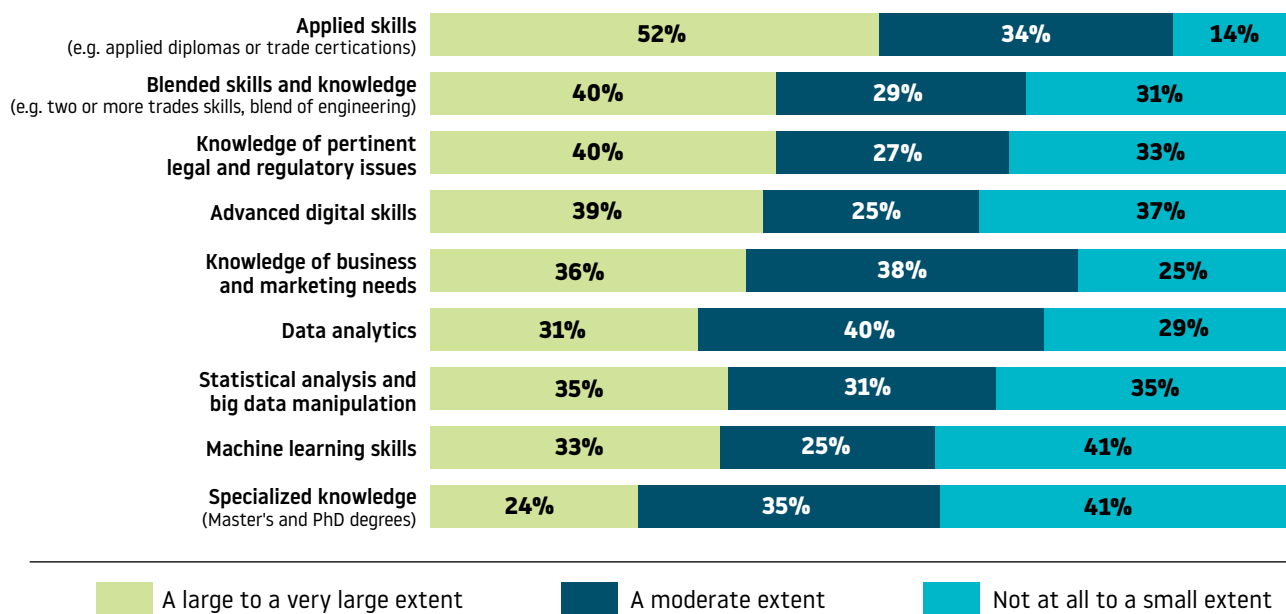
The areas of greatest concern—those where most respondents believe the workforce's skills are lacking considerably—are specialized knowledge (41 per cent), machine learning skills (41 per cent) and advanced digital skills (37 per cent). Regarding machine learning skills, this finding reflects the overall lack of importance stakeholders associate with those skills.

**Figure 14.** Skills that will be necessary for the future of work in the electricity sector



**Note:** Data in this figure represent weighted sums, expressed as a proportion relative to the maximum weighted sum possible for each category (N\*number of items). Higher values correspond to a greater number of respondents ranking the skill as being necessary for future workers in the sector.

**Figure 15.** Extent of development of the skills that will be necessary for the future of work



**Note:** The values indicate the proportion of respondents who selected each category.



The key to delivering **adequate and comprehensive skills** training is the building of relationships between key stakeholders.

## The future of training and skills development

The transformation of the electricity sector will require a concerted effort from employers as well as postsecondary and training institutions—such as universities, colleges and polytechnics—to ensure current and future workers have the skills to succeed.

The key to delivering adequate and comprehensive skills training is the building of relationships between key stakeholders in the electricity sector and the education and training sector. Developing responsive curricula for occupations in the sector will also require greater alignment of the priorities of policymakers, employers, workers, students, unions, utilities and postsecondary institutions.

Our research explored the extent to which employers in the sector are prepared to address the skills needs of their workers. This includes the proportion of employers that have a plan to address skills needs resulting from technological changes, the proportion of businesses currently offering workplace training, and the proportion of training programs that directly address digital skills. Additionally, we assessed the extent to which postsecondary and training institutions are providing students with the education and skills they'll need for a future in the electricity sector.

### ***Workplace training programs***

The expected scale of digital transformation in the sector will eliminate some existing occupations but transform many others. Workers currently in these occupations will need training and upskilling to ensure they can adapt to new job requirements. Because companies can't afford to send their entire workforce back to school, much of this training will need to be offered through workplace training programs.

Workplace training programs are important tools for employee skills development or upskilling. In contrast to postsecondary and training programs that focus on specific occupations or general programs of study, workplace training offers contextualized and relevant skills development to ensure workers have the skills needed in their own workplaces. Employers have an opportunity to select training programs that directly address common knowledge gaps in their workers, often customizing curricula in ways that improve their employees' job performance.

Our national survey sought to uncover the extent to which companies offer workplace training to their employees. Nearly one-third of survey respondents (30 per cent) said they work at companies with no training programs on offer. Of those organizations that do offer training, many provide it in the workplace (38 per cent) while some partner with training firms for delivery (30 per cent). Just over one-quarter of respondents (26 per cent) work with a postsecondary or training institution (e.g., college, university, polytechnic) to develop or deliver workplace training. A smaller proportion of respondents (13 per cent) indicated using a different format for skills training, generally on an ad hoc basis as needs arise, at an employee's request or as part of an employee's learning plan.

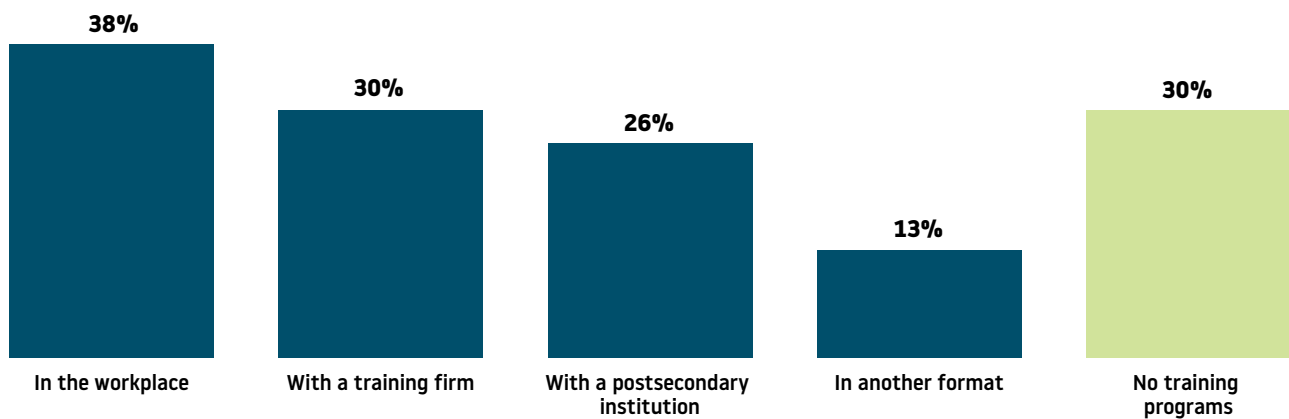


How do we expose [workers] to other occupations so that there is a bit of a transition and at what point do we start doing that? In some of our HR programming, we're looking at cross-functional training and job shadowing, to try to pique interest in people, to try to think outside their technical career box of what maybe 10, 20, 30 years ago their future would look like.

We're starting those conversations about how we can get people thinking about what else they could potentially do that would be a fit and then really making sure that that in our assessments, we're assessing talent. We're not as narrow-minded in terms of career pathing anymore. We're trying to take a broader look when we're talking about career pathing. It's changed how leaders and how HR are talking to people about it. And we have to be way more flexible.

*Key informant*

**Figure 16.** Extent and format of workplace training programs in the electricity sector

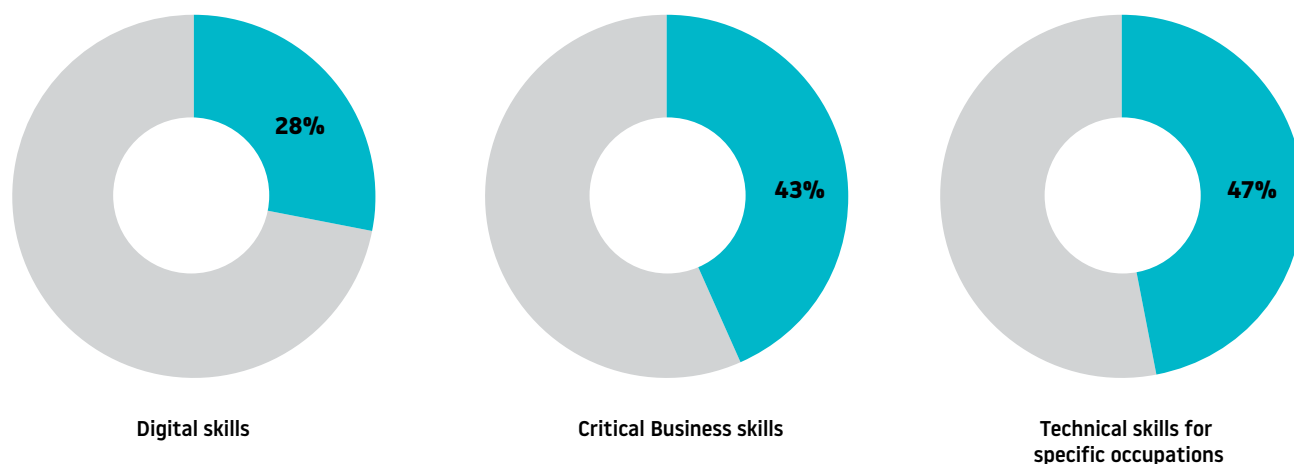


**Note:** The values indicate the proportion of respondents who selected each category.

Among the organizations that provide training programs to their workers, less than one-third (28 per cent) offer programs that target digital skills. Most workplace training programs (47 per cent)

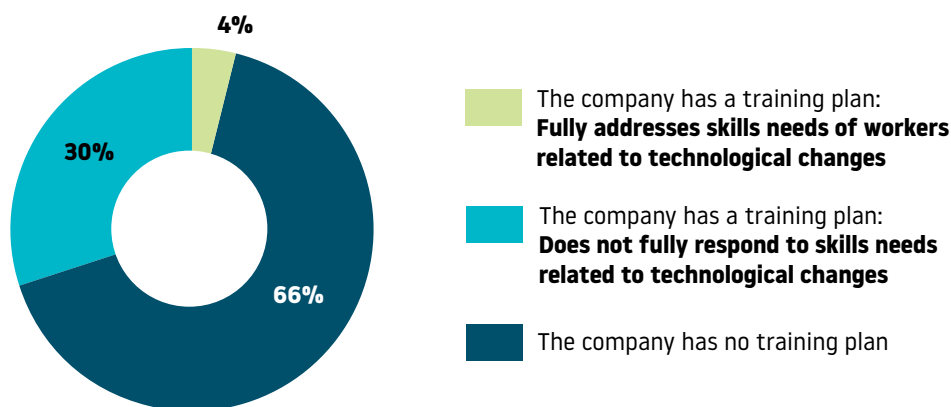
focus on technical skills development for specific occupations, and just under half of responding organizations (43 per cent) have programs that seek to enhance critical business skills.

**Figure 17.** Types of skills addressed by workplace training



**Note:** The values indicate the proportion of respondents who selected each category.

**Figure 18.** Workplaces with a plan to address skills needs of workers



**Note:** The values indicate the proportion of respondents who selected each category.

Organizations with a training plan to address the skills needs of their workers, especially those with plans to address digital skills needs, will be well placed to manage the sector’s digital transformation. While more than two-thirds of the companies we surveyed report having a training plan in place, only four per cent have

a plan that fully addresses the skills needs of workers in relation to technological changes. Most organizations (66 per cent) have training plans that fall short of responding to the expected technological changes in their workplace.

These survey results echo similar opinions shared by our key informants. In effect, there is a great deal of disagreement among stakeholders regarding companies' responsibilities for upskilling their workforces. Respondents tend to describe the implications of the sector's transformation in one of two possible scenarios: rapid transformation or progressive transformation.

### RAPID TRANSFORMATION

#### REPLACE AND REHIRE

**Stakeholders expect change to happen quickly. Rather than retrain their workforce, they expect their workforce to transform through new hires.**

Stakeholders believe digital transformation will increase the demand for occupations in vastly different fields than their current workforce. Utilities will transform into information management companies, relying on big data and artificial intelligence to optimize the flow of electricity to their customers.

As decarbonization strategies accelerate, the sector will rely on fewer large-scale, labour-intensive coal power plants. Fewer jobs in energy generation will be available, with very little opportunity for upskilling/reskilling workers.

Responding to these changes will require replacing workers with new hires and seeking out workers with the required skills for new occupations.

### PROGRESSIVE TRANSFORMATION

#### RETRAIN AND SUSTAIN

**Stakeholders expect change to happen progressively and believe training their existing workers with future skills is not only their responsibility but also good business sense.**

Stakeholders believe the transition toward digital technologies and a decentralized grid will happen progressively, over a period of years. This transition will include a significant period of technological overlap, requiring workers to interact and operate both new and legacy technologies.

In this scenario, employers will require workers with a combination of old and new skills.

Training existing workers will be a dual responsibility, shared by workers and organizations. Wherever possible, workers with the motivation to learn should be given opportunities to acquire new skills, either in the workplace or in postsecondary and training institutions.

Uncertainty about how and when this transformation will occur, and the extent to which the sector's existing workforce will be able to adapt to the new digital reality, appear to be contributing to the emergence of the two change scenarios described above.

While these scenarios may seem to present competing alternatives, they can actually be seen as complementary pathways for change. Both expect transformational change within the electricity sector, driven in large part by a shifting focus away from hardware and energy generation toward software and data.

Both scenarios also see digital skills as central to the future of the sector, emphasizing the importance of

training future and current workers to ensure they have those skills. However, the first scenario (rapid transformation) focuses on occupations that will be phased out, while the second (progressive transformation) focuses on occupations that will be transformed. In the latter case, workplace training programs would be most appropriate and potentially more successful for worker retention.

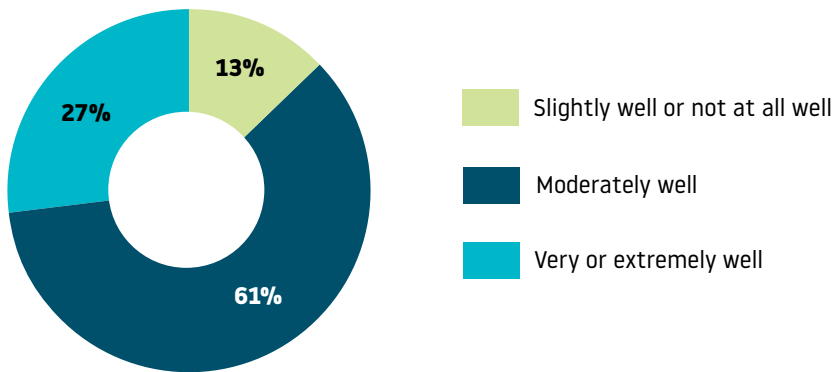
In both scenarios, comprehensive and substantive planning for workforce replacement and workforce retraining will be needed, especially to differentiate between occupations that will be eliminated or replaced and those that may be suitable for workplace upskilling or reskilling (if any).

### **Postsecondary education and training programs**

Training electricity sector workers should be a shared responsibility between employers and training institutions. Future electricity workers currently studying at a postsecondary or training institution are expected to have acquired the skills and competencies needed to excel in their occupations once they complete their program. However, as the sector transforms, training institutions will need to be responsive to technological changes and the evolving skills requirements of a digital workforce.

A majority of survey respondents (61 per cent) believe postsecondary and training institutions are moderately well-equipped to provide students with the skills needed for the future of work in the electricity sector. More than one-quarter (27 per cent) believe these institutions do this very or extremely well. While only a small proportion of respondents (13 per cent) feel these institutions are falling short of meeting training expectations, the responses we received indicate that there is substantial room for all postsecondary and training institutions to improve.

**Figure 19.** Capacity of postsecondary institutions to provide students with the skills needed for future work in the electricity sector



**Note:** The values indicate the proportion of respondents who selected each category.

There are a number of options available to postsecondary and training institutions to make their programs more effective, including improving alignment with industry priorities, offering more opportunities for work-integrated learning and adapting learning pathways to foster lifelong learning.

### **Structured systems for aligning industry priorities with skills development**

As discussed earlier, many new and emerging technologies will start transforming the sector in the next few years. To ensure students have the skill sets they need, the education system must be aware of and responsive to the needs of the electricity sector (Energy Skills Queensland, 2017). With skill demands

changing so rapidly, training institutions and sector stakeholders need to be engaged in a more systematic and structured process to facilitate curricula development and make substantive improvements to existing training programs.

Designing curricula that are responsive to the changing nature of work in the sector will require aligning priorities across multiple stakeholder groups, including policy-makers, employers, workers, students, unions, utilities and postsecondary training institutions. Many of our key informants mentioned working with postsecondary institutions to develop and deliver workplace training programs, although few are actively engaged in a process to improve educational curricula or training programs.



## Work-integrated learning

Work-integrated learning is a type of experiential education offered by postsecondary institutions that formally and intentionally combines academic studies in the classroom with practical, hands-on experience in a real workplace setting (Electricity Human Resources Canada, 2020b). That mix of technical and professional skills makes students better prepared to enter the workforce, for the benefit of employers and graduates alike.

This approach to learning has long been promoted by employers in the electricity sector, who have encouraged postsecondary institutions to integrate more “real-world” applications and opportunities for skills development into their programs (Lawrence & Hogan, 2015).

In Canada, work-integrated learning has emerged as a “key pedagogical strategy to enhance student learning and development” (Stirling et al., 2016, p. 4). The Higher Education Quality Council of Ontario defines work-integrated learning as consisting of three types of learning approaches:

- 1 Systematic training**, where the workplace is the student’s primary learning environment (e.g., apprenticeships)
- 2 Structured work experience**, where students participate in co-op programs or internships facilitated by their postsecondary institution so they can familiarize themselves with a professional environment related to their studies
- 3 Institutional partnerships**, where postsecondary institutions partner with industry or community organizations to provide students with work and volunteer experiences that advance the goals of the curriculum

## Pathways for lifelong learning

Continuous improvement and lifelong learning is already good practice for workers to maintain and increase their skills. In the future of work, it is expected to be the norm.

Policymakers, employers and researchers alike expect the scope of technological change across the economy to radically and rapidly transform how Canadians work. Opportunities for upskilling to meet the skill requirements of a changing economy and reskilling to transition to in-demand occupations will be necessary if Canada is to remain competitive on the global stage.

However, postsecondary programs have limited options available to workers who want to acquire new skills in a timely fashion and without leaving their current jobs. A more flexible lifelong learning pathway that considers the non-linear career path of workers, the need for flexible learning opportunities and new short-term targeted programs (such as microcredentialling) will be important to maintaining a highly skilled workforce.

In Budget 2019, the Government of Canada signalled its commitment to lifelong learning by announcing the Canada Training Benefit. Eligible workers between the ages of 25 and 64 will be able to accumulate \$250 per year, up to a lifetime maximum of \$5,000, to refund half the costs of courses and training (Government of Canada, 2019). The program will also include up to four weeks of income support for workers taking a leave from work to pursue education or training. The Canada Training Benefit aims to address the most crucial barriers Canadians face to ongoing learning and retraining, and provides a long-term benefit to employers who will end up with employees with upgraded skills and greater confidence about their ability to succeed.



## **Stakeholder perspectives on education and training**

Stakeholders overwhelmingly believe the quality of education programs can be improved if employers and postsecondary institutions work more closely together. In our survey, the highest-ranked strategies for improving the quality of education include greater collaboration between employers and training institutions to develop curricula, greater integration of training and education programs with workplace experience (e.g., seminars or targeted trainings sessions for new technical skills in specific occupations), more opportunities for structured work experiences (e.g., co-op programs, internships), and more real-world applications within the classroom.

Short-term upskilling programs are another important priority for stakeholders. These programs would target credentialled workers already employed in the sector, with shorter study periods providing them with greater flexibility to pursue education and training without having to leave their jobs.



**We have active partnerships with academia to ensure we have a pipeline of people that we need. We have active partnerships with colleges to train people. We work with them, whether it's a formal partnership or not, to provide input on the kinds of skills and curricula that we need.**

*Key informant*

Additionally, stakeholders believe adopting a formal collaborative process for developing training programs should be prioritized. Such a process would facilitate knowledge exchange between training institutions, employers and stakeholder groups, increasing the responsiveness and adaptability of postsecondary programs. It would also allow industry to inform the design of new programs or recommend improvements to existing programs, such as integrating digital skills within the curricula of technical programs.

As shown in Figure 20, our survey results also revealed a second “tier” of four strategies for improving training and education programs, all of which were ranked by respondents in roughly the same proportions.

The first of these strategies is for postsecondary institutions to offer dual certifications (i.e., a combination of college diploma and university degree). This approach is slightly different than joint programs (i.e., combining more than one specialization within the same program), which was ranked lower by respondents. Dual certifications have positive appeal for stakeholders because they offer hands-on, applied skills in combination with theoretical knowledge. Examples of successful bridging programs between colleges and universities, such as nursing, could serve as models for specific occupations in the electricity sector.

Also part of this second tier are opportunities for workplace learning and condensed reskilling programs specifically for credentialled workers. These two approaches essentially target similar populations: workers who are already trained and employed. Reskilling programs will become particularly important for workers in occupations that are no longer needed in the industry. Designing workplace training programs that can help reskill these workers—and also increase the skills of the entire workforce more broadly—could be an interesting approach.

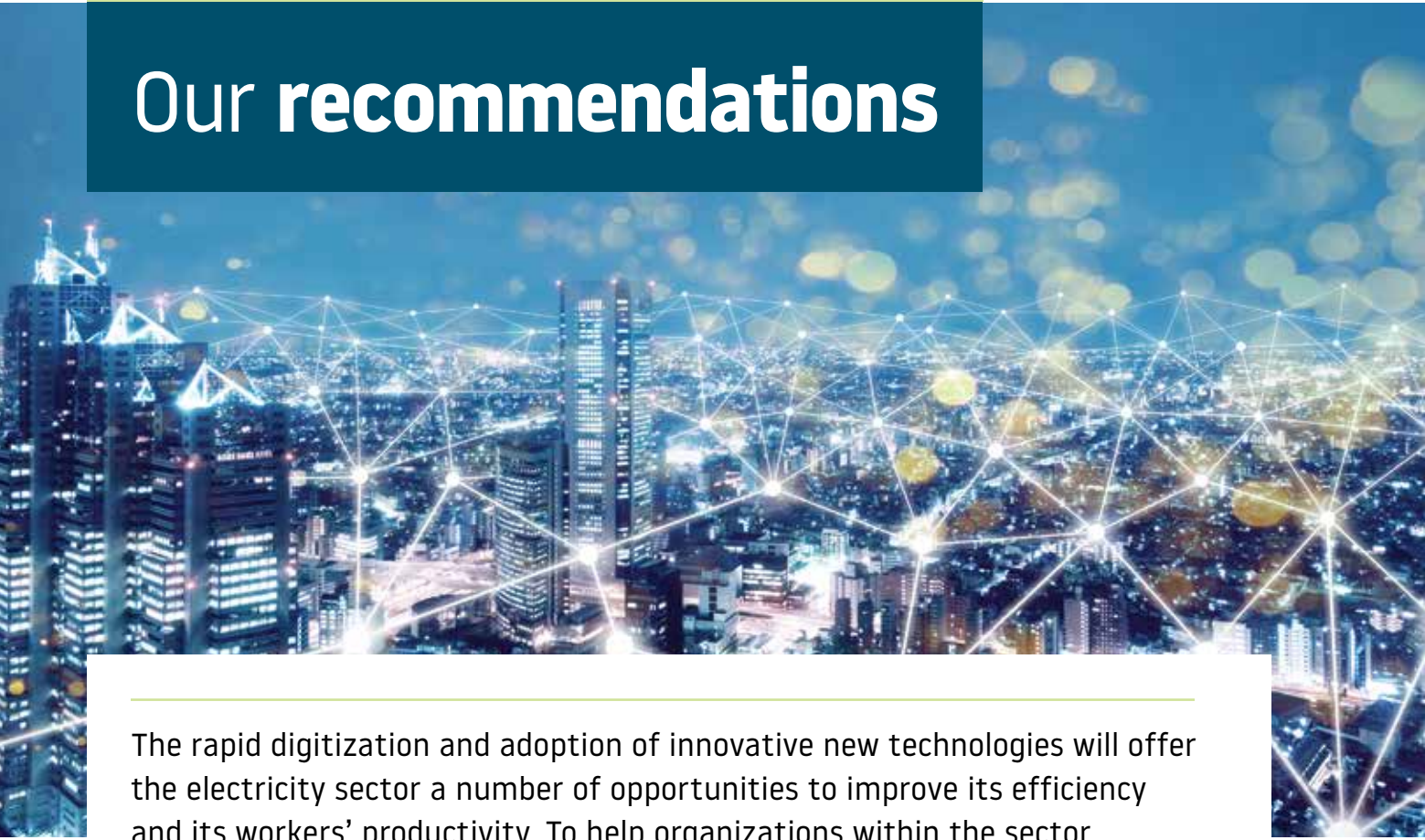
Organizations are less inclined to prioritize the integration of augmented reality (AR) and virtual reality (VR) technology in the classroom, or to increase opportunities for online and distance learning.

**Figure 20.** Strategies to improve postsecondary training



**Note:** The values indicate the proportion of respondents who selected each category.

# Our recommendations



The rapid digitization and adoption of innovative new technologies will offer the electricity sector a number of opportunities to improve its efficiency and its workers' productivity. To help organizations within the sector take advantage of these opportunities, we have put forward a number of recommendations that focus on three primary activities:

- 1** Developing a workforce management and training plan for a digital future
- 2** Developing an industry-wide learning ecosystem
- 3** Adapting existing systems and processes to focus on change and innovation



# 1 Developing a workforce management and training plan for a digital future

The future of the electricity sector lies in its capacity and ability to manage, analyze and interpret large quantities of data. However, the findings from our research clearly indicate that the current workforce lacks the digital skills the sector needs to succeed. To take advantage of the opportunities of a digital future, organizations should develop a workforce management and training plan that considers both their future recruitment strategy and the training needs of the current workforce.

## ***Develop a recruitment strategy for the future workforce***

- **Identify the occupations needed in the future:** Demand for workers in renewable energy and ICT occupations are expected to increase in tandem with technological change. While our research takes a broad view of the industry as a whole, organizations should conduct similar activities, looking internally to determine what the composition of their future workforce will look like. Part of this exercise will require a re-examination of current occupations to determine what technologies will be introduced into the workplace, what occupations will be responsible for managing these technologies, what tasks will be required of these occupations, and what new skills will need to be learned (if any).
- **Articulate a recruitment strategy:** Organizations will need to develop a recruitment strategy that targets needed occupations over the medium and long terms. The sector may find itself competing for skilled talent with leading digital and ICT companies such as Google, Shopify, Amazon and even large financial institutions. A recruitment strategy developed in collaboration with unions, trade organizations and training institutions could help establish talent “pipelines” that bring postsecondary students from the classroom to the workplace. The strategy could also explore opportunities to expose high-school students to the sector, encouraging them to consider careers in the electricity sector.

## ***Assess the training needs of current workers***

- **Develop a workplace training plan:** Any effective training plan must identify knowledge and skills gaps that hinder workers’ job performance. An organizational needs assessment can help customize learning plans that are responsive to the needs of workers.
- **Reskill workers:** Some occupations may no longer be needed as a result of technological change. To maintain organizational knowledge and experience, employers will have to determine whether reskilling workers to needed occupations is possible.
- **Upskill workers:** Technological change is expected to transform a number of occupations, especially managers, tradespeople and engineers. Current workers may find that they lack the skills needed to perform new digital tasks. To prevent productivity loss and to fully benefit from the opportunities provided by the latest innovations, employers will need to ensure their workers have the digital proficiency needed to perform these new tasks.



## 2 Developing an industry-wide learning ecosystem

Training institutions, regulators, governments and unions all have a role to play in ensuring workers have the skills they need. As emerging technologies become more commonplace and legacy equipment is more widely integrated within an Industrial Internet of Things, specialized skills (such as cybersecurity expertise and digital skills) and critical business skills (such as problem-solving and teamwork skills) will need to be embedded within academic and training curricula. To ensure that all actors are moving in concert, stakeholders in the industry should strive to implement a learning ecosystem that is built on strong partnerships.

### ***Work with partners to develop curricula and innovative training programs***

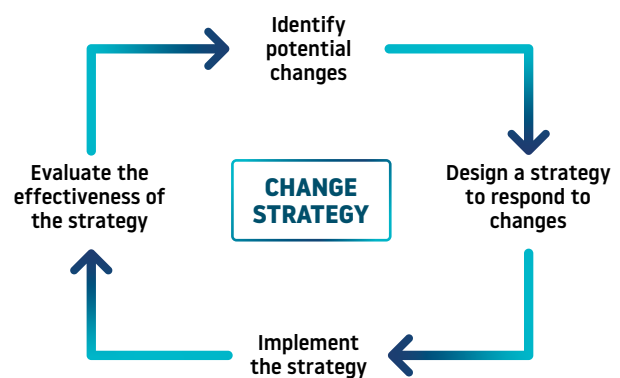
- **Develop responsive curricula:** Organizations in the electricity sector should establish ongoing partnerships with postsecondary and training institutions, including universities, colleges and polytechnics, to improve the curricula of relevant programs. These partnerships could inform the content and format of academic and training programs, ensuring that they:
  - Teach skills that are relevant to a digital workplace
  - Offer opportunities for work-integrated learning
  - Are responsive to the changing needs of the sector
- **Design customized learning programs to upskill workers:** The sector's current workforce will need to adapt to technological changes and gain new digital skills. By partnering with postsecondary and training institutions, organizations in the sector can help develop customized curricula that specifically target the skills gaps of their workers and inform their learning plans. The formats of these programs could be tailored to the needs of the workplace, which could include:
  - Cross-functional training, job shadowing and informal learning opportunities
  - Structured mentorships between experienced and new workers
  - Flexible learning programs, including short-term and carousel training models

## 3 Adapting existing systems and processes to focus on change and innovation

Digital transformation consists not only of a physical or informational change but also structural, cultural and procedural change. Digital workplaces require a digital mindset, one that is continuously learning and adapting. Companies must be prepared to adapt to change—and this requires a close examination of workplace structures along with an openness to innovate. To succeed in this transformation, organizations across the electricity sector should focus on adapting their internal processes by embracing a culture of change and innovation.

### ***Adopt a culture of change***

- **Empower change managers to implement a change strategy:** Stakeholders commented on the importance of empowering internal change managers at the highest levels of a company to implement and manage large-scale transitions. Rather than relying on external consultants, putting in place an internal change manager with executive decision-making authority ensures that someone within the company will always be responsible for managing and implementing the change strategy. Still, a change strategy will succeed only if the entire executive and management body of a company supports and owns the various aspects of the change strategy that fall within their sphere of control. Engagement, commitment and accountability must be shared by all members at the executive level.





## ***Make learning and innovation a part of workplace culture***

- **Develop a lifelong learning strategy:** If the pace of technological change continues to accelerate, companies will need to ensure they have a skilled workforce to remain competitive. Designing a flexible lifelong learning pathway that considers non-linear career paths and the need for flexible learning opportunities, and provides short-term targeted learning programs such as microcredentials, can help organizations maintain a highly skilled and competitive workforce.
- **Champion opportunities for innovation:** Shifting toward a digital workplace will require more than digital proficiency. Because digital workplaces are data-driven hubs for innovation, companies should strive to instill a culture of innovation from

within—starting by implementing more flexible processes for learning, innovation and skills development. For a sector whose primary output is a reliable service, focusing on innovation and change adds a layer of uncertainty. However, with the right planning, networks and management structures in place, the sector could become an incubator for new ideas.

- **Adopt more flexible workplace structures:** Flexible workplaces are more informal and less structured than traditional bureaucratic and vertical structures. By transforming the chain of command for internal decision-making processes and by placing greater emphasis on collaboration, adaptability and the achievement of common business goals, flexible workplaces can react more quickly to problems and foster a culture of innovation.

There are two main characteristics of **flexible workplace** structures: **workplace flexibility** and personal flexibility. While no single structure will satisfy the needs of every organization, a recent survey on international workplaces has shown that integrating flexible workplace practices can increase productivity and help attract and retain workers (International Workplace Group, 2019).

### **WORKPLACE FLEXIBILITY**

#### **FOSTERING INNOVATION BY EMPHASIZING HORIZONTAL RATHER THAN HIERARCHICAL DECISION-MAKING**

- Promote cross-departmental collaboration
- Empower workers to find solutions to workplace problems
- Encourage employee-led projects and support innovative ideas
- Adopt accountability policies focused on output

### **PERSONAL FLEXIBILITY**

#### **GIVING EMPLOYEES GREATER CONTROL OVER THEIR WORK LIFE**

- Encourage greater autonomy in setting work hours and workdays
- Offer flexibility in work locations, when appropriate
- Adopt purposeful internal communication strategies

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# Appendix A: Table of figures

<b>Figure 1.</b> Technologies with the potential to transform electricity sector business processes	10
<b>Figure 2.</b> Timeline for impact on electricity sector business processes	13
<b>Figure 3.</b> Technologies with the potential to transform electricity sector operations	14
<b>Figure 4.</b> Timeline for impact on electricity sector operations	17
<b>Figure 5.</b> Drivers of technological change in the electricity sector	18
<b>Figure 6.</b> Perceived changes in labour demand by electricity sector occupational group	24
<b>Figure 7.</b> Net expected changes in labour demand by occupation: Managers	26
<b>Figure 8.</b> Net expected changes in labour demand by occupation: Engineers	27
<b>Figure 9.</b> Net expected changes in labour demand by occupation: Trades	27
<b>Figure 10.</b> Net expected changes in labour demand by occupation: Renewables	28
<b>Figure 11.</b> Net expected changes in labour demand by occupation: ICT	28
<b>Figure 12.</b> Expected changes within existing occupations, by occupational group	30
<b>Figure 13.</b> Extent of digital skills and knowledge of current electricity sector workers	35
<b>Figure 14.</b> Skills that will be necessary for the future of work in the electricity sector	36
<b>Figure 15.</b> Extent of development of the skills that will be necessary for the future of work	36
<b>Figure 16.</b> Extent and format of workplace training programs in the electricity sector	38
<b>Figure 17.</b> Types of skills addressed by workplace training	39
<b>Figure 18.</b> Workplaces with a plan to address skills needs of workers	39
<b>Figure 19.</b> Capacity of postsecondary institutions to provide students with the skills needed for future work in the electricity sector	41
<b>Figure 20.</b> Strategies to improve postsecondary training	44



# Appendix B: Research design

Our research was conducted using a national, sector-based consultation approach, supported by a comprehensive review of relevant documents and literature. This appendix details the process and methods used by researchers to complete the project.

## Research questions

Through this study, we sought to understand and communicate the implications of the changing nature of work on workforce composition, the skills that will be needed in the sector going forward, and the education and training of new workers entering the sector as well as the skills upgrading and retraining that will be necessary for the sector's current workforce.

We started with four overarching **primary research questions**:

- 1** *What are the technological changes that will affect the electricity sector?*
- 2** *What are the factors driving these technological changes?*
- 3** *What will be the effect of these changes on the electricity sector?*
- 4** *How should stakeholders respond to these changes?*

For each primary question, we then developed a number of supporting questions to guide the research.

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**PRIMARY QUESTION 1:*****What are the technological changes that will affect the electricity sector?***

- What are the known new technologies that are currently transforming the sector? What are the expected new technologies that have the potential to transform the sector?
- When are these changes expected to occur?
- What is the current state of training in the electricity sector for new entrants and for existing workers (e.g., on-the-job training)?

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**PRIMARY QUESTION 2:*****What are the factors driving these technological changes?***

- What are the key drivers of change in the industry?
- Who are the primary leaders pushing for digitization and automation in the industry?
- To what extent are public policies related to energy infrastructure and clean energy encouraging these changes?
- What are the factors limiting or facilitating these changes (e.g., ability of staff to learn, policies allowing for lifelong learning)?

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**PRIMARY QUESTION 3:*****What will be the effect of these changes on the electricity sector?***

- How will new technologies change labour demand? To what extent are new technologies expected to displace or augment work?
- Are any new occupations expected to be created or demanded from the sector (e.g., cybersecurity programmers)? What skill sets and competencies will be required of these new occupations?

- How will new technologies affect the demand for skills, including expertise, technological skills and soft skills (e.g., creativity, communication, teamwork, leadership, initiative, empathy)? How will demand for these new skills affect workflows and management skills?
- Which occupations within the sector are expected to be the most affected by these changes? Which job functions for each affected occupation will be affected? In the future, what new competencies will be required of current occupations?
- What are the specific skills that will be required of workers in the electricity sector? How do these skills differ by occupation?
- What core competencies will be required across occupations or occupational groups within the electricity industry?
- What upskilling or reskilling will be needed to address any future skills mismatches? To what extent will workers need to adjust or upskill as a result of these new required competencies?

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**PRIMARY QUESTION 4:*****How should stakeholders respond to these changes?***

- How should employers restructure workplace training programs to ensure they are flexible enough to respond to upcoming skill requirements?
- How can training and postsecondary institutions better prepare new entrants for the future of work? How should these institutions change their curricula or credentialing programs to ensure their graduates have the required skills?
- What should the role of major industry players, such as unions and large investors, be to ensure workers are skilled for future jobs?



## Methodology

We used a mixed methods approach with this project, relying on qualitative and quantitative data collected from primary and secondary sources to respond to our research questions. Importantly, we sought to

provide stakeholders in the electricity sector with ample opportunities to share their perspectives and their expectations on how new technologies may affect the sector's labour force.

Three Primary research activities were completed:

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**1 Comprehensive literature and document review:** EHRC conducted an in-depth analysis of academic and peer-reviewed papers, government publications, and analysis reports by leading national and international organizations. The review first took a broad approach to the research questions, looking to understand the effects of automation and technological change on skills and labour composition in the macroeconomy. It then took a more focused lens to understand those effects on the electricity sector specifically, aiming to identify and describe new technologies that are affecting the sector, factors that are driving technological change, and opportunities for businesses and training institutions to respond to the training needs of a changing workforce.

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**2 National stakeholder survey:** The results of the literature and document review informed the development of a questionnaire for a survey that would provide electricity sector stakeholders across Canada with an opportunity to comment on the review's findings. The survey sought to

gauge respondents' expectations regarding the extent of disruption that some technologies may have on their businesses and the sector as a whole, the expected timeline of these changes, the effect of those changes on the composition and size of the sector's workforce and its occupations, and the training needs of workers resulting from technological change. Survey data were mostly quantitative in nature, with some additional open-ended questions added throughout to allow respondents to qualify their responses.

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**3 Key informant interviews:** Finally, in-depth interviews with key thinkers and leaders in the electricity sector were conducted. These 45- to 60-minute interviews allowed respondents to provide greater context on the implications of technological changes on the sector, contributing more nuanced perspectives on some of this project's key themes. Recruitment for these interviews was challenging, however, with only seven interviews completed.

## Survey sample

The national survey sought to gather the opinions and ideas of stakeholders with varied experiences and backgrounds. Invitations were sent to a wide array of individuals within the sector and in adjacent

sectors, including education and training. A total of 140 individuals responded to the survey, with 83 completing the survey in full.

The following tables provide an overview of the survey sample.

**Table 2.** Proportion of survey respondents by type of organization

Type of organization	%
Utility	48.7%
Contractor or private company	13.2%
Crown corporation	10.5%
Labour organization	7.9%
Government	6.6%
Industry association	3.9%
Professional association	3.9%
Education and training institution	3.9%
Other	1.3%

**Table 3.** Proportion of survey respondents by sector of activity

Sector of activity	%
Distribution	29.6%
Generation	14.1%
Renewable energy and energy storage	14.1%
Independent system operators (ISO)	8.5%
Transmission	7.0%
Construction	7.0%
Manufacturing and supply	7.0%
Customer-facing	4.2%
Education, training and accreditation	4.2%
Cross-sector (generation, transmission and distribution)	4.2%
Other	5.6%

**Table 4.** Proportion of survey respondents by occupational group

Occupational group	%
Managers/supervisors	17.6%
Engineers/engineering technologists	13.5%
Trades	13.5%
Human resources managers	10.8%
Information and communication technology	9.5%
Office administration and support	8.1%
Business and policy analysts	6.8%
President, owners and vice presidents	6.8%
Program, financial managers	6.8%
Renewable energy occupations	2.7%
Other	6.8%

**Table 5.** Proportion of survey respondents by area of operations

Area of operations	%
British Columbia	25.0%
Alberta	27.6%
Saskatchewan	9.2%
Manitoba	13.2%
Ontario	64.5%
Quebec	11.8%
New Brunswick	11.8%
Nova Scotia	11.8%
Prince Edward Island	11.8%
Newfoundland & Labrador	13.2%
Nunavut	7.9%
Northwest Territories	6.6%
Yukon	6.6%
International	17.1%

**Note:** Respondents' organization may operate in multiple jurisdictions. As a result, the categories are not exclusive and the sum total can exceed 100 per cent.

**Table 6.** Proportion of survey respondents by organization size

Organization size	%
Small (fewer than 100 employees)	17.1%
Medium (100 to 499 employees)	26.3%
Large (500 employees or more)	56.6%

# Appendix C: Acknowledgements

## National Advisory Committee

We express our sincere gratitude and appreciation to the following individuals who participated on the National Advisory Committee.

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Chair of the Advisory Committee  
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**Indy Butany-DeSouza**

Alectra Utilities

**Paul Dabrowski**

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FortisBC

Hydro One

Hydro Ottawa

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ILSCO of Canada

Kaihen

Kinectrics

MaRS Discovery District

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TransCanada

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