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LABOUR MARKET INFORMATION

Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce

February 2021

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Executive Summary

Canada has joined over 120 countries in committing to net-zero emissions by 2050. Increasing energy efficiency is one of the primary ways to achieve this goal and reduce our reliance on carbon-emitting energy.

The building sector has recently been acknowledged as Canada's "lowest-hanging fruit" when it comes to the cost of achieving significant carbon reduction. In 2017, ***Build Smart: Canada's Building Strategy*** established a pan-Canadian framework for the building sector in which **"energy efficiency will be the norm by 2030"**. Canada's transition to an energy efficient building stock will require our building sector to grow and evolve, along with its workforce. The individuals who **design, construct, commission, manage and retrofit** our buildings are, therefore, in a prime position to bring about changes that will make a lasting impact.

This report outlines the capacity and challenges of today's building sector workforce to achieve energy efficiency within new and existing commercial, institutional and multi-unit residential buildings. The report also suggests how stakeholders can address skills gaps in the building sector's workforce.

Overall talent needs and gaps

Our research indicates that many of the pieces are in place for the transition to energy efficient buildings. For example, the technology, equipment, materials, and processes required to build and operate energy efficient, high-performing buildings are proven and available. However, Canada's building sector workforce **does not have the widespread experience or skills required to perform their roles in a manner that achieves energy efficiency goals**. Until the essential occupations and skills become widespread, this workforce will not be fully prepared to support the development of energy efficient buildings.

The federal government's commitment to reducing carbon emissions is reflected in the introduction of the *Canadian Net-Zero Emissions Accountability Act* to the House of Commons on November 19, 2020. Among other things, this act proposes to set rolling five-year emissions-reduction targets with plans to reach each one and report on progress.

In contrast to the sequential, more siloed approach that is common today, energy efficient buildings are optimized by more integrated work processes across the building life cycle and an energy efficiency mindset. This mindset drives "building-as-a-system" throughout the building life cycle, including how the building operates, its response to external environmental factors, how the tenants enjoy it and how it holds up over time.

A "building-as-a-system" approach is integrated, collaborative, multi-disciplinary and requires a combination of technical and soft skills typically acquired through experience or cross-training. As workers are increasingly called upon to function within **multi-disciplinary teams**, soft skills such as **collaboration and facilitation become essential**. This approach will involve a **workforce culture shift**, as individuals in various occupations will need to work together throughout the building life cycle.

Occupation-specific needs and gaps

For this research, occupations needed throughout the building life cycle were clustered into nine categories:

1	**Design and engineering professionals**
2	**Energy managers, modellers, specialists and advisors**
3	**Construction management and onsite supervisors**
4	**Construction and related trade workers**
5	**Commissioning professionals**
6	**Quality control and assurance specialists**
7	**Building operators**
8	**Information technology specialists**
9	**Regulatory specialists and officers**

Designers, builders, and energy managers and specialists will be increasingly called upon to help building owners navigate myriad options and complex choices involved in the energy efficient building process. With the technology available to simulate design options and model return on investment, these professionals will be able to inform owners about the environmental, financial and social performance of their buildings and asset portfolios and drive evidence-based decision-making.

Increased digitization and automation will also have a widespread impact on the building sector and its workforce, as more and more building projects focus on achieving energy efficiency goals. Developing energy efficient buildings relies on having and using the right data to evaluate available design options, assess whether technology has been installed correctly, predict maintenance requirements and facilitate collaboration.

- As the Internet of Things (IoT) and Industry 4.0 offer the building industry technological solutions to increase energy efficiency, maximizing the benefits offered by these and other advanced technologies will result in increased demand for **digital skills and literacy** across select occupations.
- There will also be an increase in demand for **information technology (IT) specialists** in the energy efficiency building sector due to the increased use of digitization, automation, advanced building control systems and an upsurge in information management software. IT occupations that will be needed in the energy efficient building sector include **web/application developer, software developer, software programmer, cybersecurity specialist, data analyst, data engineer, data operations (DataOps) engineer, integration specialist and business intelligence (BI) developer**.

Challenges associated with attracting new talent into the building sector, combined with an aging workforce, have caused labour shortages across several occupational clusters, including **construction managers and on-site supervisors, construction and related trades workers, commissioning professionals, building operators and managers, and regulatory specialists and officers**.

Core and growing occupations and skills

To assess the capacity of the building sector workforce to meet Canada's *Build Smart* goals and an energy efficient future, we developed two categories for consideration:

Core	Growing
Occupations and/or skills currently available within the building sector workforce and that remain especially important for the growth of energy efficient, high-performing buildings.	Occupations and/or skills currently available but that are expected to grow at a faster rate than others due to their involvement with specific, energy efficient related technologies, materials and/or processes.
For example: • architects • building operation and facility manager • construction trades	**For example:** • thermal energy engineering/design • passive house design • building systems analysis

Recommendations for action

The demand for energy efficient buildings might increase for many reasons, including changes in policy and regulations, pressure from investors, falling costs, or the broader environment in which businesses operate. Regardless of the motivation, flexibility is key when it comes to driving building project owners to pursue energy efficiency goals and workers to acquire the skills and experience necessary to complete energy efficient building projects successfully. Grassroots approaches tailored to regional characteristics appear to be effective at shifting the mindset and changing the incentives of project owners, employers, and workers.

Based on our primary and secondary research, we provide seven broad recommendations for meeting the workforce requirements of an energy efficient building sector:

1. Develop labour market information and an industry outlook of workforce demand

A lack of labour market information limits quantitative insights into the employment and occupational opportunities associated with energy efficient buildings, hampering the ability of job seekers and career decision makers, educators and trainers, associations, and industry to plan effectively.

2. Promote industry and career awareness and outreach

The need to attract, develop and retain workers to the sector's talent pipeline is evident throughout the building life cycle and related occupational clusters. The building sector is challenged to compete with other industries for certain types of talent and there are risks this will escalate as the sector adopts more digital and automation technologies. The building sector is not viewed by new entrants as progressive or technologically advanced or as offering the opportunity to be involved in solving today's most pressing global problems.

3. Develop programs to target untapped supply pools and under-represented groups

Interviews with industry and industry associations indicate a strong interest in attracting a more diverse and inclusive workforce as another way to address labour and skill shortages, encourage new ideas, and improve economic equity for disadvantaged Canadians. It was also reported that, while diversity and inclusion practices were core for some companies, they are virtually absent for others.

4. Increase alignment of post-secondary education and training with industry occupation and skills needs

Our research indicates that currently available training opportunities related to energy efficient buildings are presently under-utilized. The perceived benefits of training are expected to grow as (1) the market demand for energy efficient buildings increases, (2) the soft and technical skills required to progress energy efficiency are integrated into already-offered training, and (3) comprehensive and recognized certification programs become more common for occupations such as building operators and energy modellers.

Key aspects of the effort to align education and training with occupation and skills needs will include:

- Identifying the education and training opportunities currently available and the targeted occupations
- Incorporating sustainability and systems thinking into curriculum—impact training approach as well as content
- Incorporating digital literacy into curriculum
- Supporting apprenticeship opportunities
- Developing recognized standards programs to address specific occupational gaps: e.g., Building operators
- Providing labs, simulators and other applied learning options for experiential training
- Improving experiential components of remote training, e.g., labs turned into broadcast studios

5. Improve the capacity of employers across the building life cycle to attract, hire, develop and retain workers

Employers of all sizes and types face constraints when it comes to attracting, developing and retaining workers. Organizations managing the shifts in technology, equipment and practices required to achieve energy efficient buildings may be unaware of how these changes will impact their workforce. They will need to adapt to the new environment, creating strategies to hire and develop “soft” skills and implement succession planning.

Smaller employers, who make up a significant portion of the building sector, often face greater challenges in attracting and developing their workforce and making needed organizational changes to workplace culture. Compared to their larger counterparts, smaller companies typically have tighter profit margins and fewer staffing resources, limiting opportunities to invest in career development, new processes and technology. A lack of human resources (HR) support within smaller firms also means HR activities are often carried out by the company owner, for whom attraction, retention and/or workforce development may not be a primary area of expertise.

6. Identify best practices to accelerate skills upgrades and knowledge transfer from experienced workers

Continuous learning to keep pace with advances in technology, equipment, materials and processes will become more critical to achieving energy efficiency goals. For some occupations, such as architects and engineers, continuous professional development is increasingly common and could easily be expanded to include energy efficiency knowledge and skills. Other occupations, such as trades and building operators, are not as often engaged in continuous professional development, so the concept of lifelong learning could require more conscious efforts on the part of employees and their employers.

7. Describe skills requirements and nature of work for manufacturing/prefabrication and digitization

Our research indicates that a shift to a more manufacturing-style of construction impacts skills, knowledge and approaches used by design and engineering professionals and construction and trade workers. Modular construction and prefabrication rely on specialized design thinking and require that most design decisions be made upfront as changes later in the process are difficult and costly. Anticipated increases in modularization and prefabrication will also impact workforce requirements and working conditions for construction and trade workers, as work shifts towards being performed in an enclosed and controlled factory environment, with increased coordinated and repeat activities and greater levels of automation.

Our research also identified several different labour supply touchpoints that could be leveraged to pursue these recommendations. Governments, regional economic development groups, industry associations, employers, professional associations, unions, local grassroots organizations, youth groups, diversity organizations, and post-secondary educational institutions and training providers can all play a role in the joint effort to ensure that the building sector workforce is prepared to achieve greater energy efficiency.

This study makes a first attempt at investigating the breadth and depth of talent needs and gaps within the energy efficient building sector workforce. Further work needs to be done with a more extensive range of stakeholders representing national, regional, and local interests to develop and prioritize solutions that are most effective at addressing workforce issues. Through this work, specific stakeholder groups and organizations can be identified who will participate in, or take ownership of, the implementation of solutions. Actions that adapt best practices to fit unique and ground-level needs will achieve the greatest results.

Introduction

Canada has joined over 120 countries in committing to net-zero emissions by 2050. The federal government's commitment to reducing carbon emissions is reflected in the introduction of the *Canadian Net-Zero Emissions Accountability Act* to the House of Commons on November 19, 2020. Among other things, this act proposes to set rolling five-year emissions-reduction targets with plans to reach each one and report on progress.

The building sector has recently been acknowledged as Canada's "lowest-hanging fruit" when it comes to the cost of achieving significant carbon reduction, in comparison to other high emitting sectors, and a small financial and/or behavioural nudge in this sector has the potential to unlock large environmental and economic benefits (Institute for Sustainable Finance, September 2020). In Canada, the energy used to heat, cool and light the buildings in which we live and work accounts for 17% of our greenhouse gas emissions (GHG) (Natural Resources Canada, August 2017). The individuals who design, build and operate our buildings are, therefore, in a prime position to bring about changes that will make a lasting impact in reducing the use of carbon-emitting energy. Since expectations are high for this sector to make a sizeable contribution to a low-carbon economy, increasing the capacity of the Canadian building industry's workforce to support an accelerated transition to energy efficient buildings is crucial.

In 2017, ***Build Smart: Canada's Building Strategy*** was published, establishing pan-Canadian goals for more stringent building codes and steering governments towards Net Zero Energy Ready (NZER)[1] by 2030. The materials we use, the processes we select, and the improvements we make in energy efficiency will bring us closer to these environmental goals, provided we choose from among the many value-added construction options available and emerging, and if we have a workforce ready to execute on our choices.

1 Net Zero Energy Ready (NZER) buildings are high-performing buildings built to the same level of energy efficiency as a Net Zero Energy (NZE) buildings but do not include renewable energy production. An NZER building's fundamental efficiency potential has been maximized, given the current market-ready technologies and costs of construction (labour, materials, and others), so that the remaining energy needs could be met with renewables. Zero Carbon (ZC) buildings are highly energy efficient and produce onsite, or procure, carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations (Canada Green Building Council, May 2017).

We conducted this research to inform workforce and career planning, policy and program development, and talent management practices that support the transition to an energy efficient building sector. This report focuses on the occupations and skills needed for designing, constructing, managing, and retrofitting energy efficient commercial and institutional buildings and multi-unit residential buildings (MURBs).[2] Our objectives were to:

ASSESS THE OCCUPATION AND SKILLS NEEDS AND GAPS that must be addressed within Canada's commercial and institutional building sector to create more energy efficient buildings, including Net Zero Energy Ready (NZER), Net Zero Energy (NZE) and Zero Carbon (ZC).

IDENTIFY WAYS TO CONNECT WITH WORKERS who support energy efficient building activities through educators and trainers, industry associations, Indigenous communities, and other stakeholder groups.

Our research indicated that current building sector employers and workers will need to develop new skills in order to successfully support the transition to an energy efficient building stock and that this upskilling will include skills required for effective collaboration across multi-disciplinary teams and digital skills.

- The section following the scope and research methodology is *The Transition to Energy Efficient Buildings Requires Economic and Cultural Shifts*, which provides an overview of various factors that are changing or will need to change as Canada progresses towards a more energy efficient building stock.
- The subsequent section, *Skills Needed for Energy Efficient Buildings*, outlines the labour force and skills needed to develop energy efficient buildings and the capacity of the Canadian building sector's workforce to support an accelerated transition to an energy efficient building stock.
- *Future-Proofing the Energy Efficient Building Sector* provides a summary of core and growing occupations and skills related to design, construction, operation, and retrofitting of energy efficient buildings.
- We sum up our findings and provide suggestions for addressing the labour and skills gaps identified by our research in *Recommendations and Conclusion*.
- In *Appendix 1*, we examine factors that are likely to influence the transition to energy efficient buildings in different Canadian regions.
- *Appendix 2* breaks down the occupational clusters we have researched into job titles by building life cycle phase.

2 Our scope includes MURBs such as condominium and apartment buildings of four stories or more.

Scope and Methodology

To develop this report, we gathered information on the needs and gaps of the current workforce by conducting more than 25 stakeholder interviews with representatives of all phases of the building life cycle, holding two multi-representative focus group discussions and performing secondary research. This **qualitative research** was designed to elicit and compile insights into **current workforce requirements**[3] and **occupational and skills gaps**[4] across the energy efficient building sector, as well as by project life cycle phase and occupational clusters, with some highlights of regional differences. Information obtained during stakeholder interviews also included the political, economic, social and technological factors affecting occupations and skills needed to support the creation of an energy efficient building stock.

This report focuses on the workforce requirements for NZER and other energy efficient commercial and institutional buildings, as well as MURBs, both new and existing. The study excludes smaller residential buildings (single-family homes; multi-unit residential buildings less than four stories) and industrial buildings.

The occupations needed for each phase of the building life cycle were clustered into nine categories:

1. **Design and engineering professionals:** engineers, architects, building science technicians and technologists involved in the design of energy efficient commercial and institutional structures, including the building systems that leverage energy efficient technologies
2. **Energy managers, modellers, specialists and advisors:** energy efficiency experts who assess, monitor and audit energy use in commercial and institutional buildings and develop strategies to reduce energy-related operating costs by implementing resource-efficient systems, technologies, or processes
3. **Construction management and onsite supervisors:** oversee the implementation of the building design, including procurement of appropriate materials, equipment, and services
4. **Construction and related trade workers:** build, install, retrofit, and maintain energy efficient commercial and institutional structures

3 **Current workforce requirements** reflect what the building sector needs, in terms of occupations and skills, at the present time, with the level of energy efficiency activity as it now stands.

4 For the purposes of this research, an **occupational gap** refers to a lack of candidates with the minimum required qualifications for a specific job in a specific labour market. From the perspective of the workforce for energy efficient buildings, an occupational gap exists if there are not enough qualified workers (e.g., engineers, HVAC installers, or commissioning providers) to fill the positions available. In contrast, a **skills gap** refers to a lack of candidates with the skills required by particular employers. A skills gap in the energy efficiency workforce exists when the qualified workers do not possess all of the skills required to be successful in their roles.

5. **Commissioning professionals:** ensure that building systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs

6. **Quality control and assurance specialists:** inspectors and technologists who oversee quality assurance and control activities and ensure that construction and the installation of equipment and materials conforms to plans, specifications, codes and regulations; they are typically employed by the project owner, engineering, procurement and construction company, or building management company

7. **Building operators:** building and equipment operators operate, manage, and maintain energy efficient commercial and institutional buildings and related equipment such as heating, ventilation, and air conditioning (HVAC), lighting and electrical systems, as well as other equipment

8. **Information technology specialists:** leverage technology to optimize building performance, reduce operations and maintenance costs, and enhance the occupants' experience; ensure that data, software, hardware and systems are integrated so that others can leverage their value

9. **Regulatory specialists and officers:** occupations that oversee the compliance to government and industry standards, relevant acts, codes, regulations, by-laws, and other pertinent legislation; they are typically hired by municipal or provincial governments

It is worth noting that there are many recent publications on the skills and workforce challenges of the energy efficient building sector. Most publications and articles are focused on specific metropolitan areas or regions, occupational groups, and construction processes, technologies and equipment. The variety and quantity of available reports demonstrate the interest and urgency of the topic and, more importantly, suggests an opportunity to achieve greater awareness, support and impact by consolidating the findings and coordinating learnings. Research also points to a need for more quantitative analysis to evaluate the size and capabilities of the workforce for energy efficient buildings.

The Transition to Energy Efficient Buildings Requires Economic and Cultural Shifts

The optimal model for building and retrofitting to high-performance standards treats the building as an integrated system rather than as a collection of compartmentalized sub-systems. This “building-as-a-system” method was supported by our research and promotes the adoption of certain practices, technologies and business models that are expected to influence a more integrated approach to building construction. As these methods become more widespread, they will bring change to the building industry and its culture and drive requirements for occupations and skills needed for energy efficient buildings.

The rate of change in the construction industry will be influenced by factors such as market demand, economic viability and incentive programs that motivate service providers along the building life cycle to shift their offerings and how they deliver them. In the absence of market signals of increased demand for energy efficient buildings or incentive programs to motivate building owners, changes to the collaboration and integration of industry practices will occur more slowly. However, this integrated model could be a competitive advantage for larger, more fully resourced companies, such as full-service planning, design and engineering firms, or smaller companies providing niche and specialized planning, design and engineering services for energy efficient buildings.

Changing the Business Environment

Canada’s energy efficiency targets are ambitious and achieving them rests on establishing a business case for increased investment in energy efficiency in both public and private buildings. The ability of the building project owner to obtain an adequate return on the upfront investment is a critical factor in the owner’s decision to pursue energy efficiency. For smaller companies, the biggest barrier to investing in energy efficient buildings is access to the initial capital required for more costly building systems and materials.

For companies of any size, achieving high standards of energy efficiency in buildings, such as NZER, involves trade-offs. It requires meeting rigorous requirements that are time-consuming, costly and need significant technical expertise. Research indicates that many building owners will attain their best results by maximizing performance to the extent possible given costs and other constraints. For example, while a Leadership in Energy and Environmental Design (LEED) certified building can be a powerful tool for commercial building owners, a more attainable goal for other types of building owners might be to select some aspects of LEED or other building certifications, such as BOMA BEST, that are most important and affordable to them and their tenants.

Some investors are increasing pressure on corporations to integrate environmental, social and governance (ESG) factors into their business processes and decision making. The focus on ESG has increased largely due to pressures from institutional investors, disproportionately impacting large, public companies in urban communities. Those companies that position ESG as a part of their corporate purpose, strategy, processes, performance metrics and branding are increasingly rewarded for their efforts (Association of Executive Search and Leadership Consultants [AESC], accessed October 2020).

Developers may also be motivated to pursue energy efficiency objectives by focusing on other factors, such as asset value, their ability to attract tenants, the performance of their building systems, their ability to reduce operating costs, and recognition for the achievement of certain building standards. Developers with these factors in mind are most often applying them to energy efficient construction and retrofits for Class A commercial properties and institutional buildings. For smaller companies, the biggest barrier to investing in energy efficient buildings is access to the initial capital required for more costly building systems and materials.

Implementing Integrated Design and Delivery Processes

Energy efficient buildings are more difficult to achieve using a conventional building construction process that moves linearly through the building life cycle, whereas one phase ends, another begins. Newer methods of building design and construction, such as Integrated Design Process (IDP)[5] and Integrated Project Delivery (IPD)[6], emphasize collaboration and the engagement of key, multi-disciplinary participants across all phases of the building cycle. A facilitator, usually an engineer/designer or architect, directs a highly integrated team toward common energy efficiency goals. Despite the perceived benefits of using these practices, research participants report that they are not widely used in Canada, given the limited understanding of the return on investment for the extra costs incurred at the design and planning stages, as well as the lack of necessary tools, resources, and expertise to support collaborative decision-making (Integrated Project Delivery Alliance and the University of British Columbia, July 2020). Implementing IDP and IPD will require a culture shift among project owners and workers to operate as a team and share accountability for resolving challenges while achieving cost, schedule and quality goals.

5 Integrated Design Process (IDP) is a collaborative process among key players implemented over the full building life cycle to realize functional, environment and economic goals for the building.

6 Integrated Project Delivery (IPD) aligns project team members to achieve overall project goals of reducing waste and optimizing efficiency through all phases of design, fabrication and construction (Integrated Project Delivery Alliance (IPDA) and the University of British Columbia, July 2020).

Adapting Procurement Approaches to Integrated Practices

Traditional approaches to procurement include a “design-bid-build” structure, which sequences the work through separate contracts for design and construction. This approach to procurement is incompatible with integrated approaches to planning and construction that are effective for developing or retrofitting energy efficient buildings. Instead, energy efficient builds are reported by research participants to be better suited to a “design-build” approach, where the main contractor has the single point of responsibility to design and build. Adopting the “building-as-a-system” approach entails working from the design phase with representatives of the construction phases, building operations and commissioning providers.

Accelerated Technology Adoption and Data Sharing

Our research indicated that energy efficient buildings will require that technology be more widely adopted and available to a higher standard and that systems are integrated and data shared. Technology is an important enabler of effective design, project integration, and building automation. Increased availability of data, including financial information, supports more effective decision-making but relies on greater integration and transparency.

Collaboration across the building life cycle is a necessary element to support data sharing and requires shifts from traditional practices by service providers and among project partners. Data sharing also requires unique skills and a culture of trust among participants. As such, the widespread adoption of the data infrastructure needed to support innovation in the building industry may not be easily accomplished.

Data capture, analysis, integration and sharing provide many opportunities for better decision-making but are not without their challenges. Because of the upsurge in technology, digital occupations will be increasingly required within the building industry, and digital skills and literacy requirements will increase for existing occupations. Today, information technology specialists are required by the industry in greater numbers, and no building construction or operations occupation is immune from working with digital tools alongside their more traditional tools.

Technology is an important enabler of effective design, project integration, and building automation. Increased availability of data, including financial information, supports more effective decision-making but relies on greater integration and transparency.

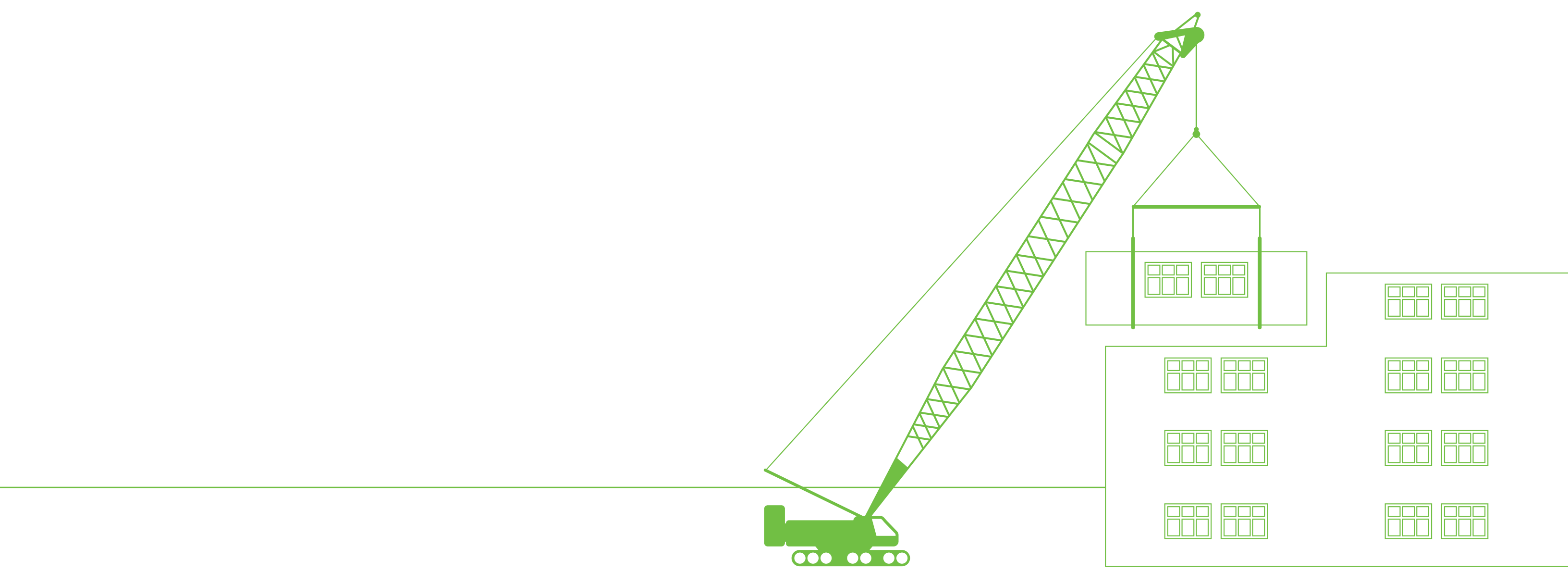
Increasing Use of Prefabricated Building Components

The increased integration of prefabricated components[7] and modules is expected to be an important element in the shift towards a more energy efficient building stock. The construction industry is already increasing its use of prefabricated (prefab) panels and modules that are constructed offsite to improve safety, environmental impacts and efficiencies, while controlling costs, logistics and schedules (Deluxe Modular, February 2019).

Prefab brings a manufacturing approach to the construction industry, helping to minimize labour costs and reduce the impacts of shortages in the skilled trades. It can facilitate employing and training lower-skilled workers, requiring fewer qualified tradespeople, and it offers a safer work environment, free from weather impacts (BC Housing, Fall 2011). With prefab, manufacturing facilities can be set up offsite in any location.

The relatively small size of the Canadian market necessitates having to import significant volumes of prefab energy efficient products, although there is a real potential to manufacture specialized components here, such as mass timber.[8]

Not all types of buildings will benefit from prefabrication. It is best suited for buildings with standard, repeatable design(s) that allow for a commitment to the design upfront and afford less chance of being modified downstream. The logistics of moving prefabricated panels and modules are also critical in order to mitigate potential damage during transport. Prefab can also cause challenges for onsite installers in assembling myriad joints and connections.



7 Prefab components include factory-produced structural elements (mass timber or concrete composite panels); complete and stackable volumetric modular units; and specialized components (mechanical rooms, bathrooms).

8 Mass timber is an increasingly popular engineered wood product containing lower embedded CO2 and manufactured in a climate-controlled environment. It is well suited for markets requiring mid-rise buildings, including rural markets, where there is generally a greater availability of timber. Some jurisdictions, such as British Columbia and Quebec, are already obtaining approval for tall-timber buildings (over six stories) using mass timber (Evergreen, November 2019).

Engaging Commissioning Professionals

Building commissioning is a quality-oriented process for achieving, verifying and documenting that the performance of facilities and systems meet defined objectives and criteria. Commissioning applies to both new and existing buildings over their full life cycles. Building owners typically outsource these commissioning services, and some require specific certifications.

Commissioning (Cx) of new buildings and existing buildings are all supported by a mindset where buildings are seen as a system and require extensive knowledge of building science and life cycles. All types and forms of commissioning have positive impacts on the energy efficiency of buildings through sophisticated functional performance testing of systems and the use of predictive tools to evaluate project feasibility. New building commissioning is an extensive quality assurance process that begins during concept design and continues through detailed design, construction, occupancy and the beginning of operations. The commissioning of an existing building is akin to a tune-up that seeks to improve how the building equipment and systems function together and ensures the building equipment and systems are operating optimally to meet current occupant needs (NRCan, 2018 and ASHRAE, 2019). Types of existing building commissioning (EBCx) include:

- **Recommissioning (RCx)** is a re-optimization process for existing buildings that have already been commissioned that seeks to improve how building equipment and systems are operating to meet current occupant needs. This is done by investigating to identify problems and integration issues and focusing on identifying low cost or no-cost operational improvements to obtain comfort and energy savings. This process can be undertaken alone or along with a retrofit project.
- **Retro-commissioning** is the commissioning of an existing building that was not originally commissioned. It aims to improve how building equipment and systems function together and resolve problems that occurred during building design, construction, or day to day running to meet current occupant needs.
- **Ongoing Commissioning (OCx)** "is a process of continuously testing and/or tuning building systems to maintain building performance as expected and previously commissioned" (ASHRAE, June 2014). Typically, this will include the implementation of technological and/or software solutions within the building's automated heating, ventilation and air conditioning (HVAC) control system, which monitor and help optimize operations on a continuous basis.

The Evolution of Building Operations

Building operations, sometimes referred to as facilities operations and maintenance, consist of activities necessary to maintain and manage buildings. Building operations include maintaining HVAC, plumbing, electrical and building systems (Enertiv, January 2019), and day-to-day activities necessary to maintain the performance of structures and equipment depended upon by building occupants (Whole Building Design Guide and Don Sapp, 2017).

As the building culture shifts towards greater integration, digitization and automation, especially for energy efficient commercial or institutional buildings, building operations will become more multi-faceted. Increasingly complex processes, technologies and skills will be required to ensure the building is serving its purpose and achieving energy use performance goals, and building operators will need to work collaboratively with service providers and consultants to fully understand the complexity of building operations and systems.

Having building operations personnel at the table during the design of new or retrofitted buildings when looking to increase energy-efficiency standards is important. It is an opportunity to leverage their operational expertise and capture their understanding of potential performance challenges that could occur during building operations. This is especially true given the increased role technology will play throughout the building.

Retrofits Key to an Integrated Approach to Energy Efficient Buildings

Buildings tend to reflect building code requirements in use at the time of construction; older buildings were often constructed to lower energy-efficiency standards. Major building renewal activities, which typically occur in 30- to 50-year cycles, are an ideal intervention point to drive deeper greenhouse gas reductions (Canada Green Building Council, 2017).

Decisions to retrofit a building are made on a case-by-case basis, taking into consideration the risks and opportunities presented by (1) the building purpose and configuration (2) the project footprint (3) the heat source options (4) and the cost, among other considerations. Research indicates that, given the cost and the complexity of retrofits, achieving “near zero” energy ready may seem a more realistic near-term goal than “net zero” energy ready for some. A collaborative effort among governments, building owners and other industry organizations in sharing the investment risk will be needed to achieve NZER.

One way to address the financial risk associated with retrofitting for energy efficiency is for building owners to engage in an energy performance contract with an energy service company (ESCO). An energy performance contract enables the project owner to engage an ESCO to install and service energy efficient solutions and utilize the cost savings achieved and guaranteed by the ESCO to cover the capital costs associated with the upgrades.

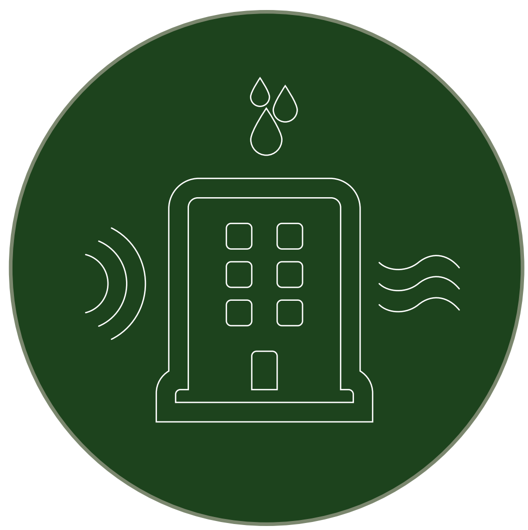
Those involved in the planning and design of retrofits are responsible for educating building owners on the range of options available to them, along with associated costs and risks. These options include heat pumps, alternative energy sources, embodied carbon calculations and abatement, and upgrades to tighten the building envelope. Predictive modelling tools and simulation software are often used to assist with decision-making for retrofits by assessing project feasibility relative to building performance goals. The ability to satisfactorily manage disruption to tenants is also a critical consideration.

The planning and design of retrofits require experience and specialized skills that are not commonly found among current design or engineering firms, thus currently limiting the practice.

Envelope First Approach Required to Achieve Energy Efficient Buildings

Climate control and protection of the indoor environment are key functions of the building envelope, which is made up of window frames, entrances, roofing, flooring, glazing, and insulation. Many of those interviewed referred to an “envelope first” approach required to achieve an energy efficient, high performing building. If the envelope is not air and vapour tight, other energy efficient technologies and systems will be compromised.

Manufactured products play a critical role in the level of protection afforded by the building envelope, including air quality, aesthetics, moisture and temperature control, and energy use. For new buildings, testing the air and vapour tightness of the building envelope can be integrated into the commissioning process but requires personnel specializing in airtightness.



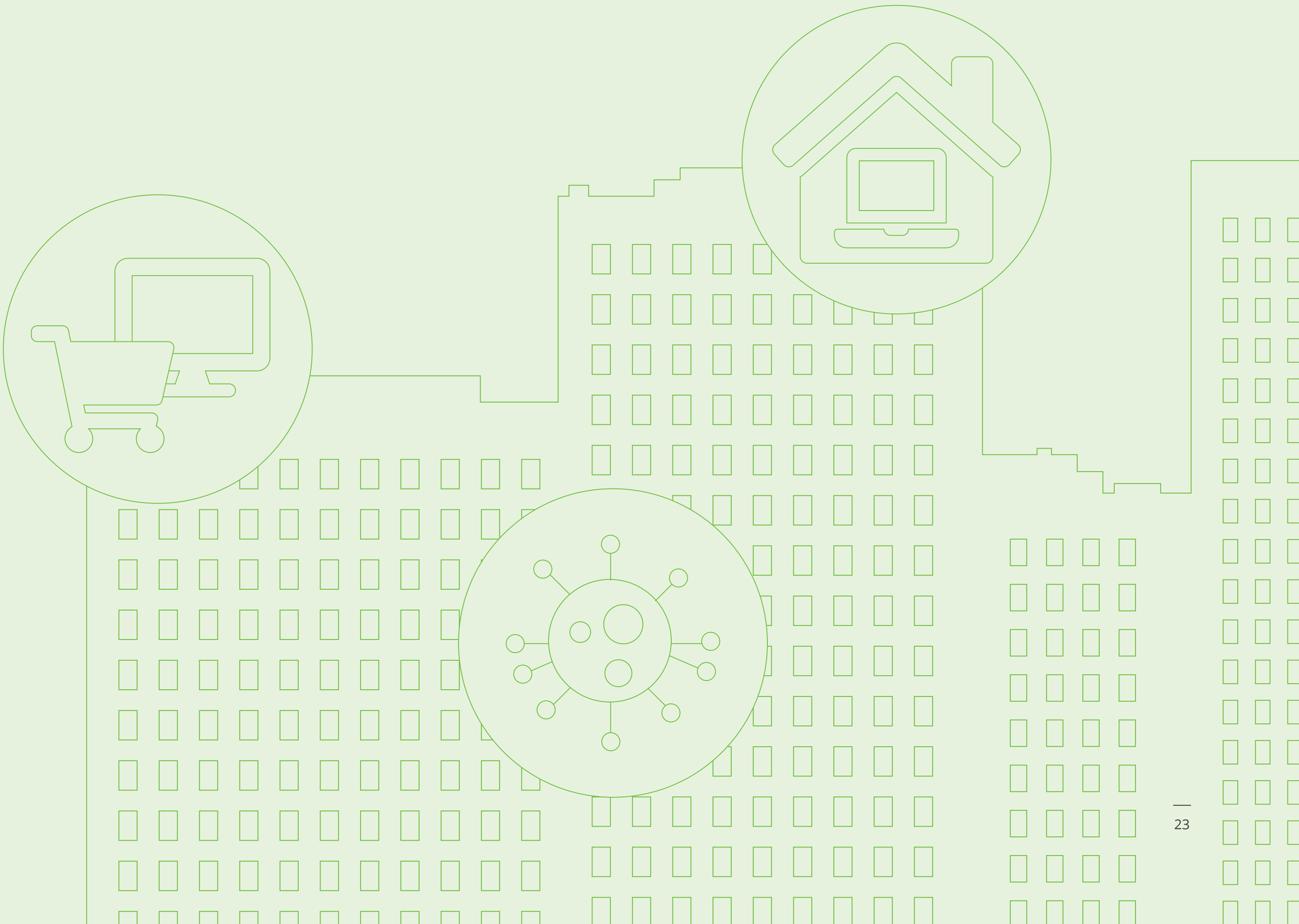
Spotlight: The Impact of COVID-19 on the Transition to an Energy Efficient Building Stock

A recent and significant influence on the building industry comes from the COVID-19 pandemic.

Commercial and retail building managers are coping with changing utilization rates, as more people are working from home, and consumers are shopping online rather than in stores. Higher vacancy rates are constraining access to capital needed for new projects.

Building operations are having to react to the considerable impacts of the COVID-19 pandemic, including the changing needs for space and redesign of interiors related to health and safety, the conversion of vacant office space to residential or other purposes, and the increased importance of remote building operations. In addition, they are taking steps to protect their own health and safety through enhanced awareness and training.

Those engaged in the building process are having to manage the construction workflow differently, making adjustments when multiple trades need to be onsite at the same time and when workers must travel from one job site to the next.



Skills Needed for Energy Efficient Buildings

The use of technologies, materials and approaches required for energy efficient buildings are not currently common practice. Given this, it is not surprising that the technical and soft skills required for energy efficient buildings tend to be found in specialized consulting firms and contracting companies and departments within large firms. To meet the goals laid out in Canada's national climate change strategies, and in response to investor and public demand, these skills, fields of knowledge and workflow practices need to become mainstream across the building sector labour force. This will not be a natural evolution. Instead, there are critical success factors and levers that can accelerate the pace at which the building sector transitions to high-performing buildings and demands a labour force with the skills to support energy efficiency practices. An available labour force is an important success factor for the growth of energy efficient buildings. Other factors include:

- an environment where regulations, standards and incentive programs are predictable and structured, providing building owners with the confidence to take risks and innovate
- programs that support the widespread adoption of technology, equipment, materials and practices that transition buildings to higher energy efficiency standards and promote a collaborative, integrated approach to project design and delivery

Workforce Requirements that Span all Occupational Clusters

The following section outlines the skills and knowledge required by all occupations, although to varying degrees, along the energy efficient building life cycle. Details regarding the level to which these skills and knowledge are required for specific occupational clusters are provided below in *Workforce Requirements by Occupational Cluster*.

Attraction and retention of new talent across all functions and phases

The need to attract and retain workers to the sector's talent pipeline is evident throughout the building life cycle and occupational clusters. An important and well-documented attribute of this talent challenge is the aging demographic of the construction workforce, especially among construction trades and managers (BuildForce Canada, February 2020). The same trend is impacting retiring engineers, where civil, mechanical, electrical and computer engineers represent the occupations with greater age-related attrition challenges (Engineers Canada, June 2015). Engineering, procurement and construction companies indicate a "missing middle" within their organizations, where their workforce is bookended by young and mature workers with serious gaps among those with five to ten years' experience—the demographic that would ideally move into roles vacated by retiring managers and leaders.

The building sector is challenged to compete with other sectors for certain types of talent, and there are risks this will escalate as the sector adopts more digital and automation technologies. The building sector is not viewed by new entrants as progressive, technologically advanced or offering the opportunity to be involved in solving today's most pressing global problems. Many of today's youth want to apply technology and innovation to improving the environment and reducing emissions.

Several regions in Canada have been experiencing shortages in the construction workforce for many years. Research participants from the Greater Toronto Area and the Lower Mainland of B.C. expressed the greatest concern about labour and skills shortages and protracted challenges attracting and retaining workers to the construction industry. Both the magnitude of activity and the higher cost of living contribute to workforce attraction and retention issues in these regions. In contrast, Alberta currently has a significant pool of unemployed workers from across the building life cycle due to the economic downturn (Alberta Economic Dashboard). However, it is likely that many of the unemployed designers, engineers and construction workers in this province have spent most of their careers in the industrial construction sector (BuildForce Canada, January 2019). These examples of regional differences in the construction labour market highlight an opportunity to support the transition and mobility of skilled workers from industrial construction and slower markets to commercial and institutional construction in regions with overheated markets.

Interviews with industry and industry associations indicate a strong interest in attracting a more diverse and inclusive workforce as another way to address labour and skill shortages, encourage new ideas, and improve economic equity for disadvantaged Canadians. It was also reported that, while diversity and inclusion practices were core for some companies, they are virtually absent for others. Over the last two decades, there have been surges in cultural diversity in many North American industries, including information technology, public accounting and even pockets of the oil and gas industry (Laroche and Yang, 2014). These increases are attributed to an outright necessity for industries and organizations to grow. Despite shortages of workers and sector growth in many areas of the construction industry, the number of new Canadians choosing this sector has been declining for decades, especially in the skilled trades (BuildForce Canada, October 2020). While it is encouraging that some companies are fully embracing diversity and inclusion, they are unable to impact the overall perception of the sector if the rest of the industry is not on the same page.

Energy efficient buildings and building-as-a-system mindset

The workforce needs to understand what it takes to design, construct, retrofit and operate sustainable and resilient buildings. For many of the workers along the building life cycle, this will require expanding their knowledge of climate change resiliency, including regional considerations such as seismicity; low-emissions technology, equipment and materials; renewable energy and storage; and the circular economy as it relates to buildings.

An energy efficiency mindset also means being able to think about “building-as-a-system” during and after construction, including how the building operates, its response to external environmental factors, how it’s enjoyed by the tenants and how it holds up over time. This will help workers pivot from decision-making based on individual events, components or individual datasets to a “building-as-a-system” approach that looks at how constituent parts are interrelated and work together within a larger building performance context.

An energy efficiency mindset and “building-as-a-system” thinking are achieved by taking an integrated, collaborative, multi-disciplinary approach to design, construction, operations and decommissioning.[9] This requires a view of the big-picture and a combination of soft and technical skills, often acquired through experience or cross-training.

9 Decommissioning a building in a low-carbon economy will need to go beyond traditional waste management activities and incorporate knowledge and principles associated with a circular economy such as recycle, reuse and re-manufacture. Decommissioning providers have a set of specialized skills and knowledge related to dealing with hazardous materials and contaminated sites, which differ from the skills and knowledge of new and existing building commissioning providers.

Knowledge of regulations, standards, certifications and metrics

There are lots of moving pieces to the building of energy efficient buildings, starting with related layers of regulations and acts that vary among provinces and territories (Efficiency Canada and Carleton University, September 2020). There is also a variety of standards and certifications that can be used to construct or retrofit a building and an array of materials and technologies from which to choose.

Navigating the many requirements of the building process can be a barrier to owners making the decision to pursue energy efficiency or other high-performance standards. Helping them sort through myriad options are designers, energy professionals and builders who have the skills and knowledge to help project owners decipher the increasingly complex choices that face them regarding high-performing buildings. These professional resources can also help owners answer the important questions investors are asking about the environmental, financial and social performance of their individual buildings and asset portfolios. Technology to simulate design options and model return on investment (ROI) is increasingly available to generate data and drive evidence-based decision-making.

Those involved in building operations also need to understand and utilize data and analyze the impact of different solutions to make energy efficiency decisions, including optimizing systems and maintenance to ensure an owner's performance intentions are met. Building operators are also relied on to interface with tenants and provide education and advice on how to properly operate the energy efficiency technology incorporated into buildings.

Accelerated digitization and automation—across the building life cycle

The Internet of Things (IoT) and Industry 4.0 offer the building industry technological solutions to manage costs, optimize operations and address climate concerns. Research conducted by REALPAC, R-LABSs and PwC (2019) indicates that commercial building owners plan to focus future technology investment on:

- Smart buildings and leveraging IoT
- Data collection
- Artificial Intelligence (AI) solutions and applications
- Energy management and sustainability technologies
- Tenant focused technology solutions

Technology that enables integration and collaboration across the building life cycle is available and used to support project design and delivery in high-performing buildings. Beyond having the appropriate technical knowledge to interact with technology, workers will need the communication skills to share information and ideas with clarity utilizing digital tools.

The purpose behind the sensors, meters and systems networks installed and maintained by trades workers is to collect and enable the use of data. Companies are increasingly looking to data analytics, simulations and modelling for more robust decision-making during the design and operations phases of the building process. Using data for artificial intelligence and machine learning applications is key to achieving economic and environmental benefits associated with automation.

While the internet offers quick access to information on all topics, the availability of vast amounts of unsubstantiated information means all workers need to be able to think critically about the value and accuracy of the information being presented before using it to make decisions.

Occupations that are appearing in the construction industry due to the increased use of digitization, automation, advanced building control systems and a variety of information management software include **web/application developer, software developer, software programmer, cybersecurity specialist, data analyst, data engineer, data operations (DataOps) engineer, integration specialist and business intelligence (BI) developer**. As identified earlier, other industries across the economy are also focused on accelerating technological solutions to address cost, business and environmental concerns, leading to significant competition for these occupations and, as it currently stands, the construction sector is not seen as “high tech,” making it harder for employers to attract their share of the qualified workforce.

Digital skills and literacy are expected to be increasingly required for all existing occupations to maximize the benefits offered by advanced technologies. Requirements for digital skills are further detailed in the occupational cluster skill and knowledge assessments.

Modular construction and prefabrication—impacts across the building life cycle

Our research indicates that a shift to a more manufacturing-style of construction impacts skills, knowledge and approaches used by design and engineering professionals and construction and trade workers. Design and engineering for modular construction and prefabrication require specialized design thinking and require that most design decisions be made upfront as changes later in the process are both costly and difficult. Anticipated increases in modularization and prefabrication will also impact workforce requirements and working conditions for construction and trade workers, as work shifts towards being performed in an enclosed and controlled factory environment, with increased coordinated and repeat activities and greater levels of automation.

Changing supply chains—different skills, knowledge and approaches

While readily available, energy efficient technology, equipment and materials are somewhat different than those for traditional builds. Some products are not available in Canada, and the suppliers, steps and logistics required to secure them may add a level of complexity not experienced with traditional builds. This, coupled with the anticipated accelerated use of prefabricated modules and components, means those involved in procurement will need to understand where new suppliers are, how to access them, and the potential for increased logistics (as with prefabrication). They will also need to establish new relationships, including with international suppliers operating in different languages and business cultures.

Retrofitting requires complex and wide-ranging skills, knowledge and experience

Adding high-performing building technologies, systems, materials and equipment to the existing building stock is integral to Canada meeting its *Build Smart* 2030 goals. This is a complex undertaking and requires an equally complex array of skills, knowledge and experience. Insights into the specific shifts in skills, knowledge or approaches required at an occupational level to carry-out retrofits are discussed further in the occupational cluster section to the extent that the research provided such information.

An energy efficiency mindset and understanding "building-as-a-system" are imperative to retrofits as designers, builders and operators must find the most effective way to integrate legacy systems with new systems to achieve energy efficiency goals.

A key difference between a new build and a retrofit is that an existing building already has paying occupants that will be inconvenienced by the construction. Construction managers need to interact with tenants as they build and erect temporary walls to create a separation between their work and the tenants. Managing the relationship with tenants during a retrofit most often falls to the building manager and operators. This requires an array of communication, negotiation and problem-solving skills that are not typically taught within technical training programs.

Lifelong learning

The transition to an energy efficient building sector will require the adoption of new technologies, equipment, materials and processes, and these will not stay static. The workforce, therefore, cannot stay static either, needing to continuously enhance knowledge and skills to stay relevant and effective. Some occupations, such as architects and engineers, are encouraged to engage in continuous professional development, so adding learning opportunities around energy efficiency will be more fluid and easily achievable. Other occupations, such as trades and building operators, are not as often engaged in continuous professional development, so the concept of lifelong learning could take more conscious efforts on the part of employees and their employers.

Key Workforce Issues Across Occupational Clusters

Establishing a skilled, productive and sustainable workforce for energy efficient buildings requires finding solutions to the following four main issues:

1. **Industry's image and culture**
    - The industry's ability to attract the workforce it requires is hampered by the perception that it is low-tech and unsophisticated, especially to youth and diversity audiences.
    - Shifting to a culture that recognizes work processes as more integrated, collaborative and that engage multiple disciplines across the building life cycle, rather than the sequential, more siloed approach that is common today, is core to achieving high-performing buildings.
    - There is a need for lifelong learning to keep pace with the acceleration of technologies, equipment, materials and processes required to achieve energy efficient buildings.
2. **Occupational and skills needs and gaps related to energy efficiency**
    - Challenges associated with attracting new talent into the industry combined with an aging workforce have already caused labour shortages in some occupations.
    - Technical and soft skills shortages will emerge as new technologies, practices and materials are adopted for energy efficient buildings.
    - The magnitudes of these gaps are as yet unknown due to limited quantitative labour market information, hampering the ability of job seekers and career decision-makers, educators and trainers, associations and industry to plan effectively.

An **occupational gap** refers to a lack of candidates with the minimum required qualifications for a specific job in a specific labour market (i.e., there are not enough workers to fill the positions available). In contrast, a **skills gap** refers to a lack of candidates with the skills required by particular employers (i.e., job applicants do not have all of the skills required to be successful in their role).

3. **Limitations of existing training**
    - Available training is under-utilized due to access, cost and perceived value. Without market demand for energy efficient buildings, there is less demand for training to attain the related skills.
    - Soft and technical skills required to progress energy efficiency are not consistently integrated into current foundational training.
    - There is an inclination towards micro-skills training over more comprehensive and recognized certification programs for some occupations such as building operators and energy modellers.
    - The need to rapidly shift to remote training due to the COVID-19 pandemic may lead to some critical learning requirements not being as effectively addressed as they could be with in-person training: soft skills, experiential learning, shop time for apprenticeships.
4. **Employer capacity constraints**
    - Smaller employers, which make up a significant portion of the building sector, often face greater challenges to attract and develop their workforce and make needed organizational changes to workplace culture for the following reasons (Keap, October 2019 and Small Business Majority, October 2020):
        - Tighter margins typically associated with smaller companies make investments in new technology, materials, tools and equipment or costs driven by new regulation more challenging.
        - Lack of human resources (HR) support means HR activities are often carried out by the company owner, and attraction, retention and/or workforce development may not be a primary area of expertise.
        - Smaller companies might experience difficulties competing with larger companies on compensation and career development opportunities.
        - Having fewer staffing resources makes it difficult to pull people away from their core work for training or engage in other activities that will assist the company shift. This could include establishing new processes, contracts, supply chains and relationships to guide a change in doing business.

These four categories were substantiated by our primary and secondary research and will be further expanded for each occupational cluster.

Workforce Requirements by Occupational Cluster

This sub-section focuses on the occupational clusters required to achieve energy efficiency in the building sector and outlines the key skills and knowledge requirements and gaps for each. Table 1 provides a high-level overview of the occupational clusters required throughout the building life cycle. A matrix that identifies job titles for each occupational cluster by building life cycle phase is provided in *Appendix 2*.

Table 1

Occupational Clusters Needed by Building Life Cycle Phase

	Project Development	Planning & Design	Construction & Manufacturing	Commissioning & Inspection	Building Operations & Maintenance	Decommissioning, Deconstruction & Renovation
Design and engineering professionals	●	●	●	●	●	●
Energy managers, modellers, specialists and advisors	●	●		●	●	●
Construction management and onsite supervisors	●	●	●	●		●
Construction and related trade workers			●	●	●	●
Commissioning professionals	●	●	●	●	●	
Quality control and assurance specialists		●	●	●		
Building managers and operators	●	●		●	●	
Information technology (IT) specialists		●			●	
Regulatory specialists and officers				●	●	

Design and Engineering Professionals

This occupational cluster includes **engineers, architects, designers and building science professionals** involved in the design of energy efficient commercial and institutional structures. They could be employed by companies of all sizes, including operating as consulting professionals.

Design and engineering professionals assist project owners in their decisions related to building design and therefore have the opportunity to educate owners about the value of incorporating energy efficient systems, materials and technologies. Because of this, they need to be up to date on the technology and materials available to support energy efficiency and the progress towards net zero buildings. When used as intended, Building Information Modelling (BIM) plays a big role in the integrated design process, as it enables evidence-based design decisions and helps facilitate a collaborative process. The model developed using BIM should act as a “single source of truth” about the building’s design, as-built construction and operational information.

The engineers, architects, designers and building science professionals can influence the early stages of a project, such as the approach to staging the work (workflow), and can encourage a collaborative, integrated, multi-disciplinary approach to design and project delivery that are integral to high-performing buildings. It is often the architect or a lead engineer who is responsible for facilitating project integration and collaboration, resulting in shared goals for everyone involved in the project, a more coordinated and proactive approach to addressing problems, and improved efficiency and return on investment.

A solid understanding of building science and a “building-as-a-system” mindset, supported by the use of technology, are required to deliver precise designs for new builds and retrofits that reduce energy demand and increase performance. Systems and approaches under their purview include:

- Building envelope tightness
- Reduced-carbon materials
- Passive design
- Renewable energy (solar or thermal)
- Water efficiency
- Indoor environmental quality
- Building automation and controls

Retrofits are more technically and logistically complex from a design and engineering perspective than new construction, requiring skills and knowledge to effectively assess the trade-offs among potential performance improvements, disruption to tenants and the availability of incentives and costs. Considerations include (Pembina Institute, July 2020):

- **Conducting an assessment of the existing building** to understand historic construction, the current condition of all building systems as well as energy use, the building envelope, climate resiliency, embodied carbon, etc., and its suitability for prefabrication
- **Understanding the amount of building preparation required**, including demolition and decommissioning[10], service disconnects and re-routing, effective recycling or potential reuse of materials
- **Accounting of soft costs including engagement with building occupants**, clear and timely communication with all stakeholders like clients, code officials, tenants, and multi-disciplinary contractor teams, while navigating policies and incentives

Design and engineering for modular construction and prefabrication require specialized design thinking. Initial designs take longer than traditional construction, but the time is shortened as the designs are repeated. A significant benefit to modularization and prefabrication is the ability to mass-produce certain products offsite; however, it requires that most design decisions be made upfront as changes later in the process are both costly and difficult.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

10 Decommissioning a building involves shutting the building down and protecting it from hazards until the future of the building has been determined (Designing Buildings Wiki, April 2018).

Table 2

Workforce Challenges—Design and Engineering Professionals

Industry image and culture shifts	• Potential for culture clash between those accustomed to a structured, risk-averse culture and the agile work culture associated with high tech/IT • Communicating with occupations across the building life cycle as required for an integrated, multidisciplinary approach to building design requires a culture shift
Occupational and skills needs and gaps related to energy efficiency	• Need to enhance soft skills required to lead and/or participate in an integrated, collaborative, multi-discipline approach to design and project delivery, such as collaborative, integrated problem-solving and facilitation skills • Expand and enhance communication skills to educate the client on value proposition and return on investment for high-performing buildings • Building envelope expertise requires further development—technology, approach, testing that may not be included within engineering or architectural degrees • Ability to optimize digital tools available, including multi-dimensional modelling and clash detection analysis to help facilitate project design integration and inform pre-construction fabrication, building information modelling (BIM), Lean tools, virtual reality (VR)/augmented reality (AR) • Shortages for deep retrofits include the ability to develop existing building assessments, integrate design across mechanical and passive systems, integrate onsite renewable energy, integrate legacy systems with new ones
Limitations of available training	• Retrofits require experience, and it is difficult to obtain the required experience purely through training • Requirements for new skills are not fully addressed by traditional engineering programs, and upskilling options can be limited
Employer capacity constraints	• Fewer staffing resources makes it difficult to pull people away from their core work for training or to engage in other activities that will assist the company shift – This could include establishing new processes, contracts, supply chains and relationships to guide a change in doing business

Energy Managers, Modellers, Specialists and Advisors

This occupational cluster includes **energy efficiency experts** who model, assess, monitor and audit energy use in buildings and develop strategies to reduce energy-related costs. In the pursuit of energy efficient, net zero energy and high-performing buildings, this occupational cluster will likely be called upon to expand the metrics they work with beyond energy metrics and to integrate other building performance measures such as carbon and other emissions, water use and waste disposal. Roles in this cluster are more typically engaged after the design phase, if at all. Energy efficiency experts will need to be involved earlier, starting with the design and continuing across the full building life cycle, in order to support the transition to low emissions buildings. Energy modelling achieves its greatest results when it is initiated at the beginning of the design process and used to inform design decisions.

Energy managers, modellers, specialists and advisors are, therefore, essential to the design and operations of high-performing buildings. During the design phase, they provide the technical knowledge to model and compare a variety of energy efficiency measures to inform decision-making, supporting the business case for implementing energy efficiency and climate resiliency systems, including their associated technologies and processes. They also help to establish performance benchmarks used for ongoing auditing after the building is in operation.

Like design and engineering professionals, energy/performance specialists can help to deliver the value proposition and business case for energy efficient/net zero buildings, including retrofits, to project owners and developers. To do this requires a cross-section of operational, technical and financial skills. It also requires an understanding of:

- Regulations, standards and certifications
- Materials and equipment available
- Energy options, efficiency strategies and solutions, including renewable energy and storage

Energy professionals use building simulations to help predict energy and other performance impacts resulting from design decisions of new buildings, and they contribute to the cost-benefit analysis of retrofits. Simulations can consider energy efficiency incentives or carbon offsets that may be available while helping to inform decisions related to optimal design, energy budgeting and achieving desired levels of compliance.

During building operations, energy modelling and auditing are important to assess energy performance and identify opportunities to correct and/or optimize operations. Ideally, energy professionals are also engaged during commissioning and recommissioning activities to proactively identify building inefficiencies and improve performance. If a building owner and ESCO have engaged in an energy performance contract for a retrofit, energy analysts and auditors play a significant role in measuring the cost-savings achieved and the execution of the associated financial agreement.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

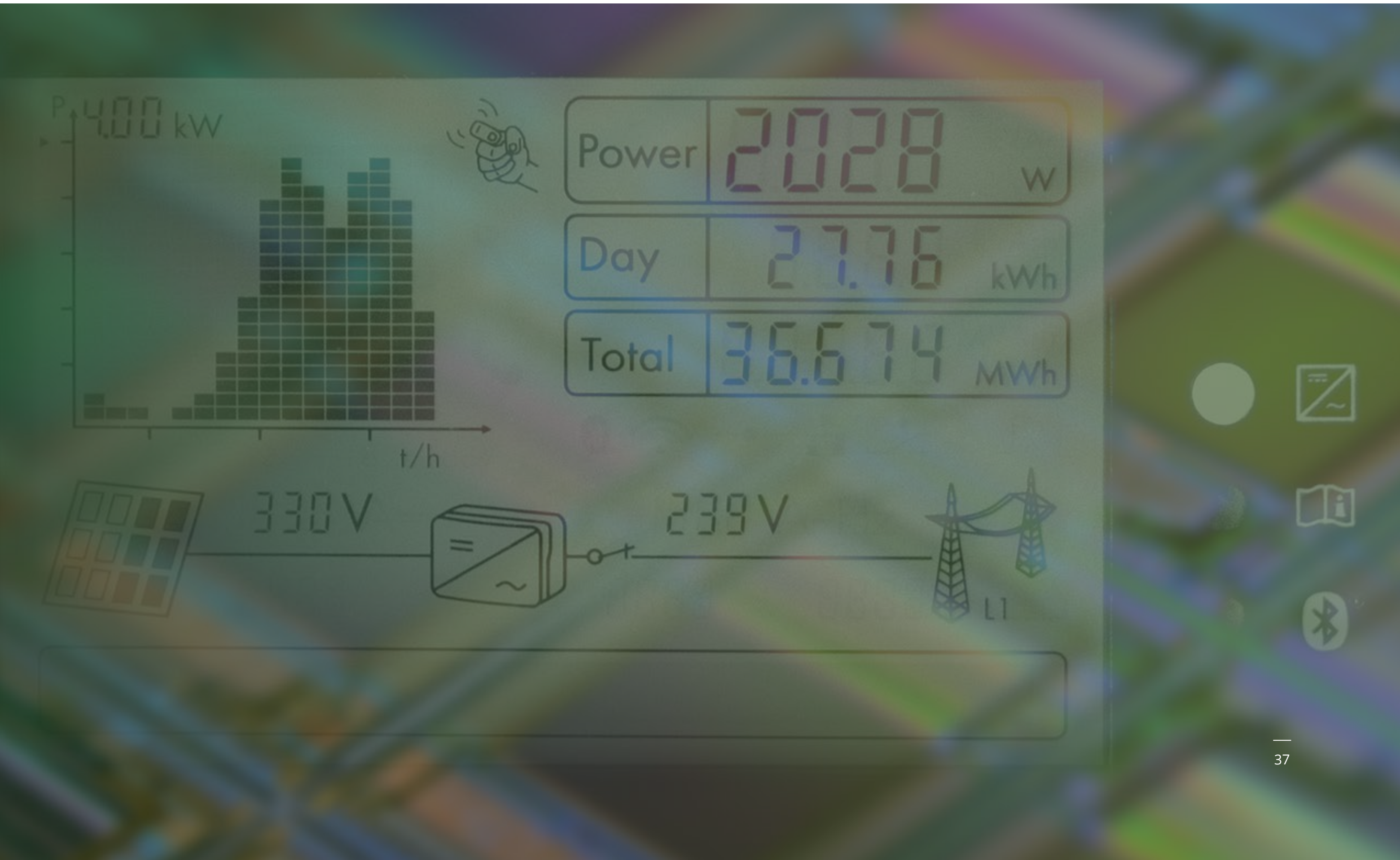


Table 3

Workforce Challenges—Energy Managers, Modellers, Specialists and Advisors

Industry image and culture shifts	• Significant value can be gained if energy professionals are involved throughout all phases of the building life cycle and for retrofits and recommissioning
Occupational and skills needs and gaps related to energy efficiency	• Expanded skill sets required include a broad and integrated understanding of operations, technology (modelling) and finance • Typically need the ability to perform: – Life cycle carbon/emissions assessment through end of life – Embodied carbon/emissions calculations and analysis – Greenhouse Gas (GHG) and other emissions accounting • Shortages of skills needed to produce existing building assessments for deep retrofits, including an understanding of historical construction, condition assessments, and audits evaluating the impact of retrofits on energy efficiency and other performance goals
Limitations of available training	• Standardization around energy-related professional credentials is needed to develop a qualified workforce • Consensus is currently lacking on the effectiveness and recognition of available programs. A program that integrates the broad range of skills needed and demonstrates a career path for those considering these occupations is needed
Employer capacity constraints	• There are limited opportunities to hire entry-level candidates or provide on-the-job training, as needed skills are generally acquired through years of experience • Smaller staff and fewer people in key roles make it difficult to have people away for training

Construction Management and Onsite Supervisors

Construction management and **onsite supervisors** oversee the implementation of the building design and are often involved in the procurement of materials, equipment and services, including sub-contracted trades. These roles are essential to ensuring the equipment, materials and technologies included in the building design are installed properly and that any changes made to the design during construction, referred to as as-built decisions, are not detrimental to the expectations of high performance.

A good approach to ensuring construction conditions and as-built decisions align with the overall intention of the design is to involve construction management in the design process. As previously indicated, a collaborative, integrated, multi-discipline approach to design is a critical success factor for achieving an energy efficient building. However, this is a different approach than what many construction managers are used to.

Construction managers and onsite supervisors will be increasingly required to adopt digital tools in order to use and integrate data into building information management systems throughout the construction phase. These systems will monitor costs and schedules and take into account as-built conditions and manufacturers' operations and maintenance data and instructions so that they can interface with facility management software. These activities will help to optimize the operations and maintenance of the facility for the duration of its life.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Table 4

Workforce Challenges—Construction Managers and Onsite Supervisors

Industry image and culture shifts	• Involvement during the design phase for energy efficient buildings to offer insights into potential construction and installment issues associated with equipment, materials and technologies is recommended. This is a shift from current practice
Occupational and skills needs and gaps related to energy efficiency	• Facing a labour shortage due to an aging workforce demographic combined with significant attraction issues • Increased complexity of the role driving the need for a broad range of soft skills required to facilitate and/or participate in integrated design and project delivery • Further development of digital skills needed to effectively utilize building information modelling systems and software • Expanded knowledge of supply chains for energy efficient equipment, materials and technology required
Limitations of available training	• Need to accelerate the development of people and management skills to address the "missing middle" for this occupational cluster • Need for ongoing development of skills and experience across multiple technical disciplines: mechanical, electrical, plumbing and technology • Available training is under-utilized due to access, cost and demand issues
Employer capacity constraints	• Effective succession planning is key to ensuring an available pipeline of construction management and supervisory talent • Smaller staff and fewer people in key roles make it difficult to have people away for training

Construction and Related Trade Workers

Construction and related trade workers build, install, retrofit and maintain buildings. Research participants confirmed that, while tradespeople have the necessary skills, there is an issue in the expectations placed on them to perform discrete tasks rather than to approach their work in a more integrated, comprehensive fashion.

During the construction and retrofitting of energy efficient buildings, these occupations are essential for ensuring energy efficient equipment, materials and technologies are installed as designed. Civil trades, such as carpenters, roofers, masons and glaziers, play a significant role in constructing an airtight building envelope that is key to energy-efficiency. If as-built circumstances require changes from the design, these workers need to ensure the decisions are not detrimental to overall performance goals. Fulfilling these responsibilities requires an understanding of how energy efficient buildings work as a system.

Trade workers involved in building maintenance ensure equipment and technologies are appropriately maintained to ensure energy use goals are reached and sustained. The “building-as-a-system” mindset is also important during maintenance to make sure repairs are not just made with a specific piece of equipment in mind but that overall building performance is maintained or optimized. This type of thinking is a shift for many workers in maintenance trades because they are not traditionally required to approach a problem or job in this way.

The mechanical systems within buildings require a wide range of trades, including **heating, ventilation, air conditioning and refrigeration (HVAC-R) technicians, gas fitters, plumbers, pipefitters** and **sheet metal workers**. HVAC-R systems are integral to energy efficiency, and heat pumps are becoming the technology of choice rather than gas-fired boilers. Large mechanical companies that employ a variety of these workers generally have the ability to optimize the mix of skillsets required for construction, maintenance or retrofit projects. Our research also indicates that while trade workers currently have the foundational technical skills to work on energy efficient equipment, there are concerns that the trades training programs do not adequately cover specifics of emerging technologies and that there are not enough people choosing trades careers to replace retiring workers.

The installation of renewable energy systems is specific to NZE buildings, which will most likely be using solar or thermal options. Installation of solar systems requires **solar installers** and **electricians** familiar with photovoltaic (PV) systems. Thermal energy systems leverage the skills already found within the HVAC, plumbing and electrical trades. However, geo-exchange requires the drilling of boreholes, a process similar to water drilling.

The demand for buildings to have electric vehicle (EV) charging stations is anticipated to increase as consumers transition to electric vehicles. The installation of 240-volt EV charging stations requires certified electricians.

Since digitization and automation require sensors, meters and a network of systems, it is anticipated there will be an increased requirement for occupations such as **instrumentation technicians, electronic technicians** and **systems networkers** to look after their installation and maintenance. The foundational skills required by these occupations are available in today's workforce, but, like other trades, labour shortages are a concern.

While tradespeople are instrumental in the installation of hardware to support digitization, they will also be impacted by digitization and will require skills and literacy to effectively manage day-to-day tasks such as operating computerized equipment, accessing blueprints and manuals on digital devices and using digital diagnostic tools (Conference Board of Canada, September 2020).

The anticipated increases in modularization and prefabrication will impact workforce requirements and working conditions for construction and trade workers. These impacts result from work being performed in an enclosed and controlled factory environment, an intensification in coordinated and repeat activities, and greater levels of automation.

While HVAC-R, electrical and plumbing trades will remain important to ensure the assembly of modular components and the installation of systems are aligned with performance goals, fewer certified trades are required within a manufacturing plant. Rather, **computer numerical control (CNC) operators** or **programmers** are responsible for setting up, programming and operating the CNC machines that perform the repeatable, construction-related activities.

The onsite construction of projects using prefabricated components focuses on assembling, installing and connecting the modules at the building location. This requires a high level of precision to ensure energy efficiency performance specifications are maintained.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Table 5

Workforce Challenges—Construction and Related Trade Workers

<table>
<tr><td>Industry image and culture shifts</td><td>All trades face an aging workforce combined with significant attraction issues
Limited awareness and knowledge about skilled trades careers among youth and diverse labour force groups is an attraction barrier (Canadian Apprenticeship Forum, 2018)
University tends to be promoted as a “first choice” post-secondary option by parents and educators rather than a skilled trade career
Perception of construction trades requires improvement to increase attraction
Entails enhanced awareness that trades work involves working with technology
Stereotypes and biases regarding who is best suited to working in a trade have prevented a more inclusive and diverse workforce (BuildForce, Respectful Workplaces Blog)
Shift to offsite manufacturing/prefabrication and onsite installation of modules requires a shift in the way industry works as well as the mindset and skills of workers to operate within a highly automated plant environment and how to work with mass timber
The construction industry is currently onsite focused
Increased knowledge of how to work with mass timber required
The ability to precision install modules onsite is needed</td></tr>
<tr><td>Occupational and skills needs and gaps related to energy efficiency</td><td>Lack of awareness, understanding and expectations of the “building-as-a-system” mindset and performance-related expectations that go with it
Enhanced abilities required to use digital tools such as mobile apps to manage and share information, communicate and collaborate, and organize work
Labour shortages due to the combination of an aging workforce and significant attraction issues
Further upskilling needed for repairing, maintaining and programming automated building systems
HVAC-R: lack of standards and visibility of career path are leading to current and future labour shortages</td></tr>
<tr><td>Limitations of available training</td><td>Sustainability skills entailing a mix of technical knowledge and soft skills and systems thinking are not sufficiently integrated into current foundational trades training
Foundational training is not always keeping pace with emerging, energy efficiency technologies, equipment and materials
Shifts to remote learning may create challenges for apprenticeship training, which typically includes hands-on worksite components</td></tr>
<tr><td>Employer capacity constraints</td><td>Small businesses and contractors have a difficult time positioning the low-carbon value proposition as they are typically competing on “best price” rather than differentiating their services towards energy efficient specializations
Small businesses with lower staff numbers and fewer people in key roles make it difficult to have people away for training</td></tr>
</table>

Commissioning Professionals

Commissioning (Cx) professionals are hired by the building owner, architect or general contractor to ensure that systems are designed, installed, functionally tested and capable of being operated and maintained according to the owner's operational needs. Commissioning is done to ensure the intent of the design (energy efficiency, occupant comfort, air quality, etc.) is realized. Commissioning professionals also play a key role in helping to ensure the project owner achieves the desired return on their investment in energy efficiency. To be most effective, commissioning professionals have to be involved at the very early design stages associated with a new build or retrofit and throughout the building life cycle.

Senior commissioning authorities (CxA) tend to be seasoned experts with a broad range of skills and knowledge in building engineering and science, equipment and technologies, and operations. These competencies allow them to provide technical reviews and recommendations related to the design, specification, construction and turnover of projects in order to ensure their quality and effective integration into building operations and maintenance. They are often involved in training the operations and maintenance staff on the systems and equipment in a new building project or following a retrofit.

New building commissioning is an extensive quality assurance process that begins during concept design and continues through detailed design, construction, occupancy and the beginning of operations. The commissioning of an existing building is akin to a tune-up that seeks to improve how the building equipment and systems function together and ensures the building equipment and systems are operating optimally to meet current occupant needs (NRCan, 2018 and ASHRAE, 2019). Types of existing building commissioning (EBCx) include:

- **Recommissioning (RCx)** is a re-optimization process for existing buildings that have already been commissioned that seeks to improve how building equipment and systems are operating to meet current occupant needs. This is done by investigating to identify problems and integration issues and focusing on identifying low cost or no-cost operational improvements to obtain comfort and energy savings. This process can be undertaken alone or along with a retrofit project.
- **Retrocommissioning** is the commissioning of an existing building that was not originally commissioned. It aims to improve how building equipment and systems function together and resolve problems that occurred during building design, construction, or day to day running to meet current occupant needs.
- **Ongoing Commissioning (OCx)** "is a process of continuously testing and/or tuning building systems to maintain building performance as expected and previously commissioned" (ASHRAE, June 2014). Typically, this will include the implementation of technological and/or software solutions within the building's automated heating, ventilation and air conditioning (HVAC) control system, which monitor and help optimize operations on a continuous basis.

In addition to in-depth technical skills and knowledge, communication is a top skill requirement for commissioning professionals. They need the business acumen to deliver the value message to their audiences in the commissioning of buildings. They also must be able to converse with the workforce involved all along the project life cycle, including the project owner, design team, construction managers and crews, and building operations and maintenance personnel.

The digitization of commissioning processes and verification techniques, including the use of data analytics, will also increase the need for digital skills and literacy within this occupational cluster.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Table 6

Workforce Challenges—Commissioning Professionals

Industry image and culture shifts	• Increased acceptance and understanding of the value proposition for commissioning in new and existing buildings is needed to increase attraction to this profession – Emphasis on the inclusion of commissioning professionals throughout building life cycle, pre-design through operations
Occupational and skills needs and gaps related to energy efficiency	• Labour shortages expected due to an aging workforce • Until there is greater demand for commissioning, there is little incentive for junior commissioning technicians to pursue this career path and get hands-on experience – As demand for new and existing building commissioning increases, there will be a need to increase the workforce to meet the demand • Communication and negotiation skills are important to effectively: – Present the value proposition for commissioning – Interact with stakeholders across the supply chain – Educate building operations and maintenance personnel about equipment and systems in new buildings • The importance of collaboration skills will accelerate with increases in integrated design and project-delivery processes
Limitations of available training	• Deep knowledge and skills required by this profession are difficult to gain purely through training; hands-on experience is needed • Lack of recognition of a standard certification or accreditation may contribute to building owners’ reluctance to obtain commissioning services (Natural Resource Canada, 2018)
Employer capacity constraints	• Employers report challenges attracting and retaining this occupation and anticipate even greater challenges given the aging workforce • Smaller businesses with lower staff numbers and fewer people in key roles make it difficult to have people away for training

Quality Control and Assurance Specialists

Quality control and assurance (QA/QC) specialists plan, design, implement and maintain test processes, procedures and scripts for manual and automated testing of equipment, materials and systems. Example job titles include construction inspector, engineering inspector and QA technician. They are important to energy efficient buildings in that they mitigate risks associated with construction practices that do not align with the performance goals of a building. QA/QC programs are implemented by these specialists for both onsite construction and offsite manufacturing plants.

The role of QA/QC specialists will become increasingly important to achieve energy efficient buildings as codes, regulations and performance expectations increase the need for evaluation and verification of the building's components and the system as a whole. Robust and rigorous QA/QC programs are requiring more advanced skills, including an understanding of how to use the tools and equipment to perform accurate evaluations. Building envelope testing for vapour tightness is a specialized niche that is critical to energy efficient buildings.

Skills required by this occupational cluster include those needed to use digital quality management systems.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Table 7

Workforce Challenges—Quality Control and Assurance Specialists

Industry image and culture shifts	• The importance of this occupation will shift upward, driven by current and future increases and changes in codes, regulations and performance expectations associated with energy efficient buildings
Occupational and skills needs and gaps related to energy efficiency	• The ability to communicate with individuals and contractors across the building life cycle and engage in collaborative, integrated problem solving will be increasingly important • Digital literacy becoming more important to leverage digital quality control/management systems • Labour shortages are a risk due to the increasingly specialized requirements for energy efficient buildings and increased demand due to more stringent regulations and codes • Increasing demand for building envelope/air and vapour tightness testing for a "building envelope first" approach to ensuring energy efficiency is currently driving additional skill requirements
Limitations of available training	• Requires increasingly specialized knowledge and skills; difficult to gain purely through training; need hands-on experience
Employer capacity constraints	• No specific constraints identified

Building Managers and Operators

Building managers and operators run, manage and maintain buildings of all sizes and levels of sophistication. They play an essential role in ensuring that the systems within high-performing buildings are operating and maintained to optimize energy use and other sustainability goals and provide suitable indoor conditions for occupants.

In keeping with the collaborative, integrated and multi-disciplinary approach to design, building managers and operators need to be included in the building design process so they can bring their expertise to support the selection of equipment and the creation of operational sequences that will help to ensure energy efficient operations. Being involved during the design phase will also help the operations and maintenance staff better understand the design decisions made to achieve specific performance goals. This will contribute to ensuring buildings are managed and operated with broad environmental, social/sustainability and governance metrics in mind.

The effective operation of an energy efficient building is complex and requires a deep understanding of the inter-relatedness of building equipment and systems and the technologies installed to achieve greater operational efficiencies and optimization. Even more complex is a retrofit that likely combines new equipment, systems and technology with legacy ones, driving the need for skills and knowledge across mechanical, operational and technology disciplines.

A building manager or operator with a solid understanding of “building-as-a-system” can add value by identifying retrofit opportunities. Given their interaction with all facets of the building, its systems, data and occupants, they have the opportunity to identify root causes when systems are operating below desired performance standards. Collaboration with commissioning providers is also recommended. Those who do not use a systems-thinking approach when solving operational issues are more likely to make isolated repair decisions with little regard for how their decisions may impact the performance of other parts of the system.

Digitization and automated systems are increasing the opportunity for data-driven decision making and require operations personnel to have the ability to (American Council for an Energy-Efficient Economy, September 2020):

- Operate on-site and remote automated building systems and controls
- Use data to identify when systems are operating outside of intended parameters. This may include using modelled data from the design phase as a benchmark to assess the building's actual performance
- Program building control systems
- Conduct performance analytics and reporting
- Leverage digital tools such as computerized maintenance systems

Technology and data also allow for a more proactive approach to maintenance, rather than reacting to equipment or systems failure or near failure. This is both a cultural and mindset shift for maintenance trades and technicians.

Building operators are also the key interface with building occupants and are therefore critical in tenant engagement and communications, as well as educating them on how to properly operate the systems within their control. The building operator-tenant relationship is critical to help manage any issues or concerns that arise and is particularly important during significant disruptions such as those that can occur with retrofits.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Technology and data also allow for a more proactive approach to maintenance, rather than reacting to equipment or systems failure or near failure. This is both a cultural and mindset shift for maintenance trades and technicians.

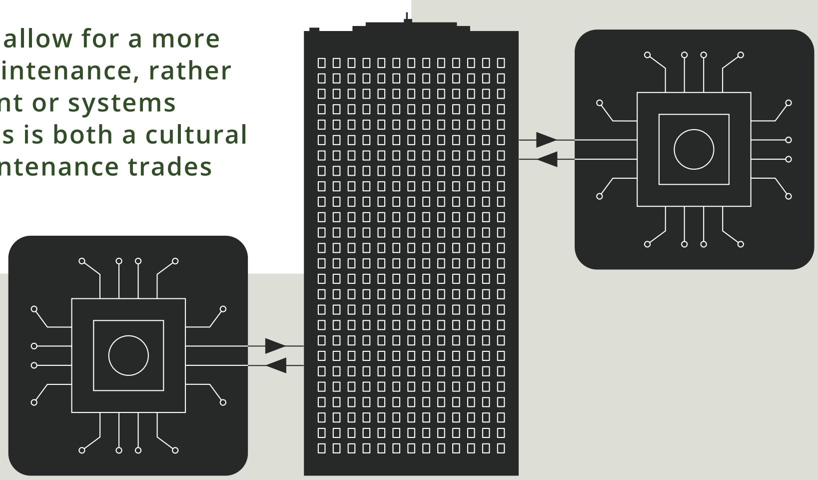


Table 8

Workforce Challenges—Building Operators and Managers

Industry image and culture shifts	• Involvement of building operations (likely at the manager level) during the design phase as required to achieve energy efficiency and higher performing buildings is a cultural shift • Building operator role not widely understood, causing challenges in attracting candidates with appropriate skills – Need to change the perception that building operation is mostly custodial work to enhance attraction • A high-tech digital environment may be challenging for some traditional workers as they need to adapt to automated systems • The introduction of digitization and automation is seen as a threat to jobs by some

Occupational and skills needs and gaps related to energy efficiency	• Increased digital literacy needed to proficiently use digital tools to perform diagnostics, carry out preventive maintenance, and operate automated systems
	• “Building-as-a-system” thinking requires enhanced skills to support performance optimization versus simply making repairs
	  – Soft skills required to communicate with building occupants about their needs and issues and educate them on optimal technology use
	• Site superintendent position requires an increasingly rare combination of qualifications, including skills and knowledge integrated across multiple disciplines, plus technology, project management and people management skills
	  – Building purpose can require further specialized knowledge, e.g., hospital
	• Maintenance managers and planners need to be familiar with a proactive, predictive maintenance approach that leverages data to make decisions
	• Lack of talent pipeline for operations management roles due to an aging workforce combined with attraction challenges

Limitations of available training	• Educational programming/training is lagging behind the technological advancements in building systems • Building operator occupation lacks occupational standards and an integrated program that provides necessary foundational skills
Employer capacity constraints	• Employers report challenges attracting and retaining this occupation and anticipate even greater challenges given the aging workforce • Smaller businesses with lower staff numbers and fewer people in key roles make it difficult to have people away for training • Smaller businesses have challenges competing with larger companies on compensation and career development opportunities

Information Technology (IT) Specialists

This occupational cluster includes several emerging and increasingly important roles required to support the accelerated digitization of the building sector. More specifically, these are occupations that, until recently, have not been employed by the building industry in great numbers and include job titles such as **software developer, data operations (DataOps) engineer, software development and operations (DevOps) engineer, user experience (UX) designer, scrum master, network design and integration specialist, systems analyst, applications developer, cybersecurity specialist and information management/information technology (IMIT) specialist**.

Digitization is the process of changing from analog to digital processes without any changes to the process itself (Gartner, accessed October 2020). It involves the acquisition of real-time data using sensors and meters or from databases. The connectivity afforded by the Internet of Things (IoT) allows the data to be transferred over a wireless network and used as inputs into a variety of systems, applications and software to assist with activities all along the building life cycle.

Technology offers the greatest opportunity to optimize building performance, reduce operations and maintenance costs, and enhance the occupants' experience when independent systems and applications are integrated to work together. An example includes the integration of the building information modelling system used during the design and construction phases with the facility management system used for ongoing operations.

This cluster of occupations has the technical skills and knowledge to ensure that the data, software, hardware and systems are integrated so that all the other occupational clusters can leverage the value they offer. This includes activities such as:

- Interconnecting and integrating systems
- Designing algorithms to automate specific tasks, monitor performance and the conditions of systems and equipment
- Updating software, adding new functions and addressing any bugs or issues using relevant coding languages to automate specific, routine operational tasks
- Querying data and conducting analytics to gain perspectives on performance and identify actionable insights to enhance energy-related and other performance goals
- Designing and automating dashboards and other visual presentations to help businesses make more strategic decisions
- Developing and updating user-friendly control applications
- Ensuring the security of systems, buildings and tenants
- Deploying technology and training other workers to utilize systems, apps, dashboards, etc.

The foundational technical training for these roles is typically obtained through universities or polytechnics; however, most IT workers also have a variety of other system and software certificates. As technology and programming languages are constantly evolving, these workers are more accustomed to continual learning and upgrading their skills. This is not always done through formal training. Many tech professionals are also involved in online training and meet-up groups focused on learning and experimenting with the latest technologies.

To optimize the skills and knowledge they bring to energy efficient buildings, IT specialists need to understand relevant building disciplines such as mechanical or electrical systems or operations. Being able to clearly communicate IT information in layman's terms is also of great value.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Table 9

Workforce Challenges—IT Specialists

Industry image and culture shifts	• IT specialists do not see the building industry as a career opportunity, primarily because the application of high tech in the industry is not promoted as a career path • The agile approach to IT work is different from the more risk-averse, structured approach to construction work, especially among occupations such as engineers and architects • IT language and terminology are unfamiliar to many of the traditional building-related occupations • The introduction of digitization and automation is seen as a threat to other occupations
Occupational and skills needs and gaps related to energy efficiency	• Difficult to find employees with combined knowledge and experience: IT and construction subject matter expertise (mechanical, electrical/instrumentation in particular) • Accelerated digitization across all industries is creating a shortage of IT professionals, especially mid-career professionals with 5-10 years of experience
Limitations of available training	• Currently, a lack of integrated training that combines IT skills with more traditional skills found in the building sector (mechanical, electrical, operations, etc.) – Training that addresses the broad range of skills needed and demonstrates a career path • Clear communication of the career path in construction for IT professionals is needed
Employer capacity constraints	• The hiring process for IT specialists may be unfamiliar to sector employers as they can be different than more traditional building sector occupations • May need to broaden typical talent sourcing strategies and tactics to attract IT specialists to the building sector

Regulatory Specialists and Officers

This occupational cluster is made up of the **building officials, code compliance officers** and **licensed inspectors** that are responsible for confirming that design meets relevant acts, codes, regulations, bylaws and other pertinent legislation. They also validate that construction is in accordance with the issued permit. They are typically hired by municipal or provincial governments.

Building officials review a multitude of structural and system elements of the building, including fire and other safety systems, energy efficiency and other environmental systems, and plumbing, mechanical and electrical systems. As such, they play a key role in ensuring building codes designed to move Canada's building stock to lower emissions and increased climate resiliency are correctly implemented.

Building officials are typically finished their work once construction is done and the building occupancy permit has been issued, while those involved in code compliance and safety inspections remain involved through a building's continued operation.

More information about the job titles included in this occupational cluster is provided in *Appendix 2*.

Table 10

Workforce Challenges—Regulatory Specialists and Officers

Industry image and culture shifts	• No specific challenges identified
Occupational and skills needs and gaps related to energy efficiency	• There is a risk of labour shortages due to an aging workforce • Upskilling and expanded knowledge are needed to address a broad range of code requirements, including understanding energy and other climate resiliency modelling techniques, testing procedures and data to ensure compliance
Limitations of available training	• Lack of consistent training due to codes and regulations varying across provinces, territories and municipalities, making training difficult
Employer capacity constraints	• Difficult for smaller municipalities with smaller staff to offer training

Future-Proofing the Energy Efficient Building Sector

To assess the capacity of the building sector workforce to meet Canada's *Build Smart* goals and an energy efficient future, we developed two categories for consideration:

- **Core:** occupations and/or skills currently available within the building sector workforce and that remain especially important for the growth of energy efficient, high-performing buildings
- **Growing:** occupations and/or skills currently available but that are expected to grow at a faster rate than others due to their involvement with specific, energy efficient related technologies, materials and/or processes

In some companies, a skill may form the basis for a specialized role, whereas, in other companies, that same skill may be a responsibility within a broader role. An example is IDP facilitation. One company may have a designated IDP facilitator, while another may require this skillset of its architects. For this reason, we do not distinguish between a skill and an occupation.

Table 11

Core and Growing Occupations and Skills Needed for Energy Efficient Buildings

- Architect
- Building Automation Technician
- Building Envelope Specialist
- Building Environmental Systems Operations
- Building Operation & Facility Manager
- Building Operator & Maintenance Technician
- Building Performance Specialist
- Building Regulator/Official
- Building Science
- Building Systems Analysis
- CNC Programmer/Operator
- Commercial Real Estate Manager
- Commissioning Specialist
- Construction Trades
- Construction Assembler/Installer
- Digital Skills (e.g., BIM, digital twinning, Augmented Reality/Virtual Reality, telematics, Artificial Intelligence/Machine Learning, Unmanned Aerial Vehicles, data analytics, software development)
- Energy Manager/Modeller/Analyst
- Engineer/Design Professional
- HVAC-R Trades & Technician
- IDP Facilitation
- Life Cycle Assessment
- Mass Timber Technician
- Mechatronics Engineering
- Passive House Design
- QA/QC Specialist
- Quantity Surveyor
- Recommissioning Specialist
- Sustainability Professional
- Systems Design & Integration
- Thermal Energy Engineering/Design

Recommendations and Conclusion

This research was initiated to support the achievement of ***Build Smart: Canada's Buildings Strategy*** by developing a better understanding of the occupations and skills required to support the energy efficient building sector and identify potential gaps in the labour force. The report focuses on the role of the occupational clusters involved along the business life cycle and the skills needed for designing, constructing, commissioning, managing, and retrofitting energy efficient commercial and institutional buildings. From the project onset, we sought to answer:

- How capable is the existing workforce of contributing to the acceleration of energy efficient building construction and retrofitting?
- What can be done to address any gaps in the sector's current capacity?

We tackled these questions by engaging key partners in the sector and conducting a review of recent printed and digital sources. We learned that there is a good reason to worry about being left behind if we do not act now and in a focused and thoughtful way. COVID-19 and its impacts on the economic climate are creating further challenges.

The skills and fields of knowledge required to progress energy efficient buildings are impacting roles within all occupational clusters involved in the building life cycle. Areas of knowledge that are uniquely important for energy efficient buildings relate to the building systems, materials and technologies that improve a building's climate change resiliency, their expanded supply chains and associated regulations, standards, certifications and metrics. As well, collaborative design and construction approaches and skills that recognize the "building-as-a-system" are key to energy efficient buildings.

Attracting workers to the construction industry who bring the requisite skills for energy efficient buildings will require the coordinated effort of the industry and its partners. Employers and workers must also be prepared for a change in culture, as the construction industry will witness a shift in behaviours, attitudes, traditions and interactions, which are essential to a more collaborative and integrated workplace. The industry will need to focus on employee retention, support diversity and inclusion, and develop lifelong learning practices in order for workers to stay relevant and effective in this changing environment.

The report illustrates that, across the building sector, we already have significant knowledge of what needs to be done. There are many examples of companies, organizations, unions, and educational institutions working hard to improve the building sector's environmental performance. However, provincial, territorial and regional factors often result in different approaches to achieving energy efficient buildings. This creates concentrations of available resources, such as qualified firms and skilled workers, within some regions and challenges accessing resources in others. Essentially, if we are to meet Canada's goals to address climate change, industry, its workforce, and its partners need to be pulling in the same direction. We need coordinated action plans to be implemented at all levels of government and among all stakeholders.

We have prepared high-level recommendations that address the labour and skills needed for the building sector to transition to a lower carbon economy while also identifying the gaps uncovered by research participants and the literature we consulted. Suggestions for labour supply touchpoints and target groups that could play a role in filling the identified gaps are also included.

Table 12

Workforce Development Recommendations for the Energy Efficient Building Sector

Recommendation	How do we get there? High-Level Activities and Initiatives	Potential Labour Supply Touchpoints
Develop a quantitative outlook of workforce demand	**Labour market information and industry outlook** • Develop 2–3 plausible scenarios and assumptions for the progression of energy efficient buildings; implications for each • Understand the relationship between drivers of activity and employment at an occupational level • Quantify occupational demand • Develop a plan to address core and growing occupations	• LMI organizations—ECO Canada, Buildforce, LMIC • Federal, Provincial and Territorial governments • Labour supply representatives • Unions • Employers • Construction Associations • Professional Associations • Engineers Canada • Regional economic development groups

Recommendation	How do we get there? High-Level Activities and Initiatives	Potential Labour Supply Touchpoints
Improve perceptions of industry attractiveness	**Create industry and career awareness and outreach strategy** • Opportunity to address climate concerns; green buildings playing a key role in shaping a low-emissions future • Promote occupations in demand and entry points: career pathways, education and training • Changes in culture and the digital environment—improve industry appeal, especially to youth	• Construction and industry associations • Employers • Unions • Labour Supply representatives • Regional economic development groups
Increase supply and skills of labour force	**Identify best practices to accelerate skills and knowledge upgrades and transfer from experienced workers** • Experiential training strategies to develop multi-skilled/ multi-disciplinary workers • People management and technical skills • Adapt best practices to regional differences • Future-proofing programs such as Hammer Heads[11] and Helmets to Hardhats[12] **Develop programs to target untapped supply pools such as under-represented and under-utilized groups** • Diversity and inclusion programs to help attract and increase the representation of women, youth, visible minorities and Indigenous workers • Transition workers from other sectors: military, oil and gas **Describe skills requirements and nature of work for manufacturing/prefab and digitization**—for owners/ employers, for the potential workforce and for the current workforce	• Unions • Employers • Local, grassroots organizations • Labour Supply representatives • Youth groups such as Student Energy, Youth Climate Lab, Global Shapers • Diversity organizations
Align post-secondary education and training to address occupation and skills requirements	**Determine and foster alignment of post-secondary education and training with occupations and skills needs** • Identify specific connections among training, occupations being targeted and for whom they are meant • Incorporate sustainability and systems thinking into curriculum—impact training approach as well as content • Incorporate digital literacy into curriculum • Support apprenticeship opportunities • Develop recognized standards programs to address specific occupational gaps: e.g., Building operators • Provide labs, simulators and other applied learning for experiential training • Improve experiential components of remote training, e.g., labs turned into broadcast studios	• Post-secondary education institutes • Training providers • Employers • Industry associations • Professional associations • Unions

11 Hammer Heads is a skill and employment-based training program within the construction sector that offers apprenticeship career opportunities to youth of under-resourced neighbourhoods in Ontario.

12 Helmets to Hardhats is a national nonprofit program that connects current and former military personnel access with skilled training and career opportunities in the construction sector.

Recommendation	How do we get there? High-Level Activities and Initiatives	Potential Labour Supply Touchpoints
Support employer capacity to attract, hire, develop and retain skilled workers	**Improve the capacity of employers across building life cycle to attract, hire, develop and retain workers** • Assess the needs of employers of all sizes and types • Create strategies to hire and develop "soft" skills while continuing to develop technical skills • Implement succession planning • Provide education and awareness for employers on shifts in technology, equipment and practices, and how to prepare their organizations to leverage them	• Industry associations supporting employers to improve attraction to the sector • Industry associations, unions and manufacturing sector to play a role in developing common training programs • Chambers of Commerce

Further work needs to be done with a more extensive range of stakeholders representing national, regional, and local interests to develop and prioritize solutions that are most effective at addressing workforce issues. Through this work, specific stakeholder groups and organizations can be identified who will participate in, or take ownership of, the implementation of solutions. Actions that adapt best practices to fit unique and ground-level needs will achieve the greatest results.

Appendix 1—Regional Factors Influencing the Transition to Energy Efficient Buildings

Our research indicates that regional factors play an important role in a building project owner's decision to pursue energy efficiency objectives.

There are numerous national, provincial, territorial and regional regulations, as well as strategies to further emission reduction goals and achieve energy efficiency for buildings, and they mostly involve different approaches according to their jurisdictions (Canada West Foundation, August 2020). These regulations and strategies help set direction and impact investment decisions. The variation among regions results in striking differences in the development of energy efficient buildings across the country. Toronto (Toronto Green Standard and Transform TO) and Vancouver (Vancouver Greens City Action Plan and BC Step Code) are examples of regions that have adopted standards that are more stringent than the model national building code and that have a higher density of energy efficient building projects than most other regions of Canada.

As noted in our report, workers with experience in the technology, equipment, materials and processes used in energy efficient buildings are found primarily within niche companies and departments within larger organizations. These employers are typically found in large urban centres in Canada but are uncommon in smaller urban centres and rural areas. This centralization of energy efficiency skills within large urban areas means that projects within those regions will be able to draw upon an established local supply of workers. In contrast, projects in smaller urban centres and rural areas will face additional costs of transporting experienced workers to their job site and providing accommodation as needed.

The size of the building project impacts the return on energy efficiency investments. Smaller building projects, which are common in smaller urban centres and rural areas, will have lower benefits associated with energy efficiency at the same time as they experience higher costs of acquiring energy efficiency technology, materials and workers, which typically need to be transported from other regions or countries.

Energy resource availability and pricing also influence building project owners who are considering energy efficiency goals. Energy efficient buildings are more appealing to developers in areas with higher energy prices. The relative price of electricity compared to natural gas is also a consideration in the decision to install a boiler or heat pump technology.

Provincial and territorial responsibility for post-secondary education results in differences in energy efficiency training opportunities for building sector workers across Canada. This adds to the complexity of energy efficiency building workforce development and reinforces the need for regional solutions.

Appendix 2—Occupations Required to Support Energy Efficient Buildings, by Building Life Cycle Phase

The following table assumes that the working conditions, technology and processes required to facilitate energy efficient buildings, as described in the body of this report, have been adopted. This includes a collaborative, integrated and multi-discipline approach to project design, delivery and operations. While energy-efficiency is a key outcome of the building, so are other performance metrics.

Table 13

In-Scope Occupations Required by Building Life Cycle Phase (Occupations are Listed in Alphabetical Order)

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
Design and Engineering Professionals and Specialists	• Architects • Commercial developers/real estate • Drone operators • Geotechnical engineers • Hydrologists • Land developers • Land surveyors • Sustainability specialists	• Architects • Automation design engineers/technologists • Building envelope specialists • Building Information Modelling (BIM) coordinators • Building performance engineers • Building science technologists • CAD/engineering technologists • Civil/Structural engineers • Climate risk engineers • Electrical/ Instrumentation design engineers • Façade engineers • Facilitators—integrated design/delivery • Lighting designers • Mechanical design engineers • Mechatronics engineers • MEP managers • Power systems engineers • Sustainability specialists	• Architects • Building envelope specialists • Building Information Modelling (BIM) coordinators • Building science technologists • Civil/Structural engineers • Electrical/ Instrumentation engineers • Facilitators—integrated design/delivery • Mechanical engineers • MEP managers • Sustainability specialists	• Building Information Modelling (BIM) coordinators • Facilitators—integrated design/ delivery	• Building Information Modelling (BIM) coordinators • Sustainability specialists	• Contaminated site specialists • Environmental engineers/ consultants

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
Energy Managers, Modellers, Specialists and Advisors	• Energy managers • Energy modellers	• Energy analysts/auditors (for retrofits) • Energy managers • Energy modellers • Life cycle assessment consultants		• Energy managers • Energy modellers	• Energy analyst/auditors • Energy managers • Energy modellers • Life cycle assessment consultants	• Life cycle assessment consultants
Construction Management and Onsite Supervisors	• Construction managers	• Construction estimators • Construction managers • MEP managers **Supply chain:** • Contracts manager/administrators • Materials management technicians • Procurement specialists • Purchasing managers • Schedulers/Expeditors	• Construction managers • Cost control technicians • Inventory control technicians • MEP managers • Onsite supervisors (by trade/discipline) • Project coordinators/administrators • Quantity surveyors • Safety officers	• Construction managers		• Construction managers • Decommissioning professionals • Environmental construction site superintendents • Hazardous/Regulated materials specialists • Materials technicians • Safety officers

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
Construction and Related Trades Workers			• Boilermakers • Carpenters • Cement masons • Construction labourers • Drywall mechanics • Electricians • Elevator constructor/ mechanics • Gasfitters • Glaziers • Heavy-equipment operators • HVAC technician—installations • HVAC-R (Refrigeration) technicians • Instrumentations technicians • Insulators • Ironworkers • Meter technicians • Millwrights • Pipefitters/steamfitters • Plumbers • Powerline technicians • Sheet metal mechanics • Welders	• Air barrier technicians • HVAC-TB (Testing & Balancing) technicians	• Carpenters • Electricians • HVAC-R technicians • Plumbers	• Construction labourers • Crane operators • Electricians • Heavy-equipment operators

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
Construction and Related Trades for Pre-fabrication & Modular Construction			• CNC programmers/ operators • Construction assemblers • Construction installers (floor, windows, drywall etc.) • HVAC technicians • Insulators • Logistics specialists • Mass timber technicians • Millwrights • Sheet metal workers • Skilled labourers • Welders			
Commissioning Professionals	• Commissioning professionals	• Commissioning professionals	• Commissioning professionals	• Air leakage control technicians • Blower door testers • Building envelope testers • Commissioning professionals • Electrical commissioning coordinators • Mechanical commissioning coordinators	• Commissioning professionals	

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
Quality Control and Assurance Specialists		• QA/QC managers • QA/QC technologists	• QA/QC managers • QA/QC technologists	• Air leakage control technicians • Blower door testers • QA/QC managers • QA/QC technologists		
Building Managers and Operators	• Building managers	• Building managers • Maintenance managers		• Building automation system (BAS) technicians • Building managers • Maintenance managers	• Building automation technicians • Building maintenance technicians • Building operators • Building system analysts • Building systems technicians • Chief power engineers • Facility/Property managers • Maintenance managers • Maintenance planners • Risk managers • Tenant engagement specialists	

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
Information Technology (IT) Specialists		• Information Management/ Information Technology (IMIT) project managers • Network design and integration specialists • Scrum masters • Systems designers • Systems integrators			• Applications developers • Business information (BI) developers • Cybersecurity specialists • Data analysts • DataOps engineers • DevOps engineers • Full-stack software developers • Information management/ information technology (IMIT) specialists • Network administrators • Network design and integration specialists • Scrum masters • Software developers • Systems analysts • UX designers	
Regulatory Specialists and Officers				• Building officers • Code compliance officers • Electrical inspectors • Elevator inspectors • Fire/safety inspectors • Gas inspectors	• Code compliance officers • Elevator inspectors • Fire/safety inspectors	

Occupational Cluster	Project Development Phase	Planning & Design Phase	Construction & Manufacturing Phase	Commissioning & Inspection Phase	Building Operations & Maintenance Phase	Decommissioning, Deconstruction or Renovation Phase
NZER/NZE Specific Requirements: **What makes energy efficient buildings unique is the use of renewable energy production, in the case of Net Zero Energy (NZE), or in the manner of construction of Net Zero Energy Ready (NZER) buildings so that fundamental efficiency potential has been maximized, and remaining energy needs could be met with renewables. In either case, the building is likely to have a solar energy system and appropriate energy storage or a thermal energy system.**						
Solar energy system (Photovoltaic solar; Solar thermal) *These occupations would be required if a solar system were being used by the building.*	• Solar energy project managers • Solar site assessors	• Energy analysts—solar energy specialists • Energy storage designer • Solar electrical estimators • Solar energy project managers • Solar energy systems designer (PV; thermal) • Supply chain specialist (solar)	• HVAC installers (solar) or mechanical contractors • Plumbers (solar) • Solar electrical installers (electrical apprentice) • Solar energy project managers • Solar system electricians • Electricians (solar)	• Electrical inspectors (solar) • Energy storage commissioning specialist	• Solar technicians	
Geothermal energy system *These occupations would be required if a geothermal system were being used by the building.*	• Geothermal site assessors • Thermal energy project managers	• Energy analysts—thermal energy specialists • Geothermal site designer • Thermal energy project managers	• Electricians (thermal) • HVAC installers (thermal) or mechanical contractors • Plumbers (thermal) • Thermal energy project managers • Geoexchange well drillers	• Thermal energy commissioning specialist	• HVAC technicians (heat pumps) • Thermal energy managers	

Appendix 3—References and Resources

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Glossary

Build Smart—lays out Canada's building strategy for achieving net zero energy ready by 2030. It includes establishing goals for more stringent building codes and steering the provinces and territories towards greater energy efficiency and overall performance in buildings.

Building airtightness—a building's ability to resist air or other vapours unintentionally entering or exiting through the building envelope. Proper airtightness is a key factor in preventing heat loss and improving ventilation.

Building life cycle—when we refer to a building's life cycle, we are including not just how long the building remains standing, but rather we are considering the design, construction, operation, demolition, and waste treatment.

Building stock—a term that is used to describe the total number of buildings in a region.

Circular economy—a system that seeks to eliminate both waste and the continual use of resources, focussing rather on reuse, sharing, repairing and recycling.

Clash detection analysis—identifies the potential risk of different components, equipment or systems of the building interfering with one another and therefore causing operational issues. Analysis is done during the design phase, usually with the assistance of building information modelling software.

Current workforce requirements—what the building sector needs, in terms of occupations and skills, at the present time, with the level of energy efficiency activity as it now stands.

Decommissioning—shutting the building down and protecting it from hazards until the future of the building has been determined.

Embodied carbon—defined as the greenhouse gas emissions associated with the development of a building, including the extraction, manufacturing and transportation of construction materials, as well as the construction processes.

Energy efficiency—an energy demand reduction strategy or activity that involves identifying, planning, and implementing innovations, technologies, or processes that require less energy use for ongoing services. Energy efficient buildings incorporate design elements, materials, technologies, and construction techniques that result in lower energy requirements and usage.

High-performing buildings—a building is considered high performing when it goes beyond energy efficiency to also minimize future building impacts on the environment, including reductions in water use, waste diversion rates and annual carbon emissions, as well as improved building resilience to hazards and occupant health and well-being benefits (BOMA Canada, 2020).

Integrated Design Process (IDP)—a collaborative process among key players implemented over the full building life cycle to realize functional, environmental and economic goals for the building.

Mass timber—an engineered wood product made from various wood products fixed together with a binding agent to form a composite material. Mass timber can take advantage of smaller trees and wood waste, making it a cost-effective and sustainable option.

Net Zero Energy (NZE) buildings—high performing buildings that combine superior standards in energy efficiency with renewable energy production to offset all the building's annual energy consumption.

Net Zero Energy Ready (NZER) buildings—high performing buildings built to the same level of energy efficiency as Net Zero Energy buildings but do not include renewable energy production. An NZER building's fundamental efficiency potential has been maximized, given the current market-ready technologies and costs of construction (labour, materials, and others), so that the remaining energy needs could be met with renewables.

Occupational clusters—a broad grouping of occupations that have similar knowledge and skills requirements

Occupational gap—a lack of candidates with the minimum required qualifications for a specific job in a specific labour market. From the perspective of the workforce for energy efficient buildings, an occupational gap exists if there are not enough qualified workers (e.g., engineers, HVAC installers, or commissioning providers) to fill the positions available.

Skills gap—a lack of candidates with the skills required by particular employers. A skills gap in the energy efficiency workforce exists when qualified workers do not possess all of the skills required to be successful in their roles.

Zero Carbon (ZC) buildings—highly energy efficient buildings that produce onsite, or procure, carbon-free renewable energy or high-quality carbon offsets to offset the annual carbon emissions associated with building materials and operations.

About ECO Canada

ECO Canada is the steward for the Canadian environmental workforce across all industries. From job creation and wage funding to training and labour market research, we champion the end-to-end career of an environmental professional. Our efforts promote and drive responsible, sustainable economic growth to ensure that environmental care and best practice is a priority.

Environmental Labour Market Intelligence

We are thought leaders in the environmental labour market. Our workforce knowledge spans nationally across all provinces and territories, as well as within major Canadian industries, including energy, forestry, mining, agriculture, manufacturing and construction.

ECO Canada investigates current environmental skills and labour trends to improve industry access and career advancement opportunities for new graduates as well as mid- to senior-level practitioners. ECO Canada's research provides timely and valuable insights on green career trends, from top jobs to skills gaps to high-growth sectors. Our data and findings can be used to make decisions and formulate strategies within policy, business, education, and career development contexts.

ECO Canada is examining new ways of measuring environmental employment:

- Analyzing job postings to identify hiring trends and skills in demand
- Estimating labour demand and supply using secondary statistics, such as employment data from Statistics Canada. Economic drivers are also factored in to create a demand forecast for environmental employment
- Profiling the environmental sector with in-depth research on trends and issues driving growth or decline within key environmental sub-sectors.

The complete report collection is available at eco.ca/research. ECO Canada welcomes comments and discussion of all its labour market information. Contact research@eco.ca.

eco canada

CONTACT US

...

ECO Canada

Suite 400, 105 12 Avenue SE
Calgary, Alberta T2G 1A1

P : 1-800-890-1924

E : research@eco.ca

W : eco.ca

ECO Canada relies on employees and partners from Vancouver to Windsor to Montreal and Halifax, as well as our Territories. Visit our website or contact us for more information.

@ecocanada

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