Deep Retrofit Accelerator Initiative (DRAI)

Technologies and Skills Memo

Submitted to:

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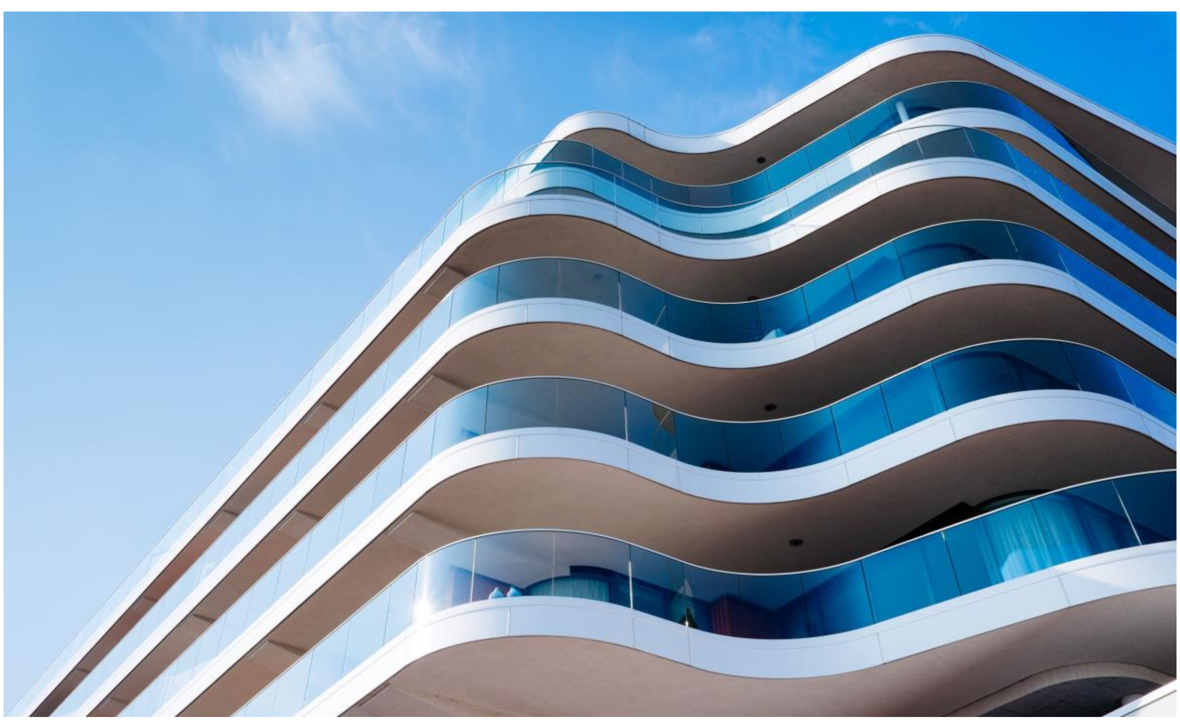
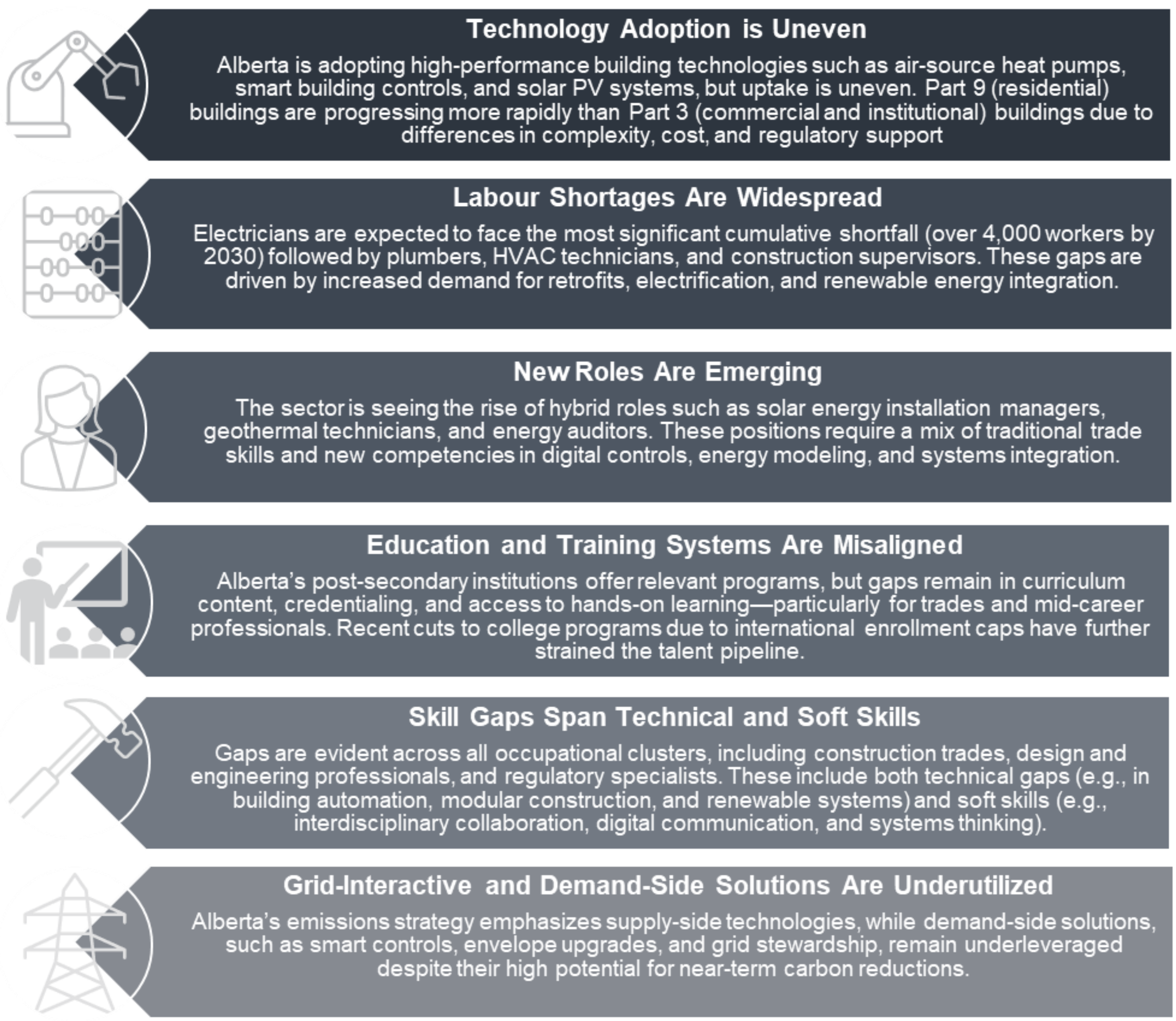


Executive Summary

This *Technologies and Skills Memo* was developed by WSP Canada Inc. for the Southern Alberta Institute of Technology (SAIT) under the Deep Retrofit Accelerator Initiative (DRAI). It provides a foundational analysis of the technologies, workforce capabilities, and education and training systems required to support Alberta's transition to high-performance, net-zero buildings. Commissioned as the first deliverable under a broader market analysis led by SAIT, in partnership with Alberta Ecotrust, this memo is intended to inform policy, workforce development, and investment strategies that will accelerate deep energy retrofits in Alberta's Part 3 and Part 9 building sector.

The study applied a mixed-methods approach, drawing on publicly available secondary research, labour market data, and expert validation. Technologies were mapped by building system (e.g., mechanical, electrical, enclosure), and workforce needs were analyzed using National Occupation Classification (NOC) codes and Alberta-specific labour forecasts. Education and training pathways were reviewed through institutional program scans and curriculum analysis. While the findings offer a strong foundation, they are based solely on secondary data and should be validated through future primary research, including interviews, focus groups, and economic modeling.

Key Findings:



Taken together, these findings highlight the need for coordinated action across government, industry, and education providers to build a resilient, future-ready workforce. Alberta's leadership in sustainable building innovation will depend on its ability to close labour and skills gaps, modernize training systems, and support the adoption of advanced technologies across the building sector. While this study provides a strong foundation, it will be essential to validate these findings, refine occupational forecasts, and develop targeted strategies for workforce development and policy design.

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1.0 INTRODUCTION

Alberta's building sector is at a critical juncture as the province works to meet its climate goals and reduce greenhouse gas emissions. High-performance (HP), net-zero buildings—those that significantly reduce or eliminate operational emissions—are central to this transition. The *Technologies and Skills Memo*, developed by WSP Canada Inc. as part of the Deep Retrofit Accelerator Initiative (DRAI), provides a foundational analysis of the technologies, workforce capabilities, and education and training systems required to support this shift. The memo is intended to guide policymakers, educators, and industry stakeholders in aligning Alberta's built environment with a low-carbon future.

This work is part of a broader market analysis initiative led by the Southern Alberta Institute of Technology (SAIT) in partnership with Alberta Ecotrust's Retrofit Accelerator. SAIT has been retained to conduct a comprehensive market analysis and deliver a series of educational sessions focused on advancing deep energy retrofits in Alberta's building sector. As part of this mandate, SAIT engaged WSP to support the market analysis by reviewing existing technologies, examining regulatory and code environments, and identifying systemic barriers to retrofit adoption. This memo represents the first deliverable under that mandate, addressing technology trends and skill gaps in the Alberta market.

Grounded in publicly available secondary research and labour market data, the memo outlines the current landscape of energy-efficient and renewable technologies—such as heat pumps, smart building controls, and advanced enclosure systems—and assesses their adoption across both new construction and retrofit projects. It also evaluates Alberta's workforce readiness to implement these technologies, identifying key occupations, skill gaps, and projected labour shortages through 2030. In doing so, the memo provides a strategic foundation for targeted interventions such as upskilling programs, curriculum development, and policy support.

The memo is accompanied by an excel document *'CA0022958.8089_SkillsTechList_Draft"* which provides the raw findings from the skills and technology market analysis and should be read alongside the summarized findings in this document.

1.1 Scope

This study provides a review and analysis of publicly available secondary research and data to support the following goals:

- **Technology baseline and trends**: Identify widely used technologies relevant to high-performance (HP) buildings in Alberta; highlight emerging technologies; analyze technology adoption trends.
- **Workforce readiness**: Identify key roles and skills for technologies; review Alberta labour market data for to identify demand and supply for technology roles, highlighting potential labor shortages.
- **Education system readiness**: Document an indicative list of industry certifications, licensing needs, and specialized training programs; highlight gaps in training availability and upskilling needs.

The scope is intentionally limited to interventions that directly impact energy consumption and emissions within the building envelope. External elements—such as landscaping—have been excluded, as they fall outside this boundary. In addition, fuel-switching strategies involving Renewable Natural Gas or hydrogen have not been considered, as advancements in this area are primarily driven by utility providers rather than building-level initiatives.

Primary research is not included in the scope for this study, and findings have not been validated by experts outside of WSP. As such, all findings should be understood as potential trends.

2.0 APPROACH

WSP applied a mixed-methods approach to identify key occupations, skills, and technologies relevant to Alberta's high-performance building sector:

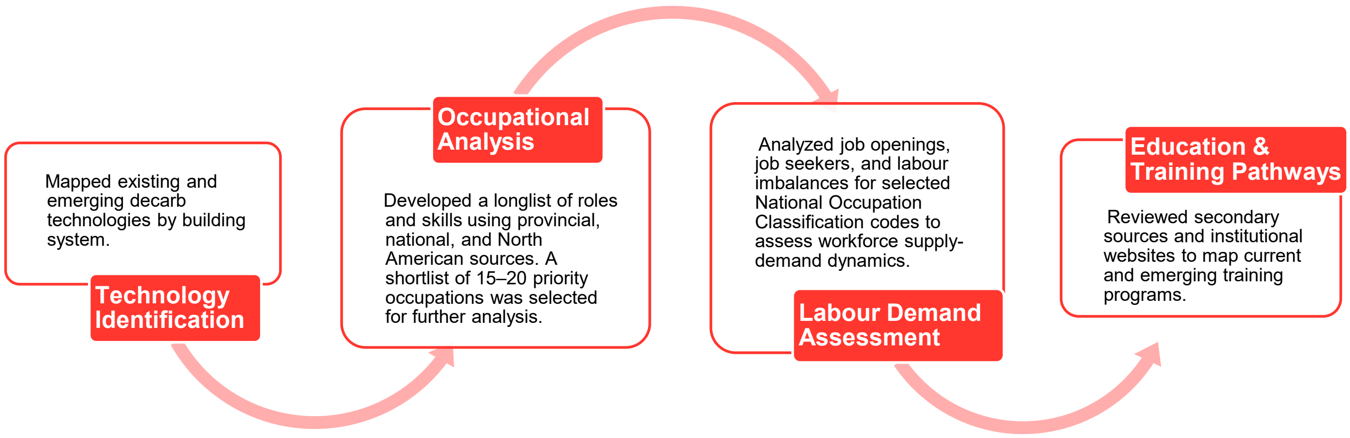

Figure 1: Project Approach

A detailed methodology description, including study limitations, is available in Appendix A.

3.0 TECHNOLOGIES

Alberta is at a critical point in advancing toward a net-zero future, with high-performance building technologies playing a key role in reducing greenhouse gas (GHG) emissions from the built environment. Decarbonizing buildings, especially those defined under Part 3 (large buildings) and Part 9 (residential and small commercial buildings) of the National Building Code is essential to achieving the province's sustainability targets. Net-zero buildings incorporate energy-efficient designs, renewable energy systems, and innovative heating solutions to significantly lower energy consumption and dependency on fossil fuels.

Part 3 buildings, such as large commercial and institutional facilities, require major system upgrades and strategic energy management, while Part 9 buildings offer scalable opportunities for residential retrofits using technologies like heat pumps, solar panels, and enhanced insulation. A comprehensive approach that includes both categories is vital to reducing emissions province-wide.

This section identified widely used technologies in energy efficiency in Alberta, including emerging technologies and innovation, and explores energy technology adoption trends in the province.

3.1 Defining High-Performance Building Technologies

In this study, WSP has established a working definition for net-zero high-performance building technologies. These are defined as any measures, combinations of measures, or design strategies implemented in either new construction or retrofit projects that enable buildings to significantly reduce or eliminate greenhouse gas (GHG) emissions throughout both the construction phase and operational life. For the purposes of this study, “high-performance” is understood to mean achieving substantial GHG emission reductions, typically in the range of 50% to 80%. This interpretation aligns with the targets outlined in Alberta Ecotrust's Deep Retrofit Plan. As a result, the study emphasizes three key areas: heating systems, the building envelope (including insulation and cladding), and on-site renewable energy technologies such as solar photovoltaic (PV) systems.

High-performance technologies typically aim to reduce or eliminate reliance on natural gas for heating by reducing building loads, incorporating electric systems and maximizing on-site renewable energy generation. These buildings are designed to operate with very low Energy Use Intensity (EUI), reflecting minimal overall energy consumption. For new construction projects targeting net-zero, this means designing building envelopes to the highest efficiency standards, installing only high-efficiency equipment, and ensuring systems are optimized for long-term performance. By shifting toward electricity as the primary energy source rather than natural gas, these buildings embody the principles of sustainable, low-emission design.

3.2 Key Concepts of Holistic Decarbonization in Net Zero High Performance Building

Holistic decarbonization is a comprehensive, systems-level strategy that targets carbon reduction across all major drivers of building energy use: occupant systems, enclosures and HVAC, fuel choices, and grid integration. Rather than making isolated improvements, this approach synchronizes building operations with real-time conditions and long-term energy goals. It improves comfort, cuts operating costs, and ensures buildings are ready for emerging carbon regulations and a renewable-powered grid.

At the heart of this approach are four foundational concepts, each represented by a set of practical, scalable solutions:

Occupant-Connected Systems & Equipment - This concept focuses on aligning building energy use with real-time occupancy and behavior patterns to optimize efficiency and performance. Technologies such as smart building automation systems—enhanced with controls and analytics—adjust lighting, HVAC, and plug loads based on actual usage. Occupancy and daylighting sensors minimize unnecessary lighting, while variable frequency drives improve HVAC motor efficiency. Demand-controlled ventilation adapts airflow to occupancy levels, cutting energy use without compromising comfort. Bi-directional electric vehicle (EV) chargers further enhance responsiveness by allowing vehicles to supply power back to the building or grid during peak periods. By integrating occupant mobility with building operations, these chargers function as mobile energy assets that support both internal efficiency and broader grid stability.

Supportive Enclosures & HVAC Delivery - This addresses the physical shell and air-handling systems of the building. High-performance enclosures reduce heating and cooling needs by maintaining better thermal stability. Techniques like thermal bridging mitigation and comprehensive air leakage testing enhance airtightness. Meanwhile, energy recovery ventilation systems recapture waste energy from exhaust air, and dedicated outdoor air systems—especially in distributed designs—improve indoor air quality while keeping HVAC loads low. Incorporating high-performance glazing further protects the building from external temperature swings, increasing comfort and efficiency.

Optimal Fuel-Switching - Optimal Fuel-Switching seeks to replace fossil-fuel systems with cleaner, often electric, alternatives. Central and distributed air-source heat pumps serve as high-efficiency heating and cooling systems. Cascading or hybrid systems combine different heating technologies to optimize performance across load conditions. Geo-exchange systems go a step further by tapping into the stable thermal properties of the earth for even greater energy savings. In addition, capturing waste heat and enabling energy sharing between zones or systems maximizes the value of energy already in use.

Grid Stewardship - Grid Stewardship empowers buildings to support a clean, resilient electrical grid. Onsite solutions like solar photovoltaics and battery energy storage help buildings generate and manage their own power. Microgrid controllers and facility-wide demand management tools allow precise coordination of loads, storage, and generation. During peak demand periods, buildings can rely on stored thermal or battery energy to reduce strain on the grid. This not only lowers carbon intensity but also fosters grid stability and energy independence.

Together, these strategies offer a complete framework for decarbonizing buildings—from internal operations to grid-level collaboration. Categorized under these four pillars, WSP developed a ‘Top 20 Decarbonized Solutions’, which are intended to help guide the most impactful actions for achieving net zero at the building level. WSP chose to focus on the top 20 solutions to provide a clear, actionable framework that balances ambition with practicality. These technologies were selected for their proven effectiveness, scalability, and relevance across Alberta’s diverse building types. By narrowing the scope, we can better align workforce development, policy, and investment strategies to accelerate adoption and maximize impact in the transition to high-performance, net-zero buildings.

The figure below groups these Top 20 Technology Measures based on the concepts explained above. The Top 20 Technology Measures are summarized in the ‘Existing_Technologies_Shortlist’ tab of the ‘*CA0022958.8089_SkillsTechList_Draft’* excel file. The complete long list of existing technologies can be found in the tab ‘Existing_Technologies_Shortlist’.

Figure 2: Decarbonized Solutions Top 20

3.3 Existing Technologies Used in Alberta

Alberta is progressing in net-zero and high-performance building technologies primarily through municipal leadership and educational efforts, particularly in cities like Calgary and Edmonton. Programs such as Emissions-Neutral Buildings Information Exchange (ENBIX) and support from institutions like SAIT are helping to promote sustainable construction and workforce development. However, the province lacks strong regulatory mandates for net-zero readiness, which limits the broader uptake of these technologies compared to provinces like British Columbia, Quebec, and Ontario, where policy frameworks and incentives are more developed.

For example, heat pump adoption—central to high-performance buildings—remains limited in Alberta, with only 2,404 units installed since 2020 through federal support. Most are hybrid systems that supplement natural gas heating, reflecting both climate concerns and Alberta’s fossil-fuel dependency. In contrast, Ontario (102,960), Quebec (66,670), British Columbia (29,559), and Nova Scotia (27,029) have seen significantly higher adoption, driven by targeted incentives, cleaner electricity grids, and robust energy efficiency programs (Canada, 2024).

Adoption of other net-zero technologies in Alberta is growing but remains slower than in leading provinces. While Alberta has strong solar potential and emerging smart building investments, provinces like Ontario and British Columbia lead in solar deployment, geothermal systems, and advanced insulation due to stricter codes and better incentives. To catch up, Alberta would benefit from stronger provincial policies and financial supports to complement its municipal and private-sector efforts.

This section summarizes adoption trends of net-zero high performance building technologies in Alberta and provides some case studies demonstrated application of these technologies throughout the province. A series of case studies demonstrating the application of net-zero high performance building technologies is provided in Appendix B.

3.3.1 Adoption Trends of Net Zero High Performance Building Technologies in Alberta: Part 3 vs. Part 9 Buildings

In Alberta, the adoption of net-zero high-performance building technologies is progressing unevenly across building types, reflecting differences in scale, complexity, and economic considerations. Part 9 buildings, which include low-rise residential homes and small multi-unit developments, are seeing a gradual increase in the use of certain technologies, particularly envelope improvements and distributed HVAC systems. Part 3 buildings—covering large commercial, institutional, and high-rise residential projects—are moving more cautiously, often limited by system complexity, upfront costs, and operational constraints.

Part 9 Buildings

Alberta's low-rise residential sector is showing early momentum in adopting high-performance, low-carbon technologies. While the province still trails national leaders, targeted incentives and growing public interest are helping drive change. The following highlights summarize the most notable trends shaping this transition:

- **Air-source heat pump adoption** is rising in low-rise residential (Part 9) buildings, especially mini-split and in-suite systems—though Alberta still lags behind other provinces (Global News, 2024; Canadian Climate Institute, 2023).
- **Simpler installation and smaller thermal loads** make these systems more viable in Part 9 buildings than in larger commercial or institutional buildings.
- **Consumer incentives and utility programs** from providers like ENMAX and FortisAlberta are helping drive adoption.
- **Envelope upgrades,** including air leakage control, vapour barriers, thermal bridging mitigation, and high-performance glazing, are more common due to their affordability and ease of integration.
- **Daylighting, occupancy controls, and rooftop solar PV** are slowly gaining traction in residential settings.
- **Bi-directional EV chargers** are emerging as part of home energy strategies, enabling vehicles to act as mobile energy storage and support future grid-interactive capabilities.

Part 3 Buildings

Adoption of net-zero technologies in Alberta's large commercial and institutional buildings remains cautious and uneven. While some high-performance new builds and pilot projects are leading the way, broader uptake is constrained by cost, complexity, and infrastructure limitations. The following points highlight the current state of technology adoption in this sector:

- **Net-zero adoption is limited to pilots and new construction,** with central air-source heat pumps and hybrid systems being tested in select developments in Calgary and Edmonton.
- **Barriers to widespread deployment** include high upfront costs, cold-climate performance concerns, and compatibility issues with existing systems—leading many buildings to retain natural gas for peak heating.
- **Operational optimization is advancing,** with Building Automation Systems (BAS), variable frequency drives, and sub-metering with real-time analytics increasingly used to manage energy use.
- **Ventilation efficiency is improving** through the adoption of Dedicated Outdoor Air Systems (DOAS) and distributed ventilation designs in new builds.

- **Advanced energy systems are being piloted,** including geo-exchange, thermal storage, and waste heat recovery, to reduce external energy reliance and increase system flexibility.
- **Battery storage and microgrid controllers** are gaining interest for resilience and renewable integration, though currently limited to institutional applications.
- **Solar PV adoption is slower** than in residential buildings, with installations typically limited to rooftops and carports.

To support the transition to net-zero, high-performance buildings, WSP identified 20 key decarbonization technologies and assessed their relevance across different building types. The table below maps each technology's applicability to Part 3 (large commercial and institutional) and Part 9 (low-rise residential) buildings. These findings reveal important trends in how technologies are being adopted, where they are most effective, and how they can be scaled across Alberta's diverse building stock.

Table 1: Net Zero High Performance Building Technology Measures by Applicability to Part 3 and Part 9 Buildings

Technology Measures	Part 3	Part 9	Both
Daylighting and Occupancy Controls			Yes
Building Automation Systems (BAS)-Controls & Analytics	Yes		
Facility Wide Demand Management (Microgrid Controllers)			Yes
Variable Frequency Drives			Yes
Air Leakage Mitigation & Testing (Air/Vapour Barriers)			Yes
Thermal Bridging Mitigation			Yes
High Performance Glazing System			Yes
Bi-Directional Electric Vehicle Chargers			Yes
Air Source Heat Pumps - Central			Yes
Cascading/Hybrid Systems (Heat Pumps)	Yes		
Dedicated Outdoor Air Systems (DOAS) + Distributed Design	Yes		
Geo-Exchange Integration (Ground Source Heat Pumps)			Yes
Decarbonized High Efficiency Combined Heat and Power			Yes
Air-Source Heat Pumps - Distributed (In-Suite/Mini-Split)		Yes	
Waste Heat and Energy Sharing	Yes		
Thermal Storage (Demand Side Management)	Yes		
Heat & Energy Recovery Systems (HRV & ERV)			Yes
Demand Controlled Ventilation	Yes		
Solar PV (Building Attached, e.g., Rooftop/Carport)			Yes
Battery Energy Storage			Yes

Key findings from Table 1 include:

- Broad Applicability Across Building Types: The majority of the technologies listed are applicable to both Part 3 (large commercial/institutional) and Part 9 (low-rise residential) buildings. This suggests strong potential for standardization and scalability across the sector, which is critical for accelerating market transformation.
- Envelope and Passive Measures Are Universally Relevant: Technologies like air leakage mitigation, thermal bridging mitigation, and high-performance glazing are applicable across both building types. These envelope upgrades are foundational to energy efficiency and are often the most cost-effective first step in retrofits.

- Part 3 Buildings Lead in System-Level Integration: Technologies such as Building Automation Systems (BAS), Dedicated Outdoor Air Systems (DOAS), waste heat and energy sharing, and thermal storage are more commonly found in Part 3 buildings. This reflects their greater complexity and capacity for integrated energy management strategies.
- Part 9 Buildings Embrace Distributed Solutions: Distributed air-source heat pumps and in-suite systems are more prevalent in Part 9 buildings, aligning with their smaller scale and decentralized mechanical systems. These technologies are easier to install in individual units and are well-suited to retrofit scenarios.
- Grid-Interactive Technologies Are Gaining Ground: Measures like bi-directional EV chargers, solar PV, battery storage, and microgrid controllers are applicable across both building types. Their inclusion highlights the growing importance of grid stewardship and the role of buildings as active participants in energy systems.
- Emerging Technologies Are Bridging the Gap: Technologies such as cascading/hybrid heat pump systems and decarbonized combined heat and power are currently more aligned with Part 3 buildings but may become more accessible to Part 9 buildings as costs decline and modular solutions evolve.

3.4 Future Technology Trends in Net Zero High-Performance Buildings

As Canada commits to net-zero greenhouse gas emissions by 2050, buildings—responsible for about 18% of the country's total emissions—are crucial for decarbonization. Policies, standards like the National Building Code's net-zero-ready provisions for 2030, and investments are advancing Net-Zero High-Performance Buildings (NZHPBs). Emerging technologies such as high-performance materials, cold-climate HVAC systems, energy storage, and digital tools are transforming building design and operation. Canada's specific challenges include optimizing for cold climates, retrofitting infrastructure, and integrating with carbon-intensive grids.

In Alberta, the harsh climate and carbon-intensive electricity grid present challenges and opportunities for building decarbonization. Effective strategies involve high-efficiency, cold-climate systems like CO_2-based heat pumps, borehole thermal storage, and Structural Insulated Panels (SIP).

Alberta's old building stock and cold winters create favorable conditions for advanced insulation and cold-climate heat pumps, though other solutions like solar-thermal systems face barriers. Early trials of technologies like phase change materials, electrochromic glazing, and modular ice-based energy storage are underway, showing promise for addressing Alberta's climate challenges and supporting NZHPBs:

Phase Change Materials (PCMs) - PCMs regulate indoor temperatures by storing and releasing thermal energy as they shift between solid and liquid phases. In Canada, these materials are being tested in wall assemblies, ceiling panels, and thermal plasters. In Alberta, early research and demonstration efforts have taken place at institutions like SAIT's Green Building Technologies Lab, which has evaluated PCMs in test walls for their capacity to buffer internal temperature swings. While market uptake is still limited, Alberta's wide diurnal temperature ranges—especially in shoulder seasons—make PCMs a promising tool for reducing HVAC loads in both residential and institutional settings.

Electrochromic / Photochromic Glass - These dynamic glazing systems automatically adjust tint in response to sunlight or electrical signals, reducing glare, managing heat gain, and improving occupant comfort. In Alberta, the Calgary Cancer Centre has incorporated electrochromic glazing in specific areas to enhance patient experience and control solar exposure without traditional blinds. Similarly, pilot projects at the University of Calgary have explored smart glass in academic buildings to balance daylight and heat. Given Alberta's high solar exposure and growing concern over summer cooling loads, this technology has high potential, especially as lifecycle costs decline and sustainability goals rise in public and institutional buildings.

Modular Ice-Based Energy Storage - Modular ice storage systems shift cooling demand to off-peak hours by making ice overnight and using it for air conditioning during peak daytime periods. While not yet widespread in Alberta, the technology is gaining traction in institutional settings. Notably, Alberta Health Services (AHS) has conducted trials in select health care facilities—particularly in central utility plants and large hospitals—to evaluate the feasibility of ice storage as a strategy for peak load reduction and enhanced grid responsiveness. These systems are especially relevant in Alberta's urban hospitals and data-intensive health facilities, where cooling demand is high, and reliability is critical. As Alberta's energy grid evolves, modular ice storage could become a valuable demand-side asset in health infrastructure and other large buildings.

A long list of emerging technologies can be found on tab 'Emerging_Future_Technologies' in the *CA0022958.8089_SkillsTechList_Draft'* excel.

4.0 WORKFORCE READINESS

Research indicates that while Canada has the technology and materials needed for energy-efficient buildings, the building sector may not have enough workers with the right skills and experience to implement these technologies effectively (i.e., insufficient labour supply[1] to meet employer demand[2]). Sophisticated technologies, greater systems integration, and expanded automation require new knowledge and skills from engineers, operations staff, equipment installers, and others (Eco Canada, 2021).

Indeed, the future impact of artificial intelligence on the building sector workforce remains uncertain, particularly in engineering, construction management, and operations occupations. While demand for physical trades and hands-on maintenance workers is expected to grow, desk-based roles will need to adapt through retraining and upskilling. These shifts may not appear in current provincial workforce data. For example, the number of maintenance staff may remain stable, but the required competencies will change. Training programs must evolve to reflect these emerging skill demands and support a workforce capable of delivering, operating and maintaining high-performance building technologies.

The following sections provide an overview of existing research on Alberta's workforce readiness to continue to adopt and implement high-performance building technologies from 2025 to 2030. These insights into Alberta's workforce capacity to support the growing demand for high-performance building technologies, can support the design of targeted programs that align with Alberta's green building goals.

4.1 Defining Occupations and Occupational Clusters

Occupational clusters refer a broad category of occupations that share common skill sets, knowledge areas, and training requirements, often allowing for transferable competencies across roles within the group.[3] In-demand occupations outlined in Section 4.2.2 fall into the following occupational clusters (Eco Canada, 2021):[4]

- Construction Management and Onsite Supervisors: Individuals who oversee construction projects, coordinate teams, manage schedules, and ensure quality and safety on-site.
- Construction and Related Trade Workers: Skilled tradespeople such as carpenters, plumbers, and HVAC technicians who carry out the hands-on work of building and retrofitting high-performance structures.

[1] Labour supply: refers to the availability of workers with the necessary skills, qualifications, and experience to fill current and future job roles within a specific industry or region. It includes both the existing labor pool and the pipeline of new entrants from education, training, or career transitions.
[2] Labour demand: refers to the number and types of workers that employers need, based on current and projected job openings, industry trends, and evolving skill requirements. It reflects the roles, qualifications, and competencies that are essential to meet organizational and sectoral goals.
[3] Existing research groups occupations into several different occupational clusters. WSP has aligned its analysis with Eco Canada's (2021) *Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce*.
[4] Other occupational clusters include energy managers, modellers, specialists, and advisors, commissioning professionals, quality control and assurance specialists, building managers and operators, and information technology (IT) specialists. Additional details on occupations that do not fall within these occupational clusters available in Appendix C.

- Design and Engineering Professionals: Architects, engineers, and building designers who develop high-performance building plans, integrate energy-efficient systems, and ensure compliance with sustainability standards from concept to construction.
- Regulatory Specialists and Officers: Individuals who ensure compliance with building codes, environmental regulations, and energy performance standards.

High-performance building technology occupations are roles that require the technology-specific (tech-specific) skills and knowledge needed to support constructing new buildings and retrofit existing ones to minimize carbon emissions. These roles often apply many of the same skills as typically used for conventional builds, but, in addition, require complementary tech-specific knowledge and skills.

The following criteria were used to refine the list of technology occupations highlighted in the body of this report:

- Occupations that do not directly interact with high-performance building technologies as defined in section 0 were excluded. For instance, associated roles in utility transmission systems, technology development, manufacturing, finance and sales roles were excluded from this analysis.
- Occupations were included from the following groups in the high-performance building technology pipeline:
  - Decision makers (e.g., policy makers, building owners, planning professionals);
  - Designers and consultants (e.g., engineers, technologists, architects, energy modellers);
  - Construction team (e.g., construction managers, building trades); and,
  - Building performance (e.g., maintenance, building managers).

4.2 Buildings Workforce Supply and Demand

An occupational gap occurs when there aren’t enough qualified candidates in a specific labor market to meet job demand. In the context of energy-efficient buildings, this means a shortage of skilled professionals—such as engineers, Heating, Ventilation and Air Conditioning (HVAC) technicians, or sustainability specialists—to fill available roles. Occupational gaps highlight where the supply of workers falls short of industry needs, directly pointing to in-demand occupations. These are the roles with the largest shortages, where targeted training, recruitment, or upskilling is most urgently needed to meet future labour market demands.

The following sections provide a scoping review of key publicly available studies analysing the workforce supply and demand needed to implement technology measures for high-performance buildings in Alberta. This review is followed by an analysis of workforce data from the Alberta Government to provide an overview of forecast occupational gaps for key roles in 2025 and 2030.

Key findings:

- Electricians are anticipated to face the most substantial occupational gap, with a cumulative shortfall exceeding 4,000 workers by 2030. This shortfall reflects the growing demand for electrical upgrades and alternative energy systems.
- Plumbers, along with contractors and supervisors in both electrical and mechanical trades, are also expected to encounter persistent shortages, underscoring the need for targeted recruitment and training initiatives.

4.2.1 Supply and Demand for Energy Efficient Building Workers

With construction activity—especially in institutional buildings—set to grow across Canada, 2022 research from the Delphi Group indicates the industry must recruit around 25,000 workers by 2030 to offset retirements and meet green retrofit demand in Alberta. Population growth among younger workers will likely help, with 23,000 new journeypersons[5] expected by 2027. Both residential and non-residential sectors are projected to expand. Their research shows that in Alberta construction trades occupations, along with engineering and facility managers occupations may face potential shortages by 2025 (Delphi Group, 2022).

A (2024) report from BuildForce Canada indicates that the transition to energy efficient buildings will generate approximately 7,300 new direct jobs in Alberta's residential construction sector. A significant portion will focus on energy-efficiency renovations, with about 34% linked to fuel-switching activities. Jobs created through energy-efficiency retrofits span a broad range of trades due to the diverse nature of the work. In contrast, fuel-switching jobs are concentrated in a few specialized trades, such as electricians and HVAC technicians, which may pose recruitment challenges (BuildForce Canada, 2024).

The shift away from fossil-fuel heating will likely drive strong demand for heating, refrigeration, and air conditioning mechanics in Alberta—adding over 1,100 new jobs between 2023 and 2032, more than a sevenfold increase from the base year. While overall demand for gas fitters will decline, fuel-switching will still require their expertise for equipment removal. However, future demand could shift if Alberta advances hydrogen-based home heating, which may sustain or reshape the role of gasfitters (WSP SME, personal communication, 2025). Trade helpers and labourers will also see increased demand, though the growth—about 14% of the base year workforce over the decade—is expected to be manageable through standard hiring practices (Delphi Group, 2022).

Additional trades likely to face labour market pressures in Alberta over the next decade include insulators, residential window and door installers, sheet metal workers, and electricians. Demand for sheet metal workers and electricians is largely driven by retrofits involving heating system replacements and electrical upgrades, while energy-efficiency renovations are expected to increase demand for insulators and installers (Delphi Group, 2022).

4.2.2 High-Performance Buildings Technology Occupational Gaps

To identify demand for key occupations supporting high-performance building technologies, WSP used labour market projections from the Alberta Government. The analysis reviewed net job openings,[6] net job seekers,[7] annual imbalance,[8] and

[5] Journeyperson: In Alberta, a journeyperson refers to an individual that holds a trade certificate from Apprenticeship and Industry Training (AIT) that confirms the holder meets all certification standards for a designated trade.
[6] Net-Change (Job-Openings): refers to the difference between the number of job openings created and the number of job openings eliminated over a specific period. It indicates whether employment opportunities in a sector or economy are growing or shrinking.
[7] Net-Change (Job Seekers): refers to the difference between the number of individuals entering the job market and those exiting it over a specific period. It reflects shifts in labour supply, indicating whether the pool of active job seekers is growing or shrinking.
[8] Annual Imbalance: refers to the difference between the total number of job openings and the total number of job seekers over the course of a year. It indicates whether there is a surplus or shortage of labour in the job market annually.

cumulative imbalance[9] from 2025 to 2033 for selected National Occupation Classification (NOC) codes.[10] This approach highlights job and skill gaps by showing where worker demand exceeds supply. Occupations with the lowest cumulative imbalance values indicate the most significant shortages and point to areas needing targeted training, hiring, or upskilling.

The projections reflect broader labour market trends across Alberta and are not limited to the high-performance buildings sector. For example, growth in trades may be influenced by population increases or broader policy shifts. While not driven by energy efficient buildings goals, these trends will affect labour availability, specialized skills, and workforce capacity needed to adopt high-performance technologies in the buildings sector.

In Alberta, a general occupational gap is expected across trades, followed by more specific gaps in high-performance building technologies. Electricians are forecast to have the highest cumulative supply gap imbalance, followed by plumbers, contractors and supervisors for the electrical trades, and contractors and supervisors for the mechanic trades, as outlined in Figure 3.

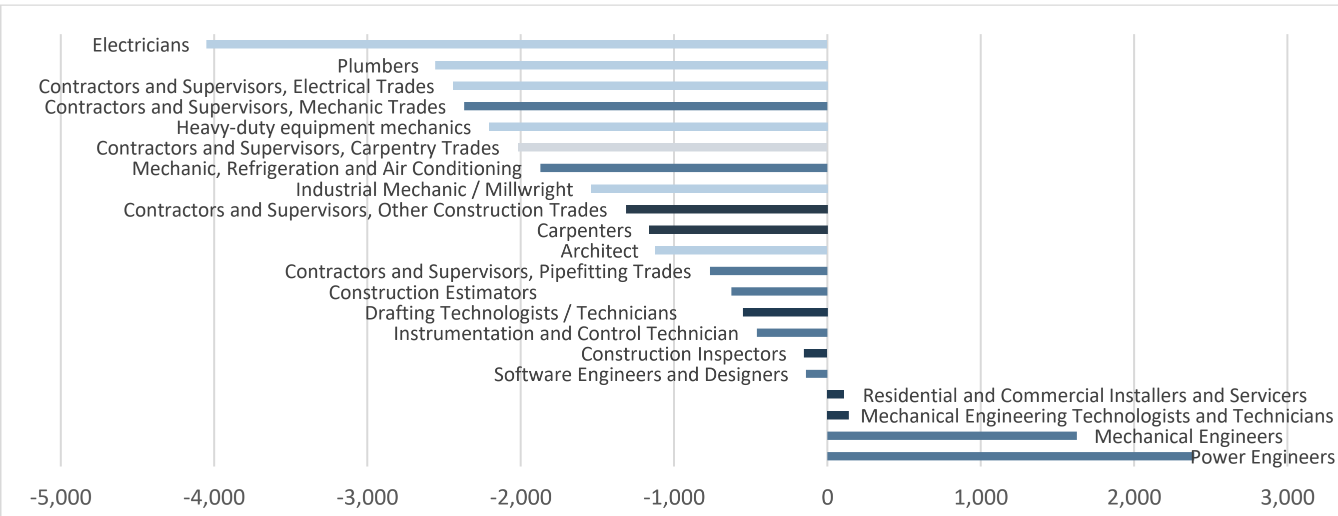

Figure 3: Percent (%) Expected High Supply Cumulative Imbalance Occupational Clusters, Alberta 2030

Source: (Alberta Government, 2024)

Note: Occupations were selected based on scoping review findings and insights from WSP subject matter experts in green buildings and technology. Key gap occupations were selected by sorting all identified occupations by 2030 the lowest number (i.e., highest forecast supply gap) for cumulative imbalance. Only roles which have the highest potential for high-performance energy efficiency impacts were selected (i.e., roles linked to heat pumps, enclosure, and alternative energy technology). NOC occupations that include emerging sustainable sub-occupations tracked by O*NET were also included, since NOC demand and supply data may not be accurate.

[9] Cumulative Imbalance: refers to the total difference between job openings and job seekers accumulated over multiple years. It shows long-term trends in labour market mismatches, highlighting persistent surpluses or shortages in specific occupations or sectors.
[10] National Occupation Classification (NOC): refers to Canada's national system for describing and categorizing occupations based on the tasks, duties, and responsibilities involved, as well as the skills, education, and experience required. Each occupation has a linked NOC code. This section summarizes available projections without additional modelling or filtering.

While there are no expected supply gaps for residential and commercial installers and servicers, mechanical engineering technologists and technicians, mechanical engineers, or power engineers, projections indicate potential gaps in specific technical skills related to high-performance building measures (WSP SME, personal communication, 2025). These gaps may include experience with advanced HVAC systems, building automation, energy modeling, and integration of renewable technologies—skills that are essential for meeting performance standards and regulatory requirements.

FUTURE RESEARCH: Publicly available secondary research available at the time of writing focuses on occupational gaps for construction and related trade occupations. In addition, no detailed analysis of occupational gap by technology measure is available.

- Economic modelling linked to technology uptake is needed on occupational clusters outside of residential construction for Alberta, including design and engineering professionals and specialists, construction management and onsite supervisors, and regulatory specialists and officers. Modelling would also be needed linked to relevant NOC codes as validated by primary research.
- Primary research (e.g., interviews, focus groups, surveys) needed to identify high-performance building technology-specific occupational gaps and validate Alberta workforce data insights.

More information on demand by occupation or occupational cluster available in Occupations_Skills_Longlist and Occupations_Skills_Shortlist tabs in the *CA0022958.8089_SkillsTechList_Draft'* excel.

4.3 Changing Skill-Sets and Emerging Occupations

Alberta's high-performance building sector is evolving through sustainability goals, digital innovation, and regulatory change—creating demand for a workforce with specialized, future-ready skills. O*NET's emerging roles framework highlights occupations shaped by new technologies, industry shifts, and policy changes. These emerging roles signal where skill gaps may form and where workforce development should focus (O*NET, 2006). This section outlines changing skill-sets for traditional occupations and new emerging occupations expected to see increased demand and potential talent shortages in Alberta's high-performance buildings sector.

Key Findings:

- Construction managers, supervisors, and trades workers must develop skills in integrated project delivery, energy-focused decision-making, and digital tools like BIM to support high-performance outcomes.
- Design and engineering roles require updated knowledge in building science, passive design, and renewable systems. BIM supports integrated planning and performance-based outcomes.
- Emerging roles—such as solar engineers, geothermal technicians, and energy auditors—demand specialized skills in renewable systems, prefabrication, and performance testing.

4.3.1 Design and Engineering Occupations

Design and engineering occupations —including engineers, architects, and building science experts—are key to creating energy-efficient commercial and institutional buildings. They may work independently or for firms of any size, guiding clients on sustainable design choices and promoting the use of advanced materials and technologies. These professionals influence early project stages, encouraging coordinated, multidisciplinary approaches that improve outcomes and efficiency. Often, architects or lead engineers drive this integration, aligning teams around shared goals. To support net-zero goals, they must stay current on innovations in energy efficiency. Tools like Building Information Modelling (BIM) are central to integrated design in early project phases, such as Part 3, offering a shared, data-rich model that supports collaboration and informed decision-making; however, their application is less common in later stages like Part 9 (Eco Canada, 2021).

A strong grasp of building science and a systems-thinking approach are essential for designing high-performance new builds and retrofits. Their focus areas include:

- Airtight building envelopes
- Low-carbon materials
- Passive design strategies
- Renewable energy systems
- Water conservation
- Indoor environmental quality
- Building automation and controls

Occupation descriptions and key skills for the emerging occupations within the construction managers and onsite supervisors cluster are outlined in Table 2.

Table 2: Emerging Design and Engineering Occupations, O*NET 2025

Occupation	Description	Key Technical Skills
Geothermal Technicians	Perform technical activities at power plants or individual installations necessary for the generation of power from geothermal energy sources. Monitor and control operating activities at geothermal power generation facilities and perform maintenance and repairs as necessary. Install, test, and maintain residential and commercial geothermal heat pumps.	▪ Seal open sides of modular units to prepare them for shipment, using polyethylene sheets, nails, and hammers ▪ Move and set up mobile homes or prefabricated buildings on owners' lots or at mobile home parks ▪ Inspect, examine, and test the operation of parts or systems to evaluate operating condition and to determine if repairs are needed ▪ Connect water hoses to inlet pipes of plumbing systems, and test operation of plumbing fixtures ▪ Remove damaged exterior panels, repair and replace structural frame members, and seal leaks, using hand tools ▪ List parts needed, estimate costs, and plan work procedures, using parts lists, technical manuals, and diagrams ▪ Confer with customers or read work orders to determine the nature and extent of damage to units ▪ Install, repair, and replace units, fixtures, appliances, and other items and systems in mobile and modular homes, prefabricated buildings, or travel trailers, using hand tools or power tools ▪ Reset hardware, using chisels, mallets, and screwdrivers ▪ Repair leaks in plumbing or gas lines, using caulking compounds and plastic or copper pipe ▪ Locate and repair frayed wiring, broken connections, or incorrect wiring, using ohmmeters, soldering irons, tape, and hand tools ▪ Open and close doors, windows, and drawers to test their operation, trimming edges to fit, using jackplanes or drawknives ▪ Connect electrical systems to outside power sources and activate switches to test the operation of appliances and light fixtures ▪ Refinish wood surfaces on cabinets, doors, moldings, and floors, using power sanders, putty, spray equipment, brushes, paints, or varnishes
Energy Engineers	Design, develop, or evaluate energy-related projects or programs to reduce energy	▪ Advise others regarding green practices or environmental concerns ▪ Analyze energy usage data

Occupation	Description	Key Technical Skills
	costs or improve energy efficiency during the designing, building, or remodeling stages of construction. May specialize in electrical systems; heating, ventilation, and air-conditioning (HVAC) systems; green buildings; lighting; air quality; or energy procurement. Excludes Wind and Solar Energy Engineers.	▪ Monitor industrial energy consumption or management ▪ Direct energy production or management activities ▪ Inspect equipment or systems ▪ Create models of engineering designs or methods ▪ Research energy production, use, or conservation ▪ Evaluate plans or specifications to determine technological or environmental implications ▪ Prepare technical or operational reports ▪ Purchase materials, equipment, or other resources ▪ Train personnel on proper operational procedures ▪ Research design or application of green technologies ▪ Perform marketing activities ▪ Operate computer systems ▪ Recommend technical design or process changes to improve efficiency, quality, or performance
Solar Energy Systems Engineers	Perform site-specific engineering analysis or evaluation of energy efficiency and solar projects involving residential, commercial, or industrial customers. Design solar domestic hot water and space heating systems for new and existing structures, applying knowledge of structural energy requirements, local climates, solar technology, and thermodynamics.	▪ Collect data about project sites ▪ Prepare detailed work plans ▪ Design alternative energy systems ▪ Provide technical guidance to other personnel ▪ Create graphical representations of energy production systems ▪ Create models of engineering designs or methods ▪ Evaluate plans or specifications to determine technological or environmental implications ▪ Recommend technical design or process changes to improve efficiency, quality, or performance ▪ Determine design criteria or specifications ▪ Determine operational methods ▪ Inspect finished products to locate flaws ▪ Analyze costs and benefits of proposed designs or projects ▪ Analyze green technology design requirements ▪ Test green technologies or processes

Source: (O*NET, n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e)(

4.3.2 Construction Management And Onsite Supervisors

Construction managers and onsite supervisors are responsible for executing building designs and often handle procurement of materials, equipment, and subcontracted services. Their role is critical to ensuring that systems are installed as intended and that any on-site changes (as-built decisions) support the building's high-performance goals. Involving construction managers early in the design process supports better alignment between design intent and construction realities. This integrated, collaborative approach is essential for achieving energy efficiency but may require a shift in traditional practices (Eco Canada, 2021).

As digital tools become more prevalent, these professionals will increasingly use building information management systems to track costs, schedules, and as-built conditions. Integrating this data with facility management systems will help optimize building operations and maintenance over the long term (Eco Canada, 2021).

Occupation descriptions and key skills for the emerging occupations within the construction managers and onsite supervisors cluster are outlined in Table 3.

Table 3: Emerging Construction Managers and Onsite Supervisors Occupations, O*NET 2025

Occupation	Description	Key Technical Skills
Solar Energy Installation Managers	Solar energy installation managers direct work crews installing residential or commercial solar photovoltaic or thermal systems.	▪ Coordinate construction project activities. ▪ Plan layout of construction, installation, or repairs. ▪ Direct construction or extraction personnel. ▪ Estimate materials requirements for projects. ▪ Estimate construction project labor requirements. ▪ Estimate construction project costs. ▪ Communicate with other construction or extraction personnel to discuss project details. ▪ Test green technology installations to verify performance. ▪ Identify opportunities to improve operational efficiency. ▪ Create construction or installation diagrams. ▪ Assess locations for potential green technology installations. ▪ Analyze costs and benefits of proposed designs or projects. ▪ Order construction or extraction materials or equipment.

Source: (O*NET, n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e)(

4.3.3 Construction and Related Trade Workers

Construction and trade workers play a central role in building, retrofitting, and maintaining high-performance buildings. While they possess the core technical skills, research participants noted a need for a more integrated, systems-based approach to their work—moving beyond task-specific roles to understanding how their work impacts overall building performance. These workers are essential for installing energy-efficient systems and materials as designed (Eco Canada, 2021).

For example:

- Civil trades such as carpenters, roofers, masons, and glaziers are key to creating airtight building envelopes. When on-site conditions require deviations from design, these trades must ensure changes do not compromise energy goals.
- Maintenance workers also play a critical role in sustaining energy performance. Adopting a “building-as-a-system” mindset is especially important during repairs to ensure overall efficiency is maintained—an approach that may require a shift in traditional maintenance practices.
- Mechanical systems rely on a range of trades, including HVAC-R technicians, gas fitters, plumbers, pipefitters, and sheet metal workers. As heat pumps replace gas-fired systems, demand for HVAC-R skills is rising. Larger mechanical firms are often better positioned to deploy the right mix of skills across projects.

Occupation descriptions and key skills for the emerging occupations within the construction and related trade workers cluster are outlined in Table 4.

Table 4: Emerging Construction and Related Trade Worker Occupations, O*NET 2025

Occupation	Description	Key Technical Skills
Manufactured Building And	Move or install mobile homes or	▪ Seal open sides of modular units to prepare them for shipment, using polyethylene sheets, nails, and hammers

Occupation	Description	Key Technical Skills
Mobile Home Installers	prefabricated buildings.	▪ Move and set up mobile homes or prefabricated buildings on owners' lots or at mobile home parks ▪ Inspect, examine, and test the operation of parts or systems to evaluate operating condition and to determine if repairs are needed ▪ Connect water hoses to inlet pipes of plumbing systems, and test operation of plumbing fixtures ▪ Remove damaged exterior panels, repair and replace structural frame members, and seal leaks, using hand tools ▪ List parts needed, estimate costs, and plan work procedures, using parts lists, technical manuals, and diagrams ▪ Confer with customers or read work orders to determine the nature and extent of damage to units ▪ Install, repair, and replace units, fixtures, appliances, and other items and systems in mobile and modular homes, prefabricated buildings, or travel trailers, using hand tools or power tools ▪ Reset hardware, using chisels, mallets, and screwdrivers ▪ Repair leaks in plumbing or gas lines, using caulking compounds and plastic or copper pipe ▪ Locate and repair frayed wiring, broken connections, or incorrect wiring, using ohmmeters, soldering irons, tape, and hand tools ▪ Open and close doors, windows, and drawers to test their operation, trimming edges to fit, using jackplanes or drawknives ▪ Connect electrical systems to outside power sources and activate switches to test the operation of appliances and light fixtures ▪ Refinish wood surfaces on cabinets, doors, moldings, and floors, using power sanders, putty, spray equipment, brushes, paints, or varnishes
Solar Thermal Installers and Technicians	Install or repair solar energy systems designed to collect, store, and circulate solar-heated water for residential, commercial or industrial use.	▪ Inspect plumbing systems or fixtures ▪ Inspect industrial or commercial equipment to ensure proper operation ▪ Test electrical equipment or systems to ensure proper functioning ▪ Apply sealants or other protective coatings ▪ Install solar energy systems ▪ Install plumbing or piping ▪ Communicate with clients about products, procedures, and policies ▪ Determine appropriate locations for operations or installations ▪ Maintain mechanical equipment ▪ Pour materials into or on designated areas ▪ Apply adhesives to construction materials ▪ Apply identification labels or tags ▪ Cut carpet, vinyl, or other flexible materials ▪ Install insulation in equipment or structures ▪ Install gauges or controls ▪ Assess locations for potential green technology installations
Solar Photovoltaic Installers	Assemble, install, or maintain solar photovoltaic (PV) systems on roofs or other structures in compliance with site assessment and	▪ Install solar energy systems ▪ Inspect electrical or electronic systems for defects ▪ Determine appropriate locations for operations or installations ▪ Apply sealants or other protective coatings ▪ Install electrical components, equipment, or systems

Occupation	Description	Key Technical Skills
	schematics. May include measuring, cutting, assembling, and bolting structural framing and solar modules. May perform minor electrical work such as current checks.	▪ Select construction materials ▪ Apply identification labels or tags ▪ Create construction or installation diagrams ▪ Select construction equipment ▪ Test electrical equipment or systems to ensure proper functioning ▪ Test green technology installations to verify performance ▪ Review blueprints or specifications to determine work requirements ▪ Determine construction project layouts ▪ Maintain mechanical equipment ▪ Record operational or environmental data
Weatherization Installers and Technicians	Perform a variety of activities to weatherize homes and make them more energy efficient. Duties include repairing windows, insulating ducts, and performing HVAC work. May perform energy audits and advise clients on energy conservation measures.	▪ Test products for functionality or quality ▪ Inspect equipment to ensure proper functioning ▪ Test characteristics of materials or structures ▪ Apply material to fill gaps in surfaces ▪ Inspect industrial or commercial equipment to ensure proper operation ▪ Install green structural components, equipment, or systems ▪ Inspect work sites to determine condition or necessary repairs ▪ Communicate with clients about products, procedures, and policies ▪ Install insulation in equipment or structures ▪ Install building fixtures ▪ Estimate construction project costs ▪ Clean equipment or facilities ▪ Maintain construction tools or equipment ▪ Record operational or environmental data ▪ Prepare operational reports ▪ Inspect completed work to ensure proper installation ▪ Install doors or windows

Source: (O*NET, n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e)(

4.3.4 Regulatory Specialists And Officers

This cluster includes building officials, code compliance officers, and licensed inspectors who ensure that building designs and construction meet applicable codes, regulations, and legislation. Typically employed by municipal or provincial governments, they review structural, safety, energy efficiency, and mechanical systems to confirm compliance with permits and standards. Building officials are primarily involved during the design and construction phases, while code compliance and safety inspectors may continue oversight throughout a building's operational life. Based on experience, a WSP SME observed that Building inspectors have been a barrier to the implementation of high-performance buildings due to a lack of familiarity with emerging technologies and strategies (WSP, 2025). For regulatory specialists and officers, including building officials, then, it gaining knowledge about high-performance building technologies is essential to support Canada's transition to low-emission, climate-resilient buildings (Eco Canada, 2021).

Occupation descriptions and key skills for the emerging occupations within the construction managers and onsite supervisors cluster are outlined in Table 5.

Table 5: Emerging Regulatory Specialists and Officers Occupations, O*NET 2025

Occupation	Description	Key Technical Skills
Energy Auditors	Conduct energy audits of buildings, building systems, or process systems. May also conduct investment grade audits of buildings or systems.	▪ Identify opportunities to improve operational efficiency ▪ Analyze energy usage data ▪ Use thermographic imaging to assess energy efficiency or detect equipment faults ▪ Analyze risks related to investments in green technology ▪ Calculate data to inform organizational operations ▪ Prepare financial documents, reports, or budgets ▪ Inspect facilities or equipment to ensure specifications are met ▪ Assess the cost effectiveness of products, projects, or services ▪ Evaluate condition of properties ▪ Advise others on business or operational matters ▪ Research issues related to the environment or sustainable business practices ▪ Correspond with customers to answer questions or resolve complaints ▪ Develop technical specifications for systems or equipment ▪ Test characteristics of materials or structures ▪ Oversee business processes ▪ Verify application data to determine program eligibility

Source: (O*NET, n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e)(

FUTURE RESEARCH: Existing research on in-demand skills and occupations focuses on “energy efficient buildings” or a particular occupational grouping (e.g., trades). Primary research needed to cross-map high-performance building technology measures to specific occupations across occupational groups.

More information on skills by occupation or occupational cluster available in Occupations_Skills_Longlist and Occupations_Skills_Shortlist tabs in the *CA0022958.8089_SkillsTechList_Draft’* excel.

4.4 High-Performance Technology Skill Gaps

A skills gap occurs when available candidates lack the specific skills employers need. For example, a skill gap in the high-performance building sector may refer to an increased demand for residential and commercial installers and servicers to support with the installation of manufactured buildings and mobile homes.

Skills gaps in the high-performance buildings workforce can have adverse impacts on building owners and occupants. Improper installation or maintenance of building systems can hinder energy and indoor environmental performance, discourage future investments in energy-efficient technologies, and slow their adoption. Increased energy use can affect the ability to meet energy or sustainability goals, lead to higher operating costs, and compromise the business case for investment in new technologies. Buildings operating outside intended parameters may result in occupant discomfort and reduced productivity (American Council for an Energy-Efficient Economy, 2020).

Building on the O*NET emerging roles key skills from Section 4.3, this section outlines high-performance building skill gaps by occupational cluster and then highlights key skill gaps from the scoping review.

4.4.1 Key Gaps by Type

4.4.1.1 Information Technology

The rise of the Internet of Things (IoT) and Industry 4.0 is reshaping the building industry. Tools such as smart sensors, AI, and data analytics are helping reduce costs, improve efficiency, and address environmental concerns (RLABS, 2019).

Integrated technologies now support collaboration throughout the building lifecycle, requiring workers to possess both technical and digital communication skills. Trades professionals are increasingly installing systems that generate data for simulations, analytics, and AI-driven decision-making. In this data-rich environment, critical thinking is essential to evaluate information reliability (Eco Canada, 2021).

As digital tools become essential across all roles, demand is rising for IT specialists and digitally fluent workers. New roles in construction include software developers, cybersecurity experts, data analysts, and systems integration specialists—highlighting the urgent need to close the digital skills gap in the building sector (Eco Canada, 2021).

4.4.1.2 Modular Construction and Pre-Fabrication

Research indicated 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 (Eco Canada, 2021).

4.4.1.3 Deep Energy Retrofit

A successful deep energy retrofit requires a multidisciplinary skill set that spans design, construction, and performance verification. However, (2025) research by RFS Energy Consulting & Research Inc for Ecotrust indicates many professionals lack exposure to the full range of competencies needed to deliver high-performance outcomes. Key gaps include:

- Building Science,
- Building envelope detailing, including glazing and curtain wall technology,
- Energy modelling,
- Building systems and their interrelationships (structural, mechanical, electrical, architectural),
- National Building Code and Energy Code of Canada requirements,
- Local building bylaws / permit requirements,
- Construction logistics and sequencing,
- Embodied carbon/energy & operational carbon/energy,
- Building controls/building management systems,
- Building electrification strategies,
- Heat pumps,
- Solar photovoltaics and grid-tied connections,

- Electrical transformers,
- Insurance Requirements for Climate Risk Mitigations, and
- Financial analysis and understanding of developer proformas (RFS, 2025).

4.4.2 Key Gaps by Occupational Cluster

Table 6 outlines scoping review findings, Ecotrust insights, and WSP insights for skill gaps for the high-performance buildings by occupational cluster. Examples of skill gaps for specific occupations are also included.

Table 6: Knowledge and Skill Gaps by Occupational Cluster

Occupational Cluster	Occupation	Potential Knowledge and Skill Gaps
Design and Engineering Professionals		■ Strengthen soft skills needed for collaborative, interdisciplinary project delivery, including facilitation and integrated problem-solving. ■ Improve communication abilities to clearly convey the value and Return on Investment (ROI) of high-performance buildings to clients. ■ Advance building envelope and mechanical systems knowledge, covering technologies, methods, and testing not typically addressed in standard engineering or architecture programs. ■ Enhance proficiency with digital tools like BIM, clash detection, Lean methods, and VR/AR to support integrated design and pre-construction planning. ■ Address skill gaps in deep retrofits, including assessing existing buildings, integrating mechanical and passive systems, incorporating renewables, and connecting legacy and modern systems.
	Architects	■ Gaps in applying passive design strategies, including solar orientation, shading, and natural ventilation ■ Limited training in thermal bridging, airtightness detailing, and high-performance envelope assemblies ■ Insufficient use of performance modeling tools such as energy simulation and daylight analysis ■ Need for stronger integration of sustainability metrics like embodied carbon and lifecycle impacts into design decisions
	Engineers	■ Gaps in designing and integrating advanced mechanical systems such as variable refrigerant flow (VRF), heat pumps, and energy recovery ventilators ■ Limited experience with controls integration and smart building technologies ■ Insufficient training in energy modeling, system commissioning, and performance verification ■ Need for deeper understanding of how mechanical systems interact with envelope performance and occupant behavior
	Energy Advisors	■ Pipeline and continuity challenges in Energy Advisor upskilling and training access ■ Gaps in skills and knowledge needed for energy modeling, commissioning, and performance verification
Construction Managers and Onsite Supervisors		■ Rising role complexity is increasing the demand for strong soft skills to support integrated design and project collaboration. ■ Digital skills development is needed to effectively use BIM systems and related software tools. ■ Greater understanding of supply chains for energy-efficient technologies, materials, and equipment is required.

Occupational Cluster	Occupation	Potential Knowledge and Skill Gaps
Construction and Related Trade Workers		■ 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 ■ Further upskilling needed for repairing, maintaining, and programming automated building systems ■ Limited knowledge of new high-performance products and systems, including proper sizing of heat pumps, airflow calculations, and ductwork adjustments ■ Insufficient training in critical practices such as air sealing, including understanding its purpose and correct application across trades
	Electricians	■ Gaps in knowledge of smart electrical systems, including energy monitoring, load management, and integration with renewable energy sources ■ Limited experience with battery storage systems, electric vehicle charging infrastructure, and grid-interactive technologies ■ Need for training in wiring and controls for advanced lighting systems, occupancy sensors, and demand response systems ■ Insufficient understanding of how electrical systems contribute to whole-building energy performance and resilience
	HVAC Technicians	■ Gaps in proper sizing and installation of heat pumps, including airflow calculations and ductwork modifications ■ Limited training in commissioning and maintaining high-efficiency systems such as VRF, ERVs, and geothermal heat pumps ■ Insufficient familiarity with building automation systems and integration with smart controls ■ Need for deeper understanding of indoor air quality, ventilation standards, and their impact on occupant health and comfort
Regulatory Specialists and Officers		■ Upskilling is needed to meet diverse code requirements, including proficiency in energy and climate resilience modeling, testing methods, and data interpretation for compliance ■ Gaps in familiarity with new high-performance construction practices and system types ■ Inconsistent interpretations of risk and compliance for non-traditional builds, leading to variability in enforcement and approval processes

Source: (Eco Canada, 2021), (Delphi Group, 2022), (WSP SME, personal communication, 2025), (Ecotrust SME, personal communication, 2025)

FUTURE RESEARCH: Existing research identified in the scoping review focuses on overarching skill gaps across occupational clusters in the energy efficient buildings workforce. No secondary information identified at the time of writing mapping specific high-performance building technologies skills to specific occupations. Primary research required to fill this gap.

More information on gaps by occupational cluster available in Occupations_Skills_Longlist and Occupations_Skills_Shortlist tabs in the *CA0022958.8089_SkillsTechList_Draft'* excel.

5.0 EDUCATION AND TRAINING PATHWAYS

As new technologies are adopted, the required skill sets will continue to expand. Education, training programs, micro-credentials, and apprenticeships can prepare new workers for complex jobs and help experienced professionals stay current. Programs targeting high school students can raise awareness of career opportunities and necessary skills, helping to recruit young workers and replace retirees (American Council for an Energy-Efficient Economy, 2020).

Specialized training and education programs for green buildings are expanding to meet the growing demands. For example, according to (2025) research by RFS for Ecotrust, commonly covered topics deep energy retrofit include:

- Energy audits, analysis, and modeling;
- Solar PV design and installation;
- Building envelope design and detailing;
- Carbon emissions and lifecycle assessments;
- Passive House and zero-carbon building principles;
- Building commissioning and performance verification; and
- General sustainable design fundamentals (RFS, 2025).

International Student Enrollment: Recent federal caps on international student permits have significantly impacted Alberta's post-secondary institutions. Smaller colleges and polytechnics have reported enrollment drops of 50–80%, primarily due to reduced international applications and uncertainty around post-graduate work opportunities. As a result, many institutions have been forced to cut or suspend 30–50% of their programs, including key technical and trades offerings (Williams, 2025). This trend poses a challenge to workforce readiness in sectors like high-performance building construction, which rely on a steady pipeline of skilled graduates.

Despite these positive developments in training and education, green building and high-performance technology training for designers, consultants, and tradespeople is inconsistent across Canada. Many post-secondary programs target engineers and architects, with limited options for trades. Several energy efficiency and retrofit courses lack Continuing Professional Development (CPD) accreditation, reducing their appeal. Slow curriculum update processes can also hinder the adoption of new high-performance technology practices. Labour unions also offer relevant training for large-scale high-performance retrofits across Canada (Delphi Group, 2022).

5.1 Trades Education and Training Pathways

Construction trades in Alberta follow various training paths, with designated trades typically completing formal apprenticeships that combine classroom and on-site learning. Others may follow voluntary programs. Continuing education—often uncredentialed and non-standardized—is available through unions, colleges, and industry providers. The Red Seal Program sets national standards, allowing certified tradespeople to work across Canada without recertification. Trades can also upskill through training providers or hands-on experience (Delphi Group, 2022). The typical trades education and training pathway in Alberta is outlined in Figure 3:

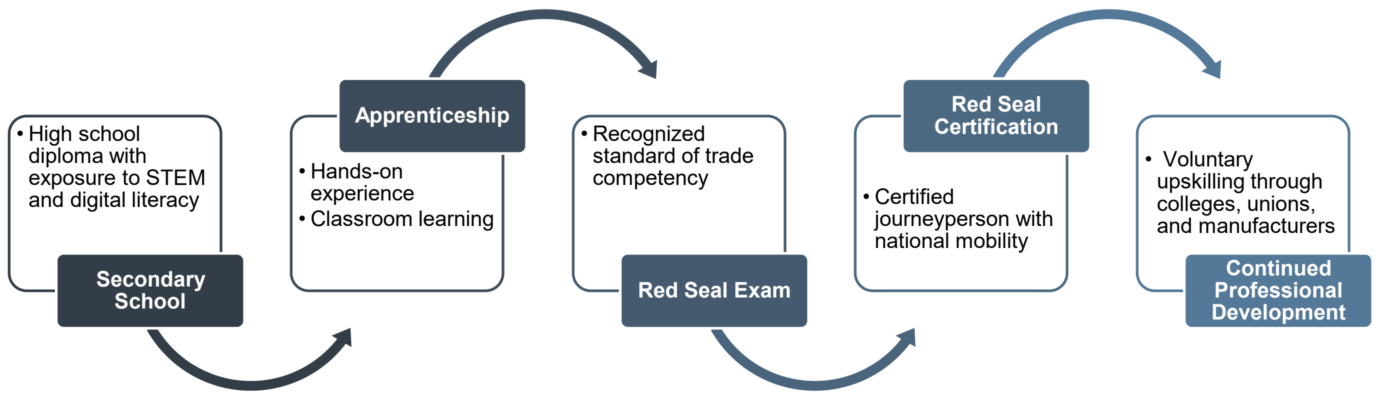

Figure 4: Trades Education and Training Pathways for High-Performance Buildings, Alberta

Source: (Delphi Group, 2022; Trade Secrets Alberta, n.d.)More information on training pathways by occupation available in

SPOTLIGHT – REFRIDGERATION AND AIR CONDITIONING MECHANIC PATHWAY: The apprenticeship period for refrigeration and air conditioning mechanics lasts four years, with each year requiring at least 1,560 hours of on-the-job training and 8 weeks of classroom instruction. Entry requires an Alberta high school diploma with specific courses or passing an entrance exam. Apprentices must show progress within 18 months. In the final year, they may take the Interprovincial Red Seal exam. Graduates earn a journeyperson certificate and an Advanced Diploma.

Occupations_Skills_Longlist and Occupations_Skills_Shortlist tabs in the *CA0022958.8089_SkillsTechList_Draft'* excel.

5.1.1 Key Trades Technology Programs

Alberta Apprenticeship and Industry Training (AIT) is the governing body responsible for overseeing trades education and certification across the province. It collaborates with leading institutions such as the Northern Alberta Institute of Technology (NAIT), Southern Alberta Institute of Technology (SAIT), and Red Deer Polytechnic to deliver high-quality, industry-relevant training. These institutions offer a range of innovative programs designed to meet the evolving needs of Alberta's workforce (Delphi Group, 2022).

Noteworthy examples include NAIT's Electrical Trade and Technology Diploma program and Advanced Carpentry Technology Diploma, SAIT's Professional Certificate in Construction Management, and other specialized training courses that support the province's shift accelerated adoption of high-performance technologies.

Example programs are outlined in Table 7 and Table 8.

Table 7: Electrical Trade and Technology Diploma, Southern Alberta Institute of Technology

Organization Name	Southern Alberta Institute of Technology's (SAIT)
Program Name	Electrical Trade and Technology
Credential	Diploma
Program Length	2 Years
Location	In person (Main Campus)
Faculty	MacPhail School of Energy

International Applicants	Accepted, PGWP eligible
Overview	Prepares students for careers in the electrical trade with a focus on residential, commercial, industrial, and institutional systems. Combines theory with hands-on training.
Key Skills Developed	Electrical theory, circuit layout, troubleshooting, safety, tool use, reading plans/specs, collaboration with other trades.
High-Performance Building Relevance	Foundation for further training in smart systems, energy monitoring, and renewable integration; Supports understanding of electrical systems in energy-efficient and automated buildings. Technologies covered may include smart lighting and control systems, high-efficiency HVAC systems, variable speed drives, building automation systems, renewable energy systems (e.g., solar PV), energy monitoring and management systems, advanced safety and fire alarm systems, and digital design tools (e.g., AutoCAD for electrical systems).
Career Pathways	Electricians (except Industrial and Power System), Industrial Electricians, Contractors and Supervisors, Electrical Trades and Telecommunications Occupations, Construction Managers
Pathway Opportunities	Eligible for post-diploma degree programs such as the BSc in Energy Engineering at University of Calgary, which focuses on sustainable energy systems and high-performance building technologies

Source: (SAIT, n.d.-a)

Table 8: High-Performance Residential Design and Construction Certificate, Southern Alberta Institute of Technology

Organization Name	Southern Alberta Institute of Technology (SAIT)
Program Name	High Performance Residential Design and Construction
Credential	Certificate
Program Length	Varies
Location	In person (Main Campus)
Faculty	School of Construction
International Applicants	Accepted
Overview	Covers building science principles, control layer continuity, and performance verification for high-performance homes.
Key Skills Developed	Building science, control layer continuity, performance verification, residential design and construction methods.
High-Performance Building Relevance	Focuses on energy-efficient construction, building envelope detailing, and performance verification.
Career Pathways	Construction managers, site supervisors, building inspectors, energy auditors.
Pathway Opportunities	May lead to advanced roles in sustainable construction and building performance analysis.

Source: (SAIT, n.d.-b)

An indicative list of education and training programs is available in the *Education_Training* tab.

5.2 Post-Secondary Education and Training Pathways

Design and consulting professionals, such as architects and engineers, gain foundational training through post-secondary institutions and accredited bodies. They can pursue optional credentials to deepen expertise, though some roles require ongoing education through CPD credits. Green building professionals may earn additional certifications from industry associations or standards-based programs like LEED or Passive House (Delphi Group, 2022).

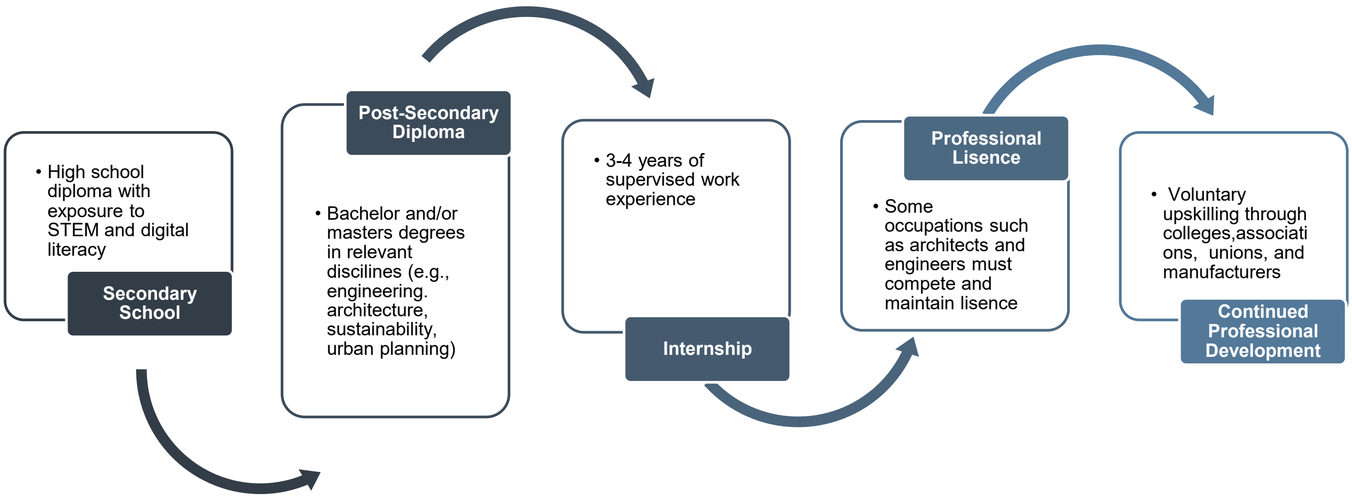

Figure 5: Post-Secondary Education and Training Pathways for High-Performance Buildings, Alberta

SPOTLIGHT – ARCHITECT EDUCATION PATHWAY: To become an architect in Alberta, individuals must complete a master's degree in architecture from an accredited program, followed by certification through the Intern Architect Program with the Alberta Association of Architects (AAA). This includes 3,720 hours of supervised work, passing the Examination for Architects in Canada (ExAC), and completing the AAA Architects Act Course. Successful candidates earn the title of Registered Architect and are licensed to practice in Alberta.

Source: (Delphi Group, 2022)

More information on training pathways by occupation available in Occupations_Skills_Longlist and Occupations_Skills_Shortlist tabs in the *CA0022958.8089_SkillsTechList_Draft'* excel.

5.2.1 Post-Secondary Technology Programs

Alberta offers a growing range of academic programs that support the transition to sustainable, energy-efficient built environments. At the university level, institutions like the University of Alberta and University of Calgary provide specialized engineering degrees, architecture degrees, and research opportunities in building science and technology, energy systems, and sustainable design.

The University of Calgary's Bachelor of Science in Energy Engineering is a standout undergraduate program that integrates alternative energy systems and energy-efficient technologies. More information on this program is available in Table 9.

Table 9: Example Programs, University of Calgary

Organization Name	University of Calgary
Program Name	Energy Engineering
Credential	Bachelor of Science (BSc)
Program Length	Two years of academic program work followed by a 12-16 month internship
Location	In-person
Faculty	Schulich School of Engineering
International Applicants	Accepted, PGWP eligible

Overview	The Bachelor of Science in Energy Engineering is a unique post-diploma program designed for graduates of energy-related engineering technology diplomas (e.g., from SAIT or NAIT). It bridges practical technical training with advanced engineering education, preparing students to lead in the design and implementation of sustainable energy systems. The curriculum emphasizes high-performance technologies, energy-efficient building practices, and the integration of renewable energy into the built environment.
Key Skills	Advanced energy systems, sustainable design, practical technical training, leadership in sustainable energy systems.
High-Performance Buildings Relevance	Emphasizes high-performance technologies, energy-efficient building practices, and the integration of renewable energy into the built environment. Technologies covered include photovoltaic (PV) solar panels, wind turbines, geothermal heating and cooling, combined heat and power (CHP) systems, battery storage systems, smart grid technologies, building automation systems (BAS), energy modeling software (e.g., EnergyPlus, eQUEST), high-efficiency HVAC systems, passive solar design, advanced insulation and glazing, net-zero and net-zero ready building design.
Linked Occupations	▪ Energy systems engineer ▪ Building performance analyst ▪ Sustainability consultant ▪ Renewable energy project manager ▪ Environmental systems designer

Source:(SAIT, n.d.-a)

An indicative list of education and training programs is available in the *Education_Training* tab.

5.2.1.1 Post-Secondary Education and Training Pathway Gaps

Alberta offers a growing number of academic programs that support the adoption of high-performance building technologies and the transition to energy-efficient built environments, but access to these pathways remains uneven. While programs like the University of Calgary's Bachelor of Science in Energy Engineering offer advanced training in high-performance technologies, they are only available to students who have already completed a two- to three-year college diploma—often in programs focused on the oil and gas sector (WSP SME, personal communication, 2025).

With NAIT's Alternative Energy Technology program now on hold, potentially cancelled, and not accepting new applicants until at least 2027, students interested in sustainability from day one face a significant barrier (Williams, 2025). The current structure requires a commitment of up to six years of training, which is longer than many other engineering disciplines and may discourage early interest in the green building sector (WSP SME, personal communication, 2025).

To address this gap, Alberta's post-secondary system needs direct-entry diploma and undergraduate programs that embed sustainability and high-performance building technologies from the outset, without requiring prior training in unrelated sectors (WSP SME, personal communication, 2025).

5.3 Upskilling Pathways and Micro-Credentials

In addition to the traditional education and training pathways outlined above, Alberta colleges and universities offer micro-credentials and short courses to address skill gaps in high-performance building technologies. For example, SAIT's online micro-credential "Introduction to Smart Home Technologies" allows students to learn about the innovations in consumer-available smart home technologies and better understand installation and use considerations (SAIT, n.d.-b). These easy-to-access micro-programs support tradespeople, designers, and managers in meeting energy efficiency standards and adopting advanced construction methods (WSP SME, personal communication, 2025).

Green building certifications operating in Canada can complement these Alberta-specific pathways by setting benchmarks for sustainable building. LEED, Built Green Canada, BOMA BEST, EnerGuide, ENERGY STAR® for New Homes, and BREEAM cover energy use, materials, air quality, and system integration (Green Building, 2024). These align with Alberta's training programs and micro-credentials, helping workers meet building codes and sustainability goals.

In addition to diploma and degree pathways, training for deep energy retrofits is also delivered via third-party providers such as the Canadian Institute for Energy Training (CIET). CEIT offers short certificate programs and webinars tailored to retrofit strategies and energy auditing. Industry associations and labour unions also provide continuing education and micro-credentials to support workforce development for deep energy retrofits (RFS, 2025).

5.4 Training and Education Gaps

5.4.1 Gaps by Occupational Cluster

Alberta offers several education programs that address the foundational principles of net-zero buildings, but gaps remain in training for specific high-performance building skills. Table 10 outlines high-level training gaps for the green building and high-performance building sector, organized by occupational cluster.

Table 10: Knowledge and Skill Gaps by Occupational Cluster

Occupational Cluster	Training Gaps and Insights
Design and Engineering Professionals	▪ May lack practical experience with building retrofits, which is difficult to gain through training alone ▪ May find that evolving skill requirements are not fully addressed by traditional engineering education ▪ Can face limited access to specialized training opportunities for emerging technologies and practices
Construction Managers and Onsite Supervisors	▪ May need rapid development of leadership and coordination skills to fill mid-level roles ▪ Require continuous training across technical areas such as mechanical, electrical, plumbing, and building systems ▪ May underuse existing training programs due to barriers like limited access, high costs, and low awareness
Construction and Related Trade Workers	▪ May lack integrated training in sustainability that combines technical knowledge, soft skills, and systems thinking ▪ Can fall behind in foundational training related to new energy-efficient technologies, equipment, and materials ▪ May face challenges with remote learning formats that do not support hands-on apprenticeship needs
Building Operators and Managers	▪ May need training to use digital tools for diagnostics, maintenance planning, and automation systems ▪ May require skills to manage buildings as integrated systems focused on performance, not just repairs ▪ Can benefit from communication training to explain systems to occupants and address their concerns ▪ May need cross-disciplinary knowledge in technology, project coordination, and team leadership ▪ May require training in using data for predictive and proactive maintenance approaches ▪ Can face a gap in workforce readiness due to retirements and limited new talent ▪ May lack skills in long-term planning, regulatory alignment, and investment planning for retrofits
Regulatory Specialists and Officers	▪ May experience inconsistent training due to varying building codes and regulations across jurisdictions, making standardization difficult

Source: (Eco Canada, 2021) (Delphi Group, 2022)

5.4.2 Gaps by Occupation

WSP Subject Matter Experts also identified potential training and upskilling needs for in-demand trades and design and engineering professionals and specialists. These training and upskilling gaps are identified in Table 11 and Table 12.

Table 11: Trades Upskilling and Training Needs, WSP SME Insights

Occupation	Primary Trade Upskilling Needs	Secondary Trade Upskilling Needs
Electricians	▪ May need vendor-specific training for smart thermostats, energy monitoring & management systems (internet of things, advanced sensors, big data analytics, artificial intelligence), premium efficiency motors (e.g., updating the Electrical Motors curriculum), variable frequency drives, electric vehicle chargers ▪ May need photovoltaic-specific hands-on training and knowledge of cladding and integration needed for building integrated photovoltaics (i.e., solar PV panels integrated with building envelop e.g. solar walls). ▪ May need solar photovoltaic training needed for hybrid measures (wind and photovoltaics).	▪ Potential vendor-specific training and various programming languages training needed for building automation systems (BAS). ▪ Potential design, hands-on training, and operational instruction needed for air to water heat pumps, water source heat pumps, air source heat pumps, and high-efficiency combined heat and power. ▪ Updates to apprenticeship curriculum may cover ground source heat pumps, in-suite packaged and mini split-heat pumps, as well as variable refrigerant flow (VRF) systems and lev kits and demand-controlled ventilation.
Plumbers	▪ May need vendor-specific training for drain water heat recovery.	▪ Vendor-specific training may be needed for hydronic loop additives. ▪ Solar thermal-specific hands-on training and knowledge of roofing integration needed for solar domestic hot water (DHW). ▪ Training may be needed to support the design, installation, and maintenance of geoexchange systems, including loop field configuration, fluid properties, and integration with mechanical systems.
Mechanic, Refrigeration and Air Conditioning	▪ May need design, hands-on training, and operational instruction for: natural ventilation (stack effect design and operable windows), air to water heat pumps, water source heat pumps, air source heat pumps, high efficiency combined heat and power. ▪ May need design and hands-on training for thermal storage (demand side management), dynamic variable air volume (VAV) optimization. ▪ May need vendor-specific training for hydronic loop additives. ▪ Updates to apprenticeship curriculum may cover in-suite packaged and mini split-heat pumps as well as variable refrigerant flow (VRF) systems and lev kits and demand-controlled ventilation and ground source heat pumps. ▪ May need hands-on training required for solar thermal-specific applications of solar domestic hot water (SDHW).	▪ Vendor-specific training may be needed for smart thermostats and advanced control systems.
Carpenters	▪ May need training to improve understanding of various components for high R-value windows and doors, wall recladding systems, and air sealing details. ▪ May need design and hands-on training for: dowel laminate timber and nail laminated timber and panelized retrofits.	▪ Potential upskilling needed to better understand the integration of various components for thermal break technology.
Instrumentation and Control Technician	▪ May need vendor-specific training and various programming languages training for building automation systems (BAS).	▪ Potential design and hands-on training needed for dynamic variable air volume (VAV) optimization.

Occupation	Primary Trade Upskilling Needs	Secondary Trade Upskilling Needs
Residential and Commercial Installers and Servicers	▪ Weatherization Installers and Technicians may need upskilling to better understand the integration of various components for thermal break technology.	▪ N/A
Architectural Technologists	▪ May need knowledge on how to design energy efficient assemblies.	▪ May need an optimized understanding of the materials that go into an assembly.

Note: The distinction between primary and secondary trade upskilling needs reflects the relative importance and focus of the skill gaps identified by subject matter experts. Primary needs refer to core competencies or technologies required for current and emerging job functions, such as drain water heat recovery (DWHR) for plumbers, while secondary needs, like hydronic loop additives, support specialized applications or system performance.

Source: (WSP SME, personal communication, 2025)

Table 12: Upskilling and Training Needs Design and Engineering Professionals and Specialists

Occupation	Potential Primary Upskilling Needs
Architects	▪ May require upskilling to effectively integrate air, weather-resistant, and vapour barriers into energy-efficient envelope designs (air leakage mitigation & testing). ▪ Could benefit from training that strengthens coordination between design and trade execution to minimize thermal bridging (thermal bridging mitigation). ▪ May need to enhance retrofit design capabilities to boost energy performance and occupant comfort (high performance glazing system, air-source heat pumps – distributed). ▪ A stronger foundation in building science may be needed to ensure airtightness and manage moisture (HRV & ERV systems).
Civil Engineer	▪ May need to incorporate high-performance materials and systems into both structural and site design (geo-exchange integration, thermal bridging mitigation). ▪ Could benefit from training in applying energy-efficient strategies across foundations, envelopes, and infrastructure (air leakage mitigation & testing, low flow water fixtures). ▪ Building science knowledge may be essential for managing moisture, thermal performance, and air barrier integration (HRV & ERV systems). ▪ May require technical training to assess and improve design efficiency and durability (solar PV, battery energy storage).
Home Building and Renovation Managers	▪ May need to build capacity to evaluate retrofits for compliance with energy and building standards (air-source heat pumps – central, low flow water fixtures). ▪ Could benefit from training in estimating costs and returns of green upgrades and technologies (solar PV, battery energy storage). ▪ Planning and budgeting skills may need to be strengthened for high-performance materials and systems (cascading/hybrid systems, thermal energy storage). ▪ May require decision-making skills to guide retrofit timing, scope, and technology integration (building automation systems - controls & analytics).
Electrical and Electronics Engineering Technologists and Technicians	▪ May need to develop skills in testing and validating high-performance electrical and green technologies (facility wide demand management, battery energy storage). ▪ Could benefit from training in integrating energy-efficient controls, sensors, and automation (daylighting and occupancy controls, building automation systems - controls & analytics). ▪ May require hands-on experience in modifying components for improved energy performance (variable frequency drives). ▪ Understanding performance data may be key to supporting sustainable engineering decisions (demand controlled ventilation).
Mechanical Engineering Technologists and Technicians	▪ May need to support the design and testing of energy-efficient HVAC and mechanical systems (air-source heat pumps – central, DOAS + distributed design). ▪ Could benefit from training in analyzing green technology requirements in building systems (cascading/hybrid systems, geo-exchange integration). ▪ Skills in modifying and evaluating mechanical components may be necessary for better energy outcomes (variable frequency drives).

Occupation	Potential Primary Upskilling Needs
	▪ May require knowledge to recommend process improvements that enhance system performance and durability (waste heat and energy sharing).
Electrical Engineer	▪ May need to design and implement electrified heating, lighting, and control systems for high-performance buildings (daylighting and occupancy controls, air-source heat pumps – distributed). ▪ Could benefit from training in integrating alternative energy and storage into electrical infrastructure (solar PV, battery energy storage). ▪ Skills in monitoring and optimizing energy use through advanced controls may be essential (building automation systems - controls & analytics, facility wide demand management). ▪ May require knowledge to tailor electrical system design to site-specific retrofit and construction needs (demand-controlled ventilation).
Mechanical Engineer	▪ May need to enhance capabilities in designing HVAC, plumbing, and solar thermal systems for energy-efficient buildings (DOAS + distributed design, low flow water fixtures). ▪ Could benefit from training in electrification of heating and integration of renewable energy and storage (geo-exchange integration, thermal energy storage). ▪ Skills in evaluating environmental impacts of design plans may be necessary for performance-driven improvements (waste heat and energy sharing). ▪ May require knowledge to identify and apply emerging technologies that improve building system efficiency (HRV & ERV systems, cascading/hybrid systems).
Power Engineers	▪ May need to analyze and apply green technology requirements in energy and mechanical systems (decarbonized high efficiency combined heat and power). ▪ Could benefit from training in testing and evaluating alternative energy and electrified heating systems (geo-exchange integration, air-source heat pumps – central). ▪ Skills in assessing environmental and technical impacts of plans and specifications may be required (solar PV, battery energy storage). ▪ May require knowledge to support the integration of energy storage, solar thermal, and high-efficiency systems (thermal energy storage, waste heat and energy sharing).

Source: (WSP SME, personal communication, 2025), WSP analysis of (O*NET, n.d.-a, n.d.-b, n.d.-c, n.d.-d, n.d.-e)()

In addition, there may be a training gap for home owners on high-performance building technologies (WSP SME, personal communication, 2025). Occupants operate many green building technologies, making education on the differences from conventional buildings essential for performance. The range of knowledge required to align occupant behavior with building systems requires a structured approach to limit the information presented in training (Deborah Steinberg, 2009) (Pérez-Sánchez et al., 2022).

FUTURE RESEARCH: Publicly available research at the time of writing does not address Alberta-specific education or training gaps related to energy-efficient or high-performance building technologies. No detailed mapping exists between specific technologies and occupational or training needs.

- Primary research is needed to identify gaps in education pathways and credential types that may limit access to feeder programs for high-performance building technology occupations.
- Curriculum mapping is required to determine which high-performance building technologies are currently addressed—or missing—in Alberta's training and education programs.
- Validation of preliminary insights from WSP subject matter experts is needed to confirm training gaps in the skilled trades and assess alignment with workforce demands.

More information on potential training and education gaps in the *CA0022958.8089_SkillsTechList_Draft'* excel.

5.4.3 Gaps for Deep Energy Retrofits

According to (2025) research by RFS for Ecotrust, training and skills development (TSD) programs for deep energy retrofits are concentrated in major urban centres, including Calgary, Edmonton, Red Deer, and Medicine Hat. However, Northern Alberta, particularly Fort McMurray, lacks access to regionally delivered programs (RFS, 2025).

Most national training programs, such as those offered by the Canada Green Building Council (CaGBC) and the Canadian Construction Association, are available online and accessible to Albertans. Regional workshops and in-person courses are offered intermittently but are not consistently available across all jurisdictions (RFS, 2025).

Training programs are predominantly focused on the residential retrofit market, with limited offerings tailored to commercial buildings. Architectural and engineering programs often emphasize general sustainability but lack specialization in deep energy retrofit practices (RFS, 2025).

Several critical skill areas remain underrepresented:

- Structural design and retrofit strategies;
- Alberta-specific building code requirements;
- District energy systems and grid integration;
- Energy storage technologies (e.g., batteries, grid-tied systems);
- Innovative materials (e.g., phase change, vacuum insulation, composites);
- Air and vapour barrier detailing, airtightness, and building air-change rates;
- Advanced building controls and automation systems;
- Demolition and waste diversion practices;
- Hazardous materials abatement;
- Environmental impact assessments;
- Building valuation and appraisal;
- Insurance requirements for climate risk mitigation;
- Financial analysis and developer proforma literacy; and,
- Understanding of qualitative co-benefits (e.g., comfort, air quality, daylight, health) (RFS Energy Consulting & Research Inc., 2025).

More information on potential training and education gaps for deep retrofits in the RFS *Narrative on Market Incentives and Training & Skills Development Deep Retrofit Accelerator Initiative* report.

6.0 CONCLUSION & KEY TAKEAWAYS

Alberta’s transition to a low-carbon economy will depend heavily on the building sector’s ability to adopt high-performance technologies at scale. This memo provides a comprehensive overview of the technologies, workforce needs, and education and training systems required to support this shift. It underscores the importance of aligning technological innovation with workforce development to ensure Alberta is equipped to meet its climate goals.

While progress is being made—particularly in residential retrofits—significant gaps remain in workforce capacity, training infrastructure, and policy alignment. The findings point to a need for coordinated action across government, industry, and education providers to build a resilient, future-ready workforce and accelerate the adoption of scalable, high-impact technologies.

Key Takeaways

- Buildings are central to Alberta's net-zero goals, especially through deep retrofits and high-performance new construction.
- Top 20 Decarbonized Solutions offer a practical, scalable roadmap for reducing emissions across building types.
- Labour shortages are projected in key trades, including electricians, HVAC technicians, plumbers, and construction supervisors, with cumulative imbalances expected through 2030.
- New and hybrid roles are emerging, requiring cross-disciplinary skills in digital systems, renewable energy, and integrated design.
- Workforce readiness is uneven, with gaps in both technical and soft skills across construction, engineering, and regulatory occupations.
- Education and training systems are misaligned with current and future needs—particularly for trades, mid-career professionals, and building operators.
- Recent cuts to post-secondary programs due to international enrollment caps pose additional risks to workforce supply.
- Grid-interactive and demand-side technologies remain underutilized in Alberta's emissions strategy, despite their potential for near-term impact.
- Future research is essential to validate occupational gaps, map skills to technologies, and model the workforce impacts of decarbonization.
- Homeowner and occupant education is also needed to ensure building systems are operated as intended and performance goals are met.

By addressing these interconnected challenges with urgency and collaboration, Alberta can position itself as a national leader in sustainable building innovation. The insights in this memo offer a roadmap for action—one that supports economic growth, environmental responsibility, and long-term resilience in the built environment.

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APPENDIX A

Methodology

Methodology

WSP employed a mixed-methods approach for this study. Specific methodologies and scoping decisions are outlined below.

Roles and Skills

WSP identified key roles and skills for existing and emerging high-performance building technologies for net-zero retrofits and new construction. Using the types of sources outlined in Table 13, WSP created a longlist of occupations and related skills in the high-performance building technology pipeline. When possible, information was included first on the provincial level (Alberta), then on the national level (Canada), and then on a North American level. This approach prioritizes local data to support report outcomes tailored to Alberta-specific needs where possible.

Table 13: Skills Information Sources

Source Type	Key Information Examples
Workforce Readiness Studies in Net-Zero Transition and Energy Efficient Buildings (Canada)	▪ Canada Green Building Council, "Trading Up: How Alberta's Trades Can Build a Zero Carbon Future" (2020) ▪ Canada Green Building Council, "Building Our Future: A Low-Carbon Training Strategy for the Trades" (2020) ▪ Chambre of Commerce Canada, "Building Canada's Net-Zero Workforce" (2024) ▪ Delphi Group, "Green Retrofit Economy Study: Summary of Workforce Supply" (2022) ▪ Electricity Human Resources Canada, "Electricity in Demand: Labour Market Insights 2023-2028" (2023) ▪ Future Skills Centre, "Jobs and Skills in the Transition to a Net-Zero Economy" (2022) ▪ Future Skills Centre, "Building Skills for a Clean Economy: Guiding Workforce Transitions as Canada Shifts to Net Zero Emissions" (2022) ▪ Pembina Institute, "Net-Zero Skills: What Will Canada Need for the Coming Energy Transition" (2022) ▪ Information and Communications Technology Council, "Clean Energy and Pathways To Net-Zero: Jobs and Skills for Future Leaders" (2023) ▪ Royal Bank of Canada, "Green Collar Jobs: The Skills Revolution Canada Needs To Reach Net Zero" (2022) ▪ Eco Canada, "Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce" (2021)
Labour Market Data	▪ O*Net, "Green New and Emerging Occupations" (N/A) ▪ O*Net, "Green Economy Sector: Green Construction" (N/A) ▪ National Occupation Classification codes (NOC)
Academic Studies, Government Reports, Industry Research, Association Research, and Relevant Policy Documents	▪ Government of Canada, "Canada Green Buildings Strategy: Transforming Canada's Buildings Sector For A Net-Zero And Resilient Future" (2024) ▪ Trade Secrets Alberta, "Trades in Alberta" (2025) ▪ Herzing College, "How Technology is Changing the Construction Industry: Skills You Need in 2025" (2025)
WSP Subject Matter Expert Interview	▪ Veronica Owens, Senior Advisor, Sustainability (Buildings) ▪ Nathan Ward, Solar Market Lead Western Renewables ▪ Christian Flores, Senior Project Manager (Buildings) ▪ Katarzyna Gajewska, Senior Building Sustainability and Performance Consultant
WSP Subject Matter Expert Review	▪ Joseph Der, Technical Lead, Energy & Carbon Analysis ▪ Nathan Ward, Solar Market Lead Western Renewables ▪ Katarzyna Gajewska, Senior Building Sustainability and Performance Consultant

To support a streamlined analysis, WSP then selected 15-20 key occupations were highlighted in the body of the memo. To develop the short list, WSP will consult the sources outlined in Table 13 and confer with internal subject matter experts.

Limitations:

- Human skills were sourced from O*NET. Uneven and likely uncomprehensive list of skills available.
- NOC names were prioritized. If not available, O*NET names were used.
- Multiple O*NET roles may be mapped to a regulated profession.
- Equivalency between O*NET codes and NOC codes varies. For new and emerging roles, equivalency is likely low.

Workforce Supply, Demand, Skills Gaps

To identify supply and demand for the 15-20 key occupations identified the memo, WSP:

- Reviewed publicly available studies related to technology workforce supply and demand for net-zero high-performance buildings in Alberta. Key sources include the Delphi Group's "Green Retrofit Economy Study: Summary of Workforce Supply" (2022) and reports from BuildForce Canada.
- Reviewed net change (job openings), net change (job seekers), annual imbalance, and cumulative imbalance from 2025-2033 for identified key NOCs to provide insight into demand for specific jobs and associated skills in Alberta's labour market. Alberta's Occupational Outlook: 2023 – 2033 will be a key source.

Limitations:

Publicly available secondary research available at the time of writing focuses on occupational gaps for construction and related trade occupations. In addition, no detailed analysis of occupational gap by technology measure is available.

- Economic modelling linked to technology uptake is needed on occupational clusters outside of residential construction for Alberta, including design and engineering professionals and specialists, construction management and onsite supervisors, and regulatory specialists and officers. Modelling would also be needed linked to relevant NOC codes as validated by primary research.
- Primary research (e.g., interviews, focus groups, surveys) needed to identify high-performance building technology-specific occupational gaps and validate Alberta workforce data insights.

In-Demand Occupations, Skills, Relevant Technologies

In this section, WSP identified priority occupations, critical skills, and key technologies expected to face increased demand and talent shortages in Alberta's high-performance buildings sector between 2025 and 2030.

WSP expanded upon the skill profiles of key occupations identified as in-demand in previous sections and linked these occupations to emerging technologies. This cross-mapping of roles and technologies was informed by WSP SMEs and an interpretation of relevant literature. Additional primary research needed to confirm initial cross-mapping exercise.

O*NET emerging roles highlight new occupations and skill needs shaped by green energy systems, automation, and artificial intelligence. The approach enables early identification of skill gaps and informs strategic workforce development.

Limitations:

- Existing research on in-demand skills and occupations focuses on "energy efficient buildings" or a particular occupational grouping (e.g., trades). Primary research needed to cross-map high-performance building technology measures to specific occupations across occupational groups.
- Existing research identified in the scoping review focuses on overarching skill gaps across occupational clusters in the energy efficient buildings workforce. No secondary information identified at the time of writing mapping specific high-performance building technologies skills to specific occupations. Primary research required to fill this gap.

Education and Training Pathways

WSP used the types of sources outlined in Table 13 to identify the education and training pathways for net-zero high-performance building technology workers. In addition, WSP reviewed publicly available secondary sources that focus on curriculum and training for the transition to net-zero (e.g., Future Skills Centre, "Navigating Net-Zero: Faculty Perspectives on Greening Post-Secondary Curricula" (2024)).

To build the indicative list of education and training available, WSP consulted education and training organization websites.

Limitations: No reviews of Alberta-specific educational gaps for energy efficient buildings identified in the scoping review at the time of writing. No reviews of training gaps specific to high-performance building technologies. Additional primary research needed to cross-map high-performance building technology measures to specific training needs and education needs by occupation in Alberta.

Technologies

WSP followed the following steps to identify technologies: We leveraged existing studies from academic reports and industry journals with WSP subject matter expert's reviewing and providing insights. We have defined key building attributes, key building systems as well as individual technologies associated with each attribute/building system. We have developed broad building categories based on the building types and systems aligned with each broad category and have a direct correlation to the retrofit measures being applied. We have identified existing technologies that are frequently used in retrofit decarbonization project in Alberta, across Canada and globally. We have also identified some emerging decarbonization technologies with the potential for greater adoption across Canada and in Alberta in a couple of years. Each technology has been organized by key building attributes such as electrical, mechanical, enclosure as well as the related key building system (windows & walls, ventilation systems, heating system, controls etc. We have estimated the GHG reduction impact of these measures based on SME expert inputs as high, medium or low impact.

Source Type	Key Information Examples
Widely Used Technologies for Net Zero High Performance Buildings	▪ Canada Green Building Council, "Trading Up: How Alberta's Trades Can Build a Zero Carbon Future" (2020) ▪ Natural Resources Canada, The Canada Green Buildings Strategy: Transforming Canada's buildings sector for a net-zero and resilient future, 2025 ▪ Canada Green Building Council, 'Decarbonizing Canada's Large Buildings: A Pathway Forward' 2021 ▪ Building and Construction Authority, Singapore, 'Super Low Energy Building Technology Roadmap' (2018) ▪ Canada Green Building Council, RealPac, 'Decarbonizing Canada's Commercial Buildings; the owner and investor perspective' (2024) ▪ Energy Transitions Commission, 'Achieving Zero-Carbon Buildings: Electric, Efficient and Flexible' (2025)

	▪ Carbon Footprints, ‘Advancing energy efficiency: innovative technologies and strategic measures for achieving net zero emissions’ (2025) ▪ RDH, ‘Building Retrofit Roadmap Prepared for Minto Apartment Limited Partnership’ (2020) ▪ Pembina Institute, ‘Canada’s Renovation Wave: A plan for jobs and climate (2021) ▪ Building Decarbonization Alliance, ‘Pace of Progress; Achieving the necessary momentum to meet Canada’s 2050 climate goals in the residential building sector’ (2023) ▪ Canada Green Building Council, ‘Building Our Future: A Low-Carbon Training Strategy for the Trades’ (2023)
Emerging Technologies for Net Zero High Performance Buildings	▪ US General Services Administration and the Department of Energy ‘Select emerging technologies to accelerate the path to net-zero federal buildings’ (2024) ▪ Renewable and Sustainable Energy Reviews Volume 181, ‘Smart window technology and its potential for net-zero buildings: A review’ (2023) ▪ Carbon Footprints: Advancing energy efficiency: innovative technologies and strategic measures for achieving net zero emissions, (2025) ▪ Building and Construction Authority: ‘Super Low Energy Building Technology Roadmap’ (2018)

Data Gap(s): Prior research on the adoption of technologies for net zero high performance buildings specific to Alberta are limited.

APPENDIX B

Case Studies of Net-Zero Technology in Alberta

CASE STUDIES OF NET-ZERO TECHNOLOGY IN ALBERTA

This appendix showcases real-world examples of how net-zero and high-performance building technologies are being implemented across Alberta. From institutional retrofits and municipal infrastructure to residential deep energy upgrades, these case studies highlight the province's growing leadership in sustainable building innovation.

Each project demonstrates how advanced technologies—such as geo-exchange systems, air-source heat pumps, smart controls, solar PV, and high-performance envelopes—are being tailored to Alberta's unique climate and energy challenges. Together, they offer valuable insights into scalable solutions that reduce emissions, enhance occupant comfort, and support long-term energy resilience.

These examples serve as practical references for policymakers, designers, builders, and educators working to accelerate Alberta's transition to a low-carbon built environment.

CASE STUDY 1: The Mosaic Centre – A Northern Net-Zero Landmark

Located in Edmonton, the Mosaic Centre for Conscious Community and Commerce stands as Canada's northernmost net-zero commercial building. Completed in 2015, this 30,000-square-foot mixed-use facility houses office spaces, wellness services, a restaurant, and childcare facilities. Designed for both environmental and human well-being, the building is a testament to integrated, sustainable design in cold climates.

At the heart of the Mosaic Centre's performance is a ground-source heat pump (geo-exchange) system that provides highly efficient heating and cooling. The envelope is engineered for thermal excellence, featuring triple-glazed windows, R30 insulated walls, and meticulous air leakage mitigation to prevent energy loss. To offset energy use, a robust rooftop solar photovoltaic (PV) array generates renewable electricity.

Smart controls elevate energy performance further. A building automation system (BAS) coordinates HVAC and lighting operations, while daylighting and occupancy sensors minimize unnecessary lighting use. Variable frequency drives and demand-controlled ventilation respond dynamically to occupancy patterns, ensuring comfort without excess.

The Mosaic Centre is LEED Platinum-certified and also meets elements of the Living Building Challenge, making it a national model of sustainable development.

CASE STUDY 2: MacKimmie Complex – University of Calgary

The MacKimmie Complex at the University of Calgary is a major retrofit and expansion project that transformed a 1960s library into a modern, net-zero carbon facility. Completed in phases between 2017 and 2022, the project significantly reduced both operational and embodied carbon.

The original concrete structure was retained, reducing demolition waste and embodied emissions. The building envelope was entirely rebuilt with high-efficiency insulation, air and vapour barriers, and triple-glazed curtain walls. Thermal bridging was carefully mitigated, and the airtightness was significantly improved through testing and detailing.

Heating and cooling are provided by a hybrid system anchored by a geo-exchange field and air-source heat pumps. Ventilation is managed by Dedicated Outdoor Air Systems (DOAS) with energy recovery, supported by demand-controlled ventilation and daylight-responsive lighting. A rooftop solar PV system offsets part of the building's energy use.

A Building Automation System (BAS) manages these systems, optimizing performance in real time. The MacKimmie Complex is certified as net-zero carbon by the Canada Green Building Council and serves as a model for deep energy retrofits in institutional settings.

CASE STUDY 3: Town of Raymond – Southern Alberta

The Town of Raymond has become Alberta's first electrically net-zero municipality. Rather than focusing on a single building, the town took a community-wide approach by installing solar PV systems across nine municipal facilities, including the arena, fire hall, and wastewater treatment plant.

These systems generate over 1,300 megawatt-hours of electricity each year—enough to cover the town's operational electricity needs. To support energy efficiency, the town also upgraded building envelopes to reduce air leakage, installed high-performance glazing, and replaced older fixtures with low-flow water fixtures and efficient lighting.

Energy use is managed through facility-wide demand controls, including microgrid controllers and energy storage systems. These technologies help balance electricity use, improve reliability, and reduce peak demand charges.

CASE STUDY 4: Sundance Housing Cooperative Deep Energy Retrofit – Edmonton, Alberta

In Edmonton, the Sundance Housing Cooperative, a 59-unit residential development built in the 1970s, undertook a groundbreaking deep energy retrofit aimed at transforming its aging infrastructure into a near-net-zero energy community. Inspired by the European Energiesprong model, the project embraced a prefabricated, industrialized approach to retrofitting, allowing for rapid, high-performance upgrades with minimal disruption to residents.

One of the central innovations was the use of structural insulated panels (SIPs), which were manufactured off-site and fitted over the existing building façades. This dramatically improved thermal performance and air tightness. In tighter areas, vacuum insulated panels (VIPs) were used to enhance insulation without compromising indoor space. To eliminate the reliance on fossil fuels, high-performance cold-climate air source heat pumps, capable of operating efficiently down to -28°C, were installed in each unit. These systems were paired with rooftop solar panels that supported solar-assisted heat pump operation, reducing grid dependency.

The retrofit resulted in more than a 70% reduction in overall energy use. Residents reported greater comfort, lower energy bills, and improved indoor air quality. The upgrades set the stage for the development to achieve full net-zero performance within a few years. The project received federal funding through Natural Resources Canada's Green Infrastructure program and provincial support from the Municipal Climate Change Action Centre under Alberta's Ministry of Municipal Affairs.

Case Study 5: NAIT's Productivity and Innovation Centre – Edmonton, Alberta

The Productivity and Innovation Centre (PIC) at the Northern Alberta Institute of Technology represents a forward-looking vision of how emerging technologies can reshape educational and commercial buildings. As both a high-performance facility and a living lab, the PIC serves as a training ground for Alberta's next generation of builders, engineers, and clean tech entrepreneurs.

The building features a digital twin—a real-time virtual model of its energy systems and performance. This allows building operators to monitor and optimize energy use continuously, enabling predictive maintenance and dynamic system tuning. Natural daylight is managed through the strategic use of light-diffusing glazing across collaborative workspaces, reducing glare while maintaining visual comfort and minimizing cooling loads. For hot water generation, the PIC adopted a CO_2-based domestic hot water heat pump system, which is not only highly efficient in cold climates but also significantly reduces the building's greenhouse gas emissions. The heating and cooling system is balanced by an automatic air balancing system, which ensures consistent airflow, thermal comfort, and energy efficiency throughout the facility.

As a result of these innovations, the building achieved LEED Gold certification and continues to operate at a significantly lower energy use intensity than comparable educational facilities. The project benefited from a combination of provincial infrastructure investment and federal funding through Natural Resources Canada and the Canada Foundation for Innovation.

CASE STUDY 6: Windermere Fire Station No. 31 – Edmonton, Alberta

The City of Edmonton set a new precedent for civic infrastructure with the construction of Windermere Fire Station No. 31, the city's first net-zero energy building. Completed in 2023, the station was designed not only to meet operational needs but to demonstrate how public facilities can integrate advanced technologies to significantly reduce emissions and energy costs.

One of the station's most innovative features is its use of electrochromic glass on the main façade. This dynamic glazing system responds to sunlight, automatically adjusting its tint to reduce solar heat gain while allowing ample daylight into the building. In the ceiling, phase change tiles were installed to absorb and store heat, helping to moderate indoor temperature swings without the need for mechanical intervention. The mechanical system itself was streamlined using a modular packaged dedicated outdoor air system (DOAS) combined with cold-climate air source heat pumps that use low-global-warming-potential refrigerants. This approach provided efficient heating and ventilation, even during Edmonton's harsh winters.

Windermere Station now operates with an energy performance 40% better than required by Canada's national energy code, and it is on track for LEED Gold certification. It has become a demonstration site for energy-conscious public infrastructure. Funding support for the project came from Natural Resources Canada's Net-Zero Energy Demonstration Initiative and the Federation of Canadian Municipalities' Green Municipal Fund.