Advancing Climate Literacy in Union Vocational Education and Training Programs in English Canada: Analysis, Findings and Lessons Learned

Climate and Industry Research Team (CIRT)

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***ABOUT CIRT**: The Climate and Industry Research Team comprises academic researchers from English Canada, Europe, the United States and Quebec whose expertise in climate science, labour relations, apprenticeship, trades training and a variety of low carbon construction issues, support its mandate under the Building It Green project to provide research on climate literacy in Canada and internationally.*

***ABOUT Building It Green**: The 'Building It Green' project of Canada's Building Trades Unions (CBTU) focuses on bringing together industry best practices from around the world to improve the education and understanding of skilled trades workers related to their role in constructing and maintaining net-zero projects and help Canada meet its climate goals. This project is funded by The Government of Canada's Union Training and Innovation Program (UTIP).*

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1.0 Summary of Interviews and Canadian Research Findings

CIRTs English Canadian Report drew on extensive interviews with trades' instructors to determine their views and insights about how climate change was impacting their trade and to identify how climate related material could be incorporated into a future curriculum for construction workers. To provide the context for the research, CIRT conducted a literature review to identify the key findings of climate science and, more specifically, how climate change is affecting the construction industry and its workforce. It examined what has been included on climate literacy in Canadian apprenticeship programs. This involved collecting examples of learning plans and other teaching material that could inform the development of new curriculum modules incorporating key elements of climate literacy. CIRT supplemented this research with an environmental scan to identify apprenticeship and trades' training organizations that incorporated climate change within their curricula. The English Canadian research concluded by providing an analysis of the barriers and opportunities that Canada faces in creating a more climate and energy literate workforce, including pathways to achieve this objective.

In 2021, the English Canadian CIRT members conducted a series of in-depth interviews with construction trades training directors and instructors recommended by Canada's Building Trades Unions (CBTU) as representative of the training programs offered by its 14 affiliates. All interviewees were experienced training directors, or instructors, having worked both as journey workers and, subsequently, as training instructors. All were also knowledgeable about the VET programs of their respective unions and all had responsibility for overseeing individual union training programs and/or supervising other trainers in their unions. Some interviewees were based in VET systems exclusively owned and managed by unions, while others worked in training schools jointly trusteed with employers as part of Joint Apprenticeship and Training Committees (JATCs) financed through multi-employer collective agreements.

Interview questions were designed to assess the extent to which union VET programs include instructional content related to climate literacy. While interviewees revealed the term climate literacy was not customarily used by English Canadian trades trainers (and instead they used other words such as 'green', 'sustainability' and 'conservation'), interviewees noted that they understood CIRT's meaning of the term and recognized that climate literacy entails an understanding of the effects of changes to the climate on our society and, more specifically, the building industry and its workers.

CIRT found that much of the instructors' curriculum includes the knowledge, skills and competencies needed to implement net zero construction practice; however, instructors were not describing their curriculum content using climate terminology; nor were they linking the knowledge, skills and competencies in the curriculum to the goal of reducing the climate footprint of buildings and infrastructure. As one instructor insightfully said: "We are teaching the how, but not the why."

While some VET programs do explicitly reference climate change in the curriculum, these were the exception. Most did not provide apprentices with information about the findings of climate science or the impact of the building sector as a contributor to GHG emissions. Nor did they discuss the positive contribution the building sector could make to lowering Canada's carbon footprint. Critical information was also missing about how cutting energy use in the construction process and in building operations are key to addressing climate change.

Interviewees noted that a major barrier to including more climate change information in VET programs is lack of demand for low carbon construction in the specifications drafted by those commissioning projects. If developers, architects, and engineers do not require projects to meet stringent environmental and energy standards, there is little scope for workers to implement net zero construction practices. A related issue is the lack of demand by contractors for workers with net zero competencies. This undermines the incentive for the trades to upgrade their knowledge and skills.

Interviewees noted the important role that employers play in what apprentices learn on the job. They felt employers need to set a clear example for apprentices in how they organize work and assign tasks. This also means avoiding conflicts between what apprentices learn in the classroom and what they instruct apprentices to do on the job. If contractors ignore low carbon construction best practices or evade building and energy code requirements, they send the wrong message. The industry's lack of focus on climate change adversely affected what instructors felt they could add to the curriculum. Because employers' supervisory practices were not something instructors controlled, they felt that basic changes in how the industry operated were necessary to promote a more climate aware workforce.

Instructors noted that a major barrier to including climate literacy material in their programs was the lack of references to climate in the Red Seal Standards which form the basis for the curriculum provinces provide to training centres across the country. Interviewees supported the Red Seal system because it ensured that key skills were covered and because it facilitated inter-provincial mobility based on agreed national standards. But they also noted its limitations, including the relatively slow pace of revising the Standards in the context of a rapidly changing industry in which new technologies and working practices were being introduced continuously.

Instructors who included material on climate change had to do so outside the scope of the formal Red Seal Standards curriculum. The absence of climate change questions on the exam deterred apprentices from focusing on it. Changes to the Standards were essential to give instructors the scope to include climate material in their apprenticeship programs. Its absence also meant that instructors interested in teaching climate issues did not have curriculum guidelines to assist them. Some felt that they were a bit over their heads in trying to cover climate science without the assistance of instructor manuals or other authorized sources of information. This underscored the urgent need for new curriculum material for instructors as

well as apprentices. (Since these interviews were conducted, the Red Seal Secretariat introduced a short statement in August 2023 indicating that climate change is now a major issue for the industry and that the apprenticeship curriculum needs to focus on creating a climate literate workforce.)

To fill the curriculum gap, several unions such as plumbers and pipefitters have incorporated modules from the US Green Building Council's GPRO program. GPRO explicitly discusses the relationship between buildings and climate change and provides students with an understanding of the basic elements of high performing construction practices that reduce energy use and GHG emissions. Other unions such as electricians, painters and ironworkers have developed curriculum modules that link the work of their apprentices with the broader objective of reducing GHG emissions and energy use.

Instructors were familiar with voluntary building standards such as ASHRAE 90.1, Passive House, LEED, BOMA BEST and R-2000 that lowered energy consumption and promoted environmental sustainability. There was agreement that the intent of these standards was good but that their climate rationale was not adequately highlighted. However, there was substantial criticism about their use as industry marketing tools, given the way in which some developers and contractors were 'gaming' the system by maximizing the credits for components of building construction that appeared to address climate change but, in reality, did not significantly reduce environmental impacts.

Several training directors raised concerns about the proliferation of micro-credentials. These are often advertised as a pathway to a 'green' job in performing environmentally sustainable work. They noted that inadequate provincial regulatory requirements, such as lack of compulsory trade designations, had facilitated their expansion. Their promoters downplayed the significant technical challenges involved in construction work and the corresponding knowledge, skills and competencies needed to do work properly, including knowing how to work safely on construction projects and understanding the high-quality standards that are essential for effective net zero construction. Interviewees felt that these courses frequently disappointed those taking them because they were narrow in scope and did not provide a long-term career based on a well-rounded apprenticeship, leaving them vulnerable to unpredictable changes in demand for the limited skills they learned.

All interviewees were agreed on the need for - and benefits of - more cooperation and collaboration among trades. The term often used was 'soft skills' (although this has the unfortunate implication that these skills are somehow less relevant than the 'hard skills' associated with knowing how to perform specific tasks). Apprentices needed to understand how their work complemented the work of other trades, an insight consistent with what we have learned about low carbon construction in Europe and the U.S. They also needed to develop critical thinking, problem solving and other skills that enable them to collaborate effectively with other trades and occupations on building sites.

Several instructors felt that all trades needed a better understanding that buildings were integrated systems, rather than a collection of siloed contracts and sub-contracts. For projects to be built properly, trades needed to have a system-wide understanding of building projects based on knowledge of the principles of building science. They noted that system thinking should be strongly reinforced in the curriculum. Similarly, more extensive teamwork and co-operation among trades was something they believed should be more fully stressed in apprenticeship programs.

Building on the insights from instructor interviews and the literature review, the English Canadian research focused on identifying the VET requirements for successful net zero construction for trades trainers, apprentices and working trades. These requirements arise from the characteristics of effective low carbon construction practice. To achieve the rigorous standards of minimizing energy use, reducing GHG emissions and promoting environmental and ecological sustainability, construction projects must achieve very high-performance standards.

Net zero construction is different from conventional construction. Buildings and infrastructure must be constructed as integrated units in which every component is properly built to meet rigorous commissioning specifications. The building envelope or fabric must be sealed and properly insulated. Building services must be installed competently. The energy performance of the resulting project must meet measurable design specifications. Projects need to be audited to ensure they meet these specifications. The construction process itself must minimize on site energy consumption, limit embodied carbon, reuse materials, recycle extensively and manage waste responsibly. Quality is a central priority for net zero construction.

Meeting these objectives has major implications for the workforce and the VET system that prepares it for this work. As net zero buildings and infrastructure are planned as integrated units, the workforce needs to learn how the various components fit together to achieve the overall building outcome. Failure in one area can prejudice the overall success of a construction project in meeting design objectives and can lead to a 'performance gap.'

Building is a social process requiring cooperation among a wide range of different occupations. It requires workers to have the social and communication skills needed to facilitate successful collaboration. They need to know what other occupations do and how the contribution of these occupations fits with their work and with the overall goals of a project. This means overcoming the industry's tendency to view projects as a collection of silos, both in terms of contractual arrangements (i.e., extensive sub-contracting) and in terms of viewing the work of each trade as separate, or independent, from that of the other trades.

Review of the international literature indicates that developing a more climate literate workforce also means enabling workers to exercise their knowledge, skills and competencies more fully in achieving climate objectives. Worker agency, that is, taking responsibility for the outcome of their work and the success of construction projects, is integral to effective

climate practice. Achieving high quality standards requires a workforce that is knowledgeable about what a good job should look like and is motivated to achieve it. Pride in the ability to solve problems on work sites and the capacity to find solutions to new challenges contributes to achieving an occupational identity as a skilled trades worker in which work provides personal satisfaction and a sense of accomplishment. Knowing that one's work contributes to a better climate and a healthier community can also be an important source of motivation and job satisfaction. The literature also indicates that readiness to change, to incorporate new working practices, and to embrace new sets of social relations, including teamwork, are major aspects of sound green construction. These elements need to be incorporated into the curriculum of VET programmes.

Transitioning to a climate literate workforce also means change to the way the industry operates, including its working culture. A successful green construction sector cannot be achieved through 'business as usual' or the traditional 'like' recruitment of 'like'. It means opening the industry to women, Indigenous people, racialized workers and others who, historically, have been under-represented.

The industry has made some progress on this issue, particularly in developing equity focused VET programs. Employer organizations, unions and governments publicly endorse moves towards a more representative workforce. But too often progress has not paralleled official pronouncements. A climate literate workforce should also be a more representative workforce. Cultural change is also needed to attract and retain the workers required to overcome its recurring labour shortages. Preparing the industry to address climate change provides the opportunity to create a more welcoming workplace culture and a more representative workforce.

An important conclusion from our research is that Canada's efforts to reduce GHG emissions and energy use are being driven largely by governments, not industry. Government policies, in turn, reflect the findings of the scientific community. It is the science that has led governments in Canada and internationally to adopt increasingly tough measures to limit GHGs and reduce energy use. To do this they are using a mix of policy tools, including more stringent building and energy codes, zoning and planning regulations, subsidies, tax breaks, research funding and support for public education programs. They have also used their own procurement of buildings to set an example of the standards they wish to implement. These measures have been informed by the knowledge, based on extensive research, that major reductions in emissions are both possible and reasonably affordable.

The most obvious way public policy has been used to promote climate goals has been through changes to Canada's building and energy codes. In recent years, governments have significantly tightened the energy and conservation requirements in the codes to require the industry to promote greener construction practices and outcomes. The goal has been to reduce the GHG emissions and energy use of buildings and related infrastructure, incrementally, over time to achieve climate targets. Governments have also put in place new regulations about water conservation, soil preservation, elimination of the use of toxic contaminants in

building materials and other measures to further achieve climate and environmental objectives.

Public policy is also driving much of the research on how to lower the climate footprint of buildings and infrastructure. At the Federal level, a wide range of publicly funded organizations are working on different aspects of the building process. The goal is to reduce carbon emissions, lower energy use, promote reuse and recycling of building materials and manage waste more responsibly. This research, in turn is showing the industry practical ways that it can meet Canada's climate goals. Provincial governments and municipalities have also been contributing to this effort by using their policy tools and regulatory standards to incent construction firms to achieve net zero. It is policy that is driving change in the industry.

Most of Canada's largest construction firms acknowledge that climate change is responsible for driving the policy changes governments are demanding. They publicly indicate their commitment to addressing the climate crisis and say they are modifying their operations to meet higher net zero standards. There are few outright climate deniers in the industry these days. However, public commitments by major industry players are not the same as support for industry transformation.

There is also considerable pushback by some firms that reject increased government regulation. Instead, they favour a market-based, voluntary approach. Consequently, they oppose policies that require higher, legally enforced building and energy code standards or increasing worker qualification requirements such as expanding the number of compulsory trades. While the mainstream industry continues to be driven by a low bid, low wage, competitive tendering model that tends to push down quality in the drive by contractors to cut costs, the principal reason governments are stepping in because this approach has failed to address the climate crisis.

The organization of much of the industry, with its extensive sub-contracting and piece work-based contract silos presents a basic challenge to the more integrated, 'whole building' approach that is needed which extensive evidence from Europe, the U.S. and Canada confirms is essential for effective net zero construction. Over-reliance on sub-contracting is compounded by the pervasiveness of low bid price competition in the industry to the exclusion of high-quality performance. Up-front cost remains a key factor that prospective investors, or developers, use to decide building specifications. There is still a widespread view in the industry that it is currently far too expensive to build to net zero standards. These issues need to be addressed if Canada's climate objectives are to be realized.

The findings validate that of other climate literacy research that the support of employers is essential to advancing climate literacy in the construction industry. Approximately 80% of the time of apprentices is spent working on construction sites. Accordingly, the extent and quality of the supervision they receive from their employers is critical to their development as qualified trades persons. The foundation of climate literacy is a knowledgeable, skilled and competent workforce.

Yet employer practices on most Canadian construction sites are still poorly regulated. The experience of apprentices varies dramatically. Some employers are strongly committed to providing a positive learning environment and do a good job. However, others do not see supporting apprentices as a priority and fail to provide them with the opportunity to learn the full scope of their trade. Apprentices may also be assigned to repetitive work that gives them little opportunity to acquire the core knowledge and skills of their trade. Some find their journey worker mentors do not have the time - or are not encouraged by their employers - to provide the needed coaching. Still other employers exploit apprentices as cheap labour. These problems in the apprenticeship system weaken its ability to provide the highly skilled workforce Canada needs for net zero construction.

Another impediment is the high proportion of small employers, most of whom do not have the capacity, or resources, to support apprentices effectively. Overwhelmingly, support for apprenticeships comes from the large, and some medium-sized, employers. Governments need new policy tools to facilitate greater participation of small and medium employers in VET programs. One option is to expand the number of construction trades (i.e., compulsory trades) that must be licensed to perform building work, something Quebec already does and common practice in much of the EU. If employers must hire a larger proportion of workers with approved credentials, they will have a strong incentive to support programs that facilitate the required training.

There are numerous organizations representing the economic and political interests of construction employers in English Canada. But most have little, or no, capacity to make binding commitments on behalf of their members to support VET programs. This contrasts with the successful experience in Scandinavia, Germany and Belgium – to cite relevant examples – where employers, collectively, support VET extensively. The ability of these employer organizations to enlist the cooperation of their member employers enables them to support system-wide VET programs. They recognize that all employers have an interest in an effective training system and that every employer has an obligation to do their part. This underscores the pressing need for governments in Canada to find ways to require employers to provide more support for training programs.

The industry also has large numbers of self-employed workers with little opportunity to enrol as apprentices and hence who are effectively excluded from VET programs. Canada's unregulated underground economy inappropriate incentives for many workers to avoid formal employment. Self-employment benefits some contractors by enabling them to shift responsibility for statutory obligations to the workers themselves. By minimizing tax and exempting themselves from other statutory contributions, self-employed workers underbid responsible contractors who provide regular employment with its associated regulatory and administrative costs as well as worker benefits.

The resulting downward pressure on costs forces contractors who employ workers to cut corners and lower quality to be competitive. However, the result undermines climate

performance standards. Governments need to enforce tax and regulatory measures to reduce the proportion of self-employed construction workers. Doing so would also provide large numbers of workers with a pathway to employer supported VET programs. Governments also need to look at the Quebec model as a key model in which everyone working on a building site must be registered and hold the appropriate qualification.

Another impediment to a more climate literate workforce is the large, unregulated underground economy. While estimates vary about its size a 2022 BC study found it accounted for approximately 19% of the province's construction workforce. Aside from the widespread exploitation of workers, the underground economy also depresses building standards, while excluding workers from access to regular VET programs. It is difficult to see how members of this workforce can acquire the knowledge, skills and competencies needed for net zero construction. If Canada is to succeed in creating a more climate literate workforce, governments will need to address this issue as a priority.

The preceding comments reveal a fundamental disconnect between the very ambitious climate targets governments have established and the reality that a large portion of the current workforce does not have the knowledge, skills and competencies to achieve these objectives. The much higher standards of net zero construction necessitate significant upskilling of the majority of construction workers and much stronger support for the apprenticeship system. Relying on the relatively small cohort of skilled journey workers – important as their contribution will be – is not going to be adequate. Canada needs more skilled workers. Yet the level of planned public investments in the VET programs does not correspond to the size of the climate challenge.

There is one area where governments do have influence. As the largest purchaser, cumulatively, of construction services in Canada, governments award numerous contracts for a wide range of building and infrastructure projects. They also influence the decisions of developers who build facilities for lease to governments. In recent years governments have modified some public procurement contracts to include a variety of social and environmental objectives. These include training and employing members of designated equity groups, following sound environmental practices, implementing health and safety measures and minimizing adverse impacts on affected communities. Governments need to include contract provisions requiring employers to support workforce climate literacy objectives.

A major observation from our European research is that countries which provide both unions and employers with meaningful roles in the VET systems through a 'social partnership' approach are more successful than jurisdictions which rely predominantly on employers to operate the training system or where the state unilaterally manages it. Giving workers and their representatives a role in overseeing the system ensures that their insights and interests are reflected in its operation. It also means that unions have a major stake in the system's success as well as the outcomes experienced by their members.

The most successful Canadian apprenticeship programs are those offered by unions and/or Joint Apprenticeship Training Committees (JATCs). Their apprenticeship completion rates are higher because unions take responsibility for helping their members find work, while employers have obligations under the collective agreements to provide apprentices with jobs and training. However, outside Quebec the building trades unions represent only one quarter of the English Canadian construction workforce. So the JATC option is not available to most construction workers. Provincial governments have been reluctant to pass legislation facilitating unionization. However, given the success of union VET programs and the pressing need to address the climate crisis, governments need to recognize that this is a viable way to achieve their climate goals.

Another successful approach for improving the workplace component of VET programs is through community benefits agreements (CBAs). These explicitly include training and employment targets for women, Indigenous people, racialized minorities, people with disabilities and members of local communities. They have provisions requiring contractors to support these objectives and include auditing systems to ensure that targets are achieved. Climate literacy modules are now being tested in selected BC CBAs and this approach has the potential, if widespread, to facilitate a more climate aware workforce.

Transformative changes are needed to meet the requirements of net zero construction, challenging the industry and its workforce to meet much higher climate and environmental standards. But climate change will also create a wide range of new opportunities for the building industry. Most significantly, will be the demand for several million new construction jobs by 2050, the date that governments plan to achieve net zero emissions. In addition to the requirements of new buildings, it will also involve retrofitting most of the 16 million residential housing units, as well as the 480,000 industrial, commercial and institutional buildings to meet net zero standards. Both governments and the private sector will be making significant new investments to cope with the climate challenge. There will be ample work for a new generation of construction workers, including a more representative workforce, who will be expected to meet the performance standards required to achieve ambitious climate objectives.

Our research indicates that creating a more climate literate workforce cannot be done by the VET system alone. It needs the support of the entire construction industry. Building work must be organized to integrate low carbon principles throughout its operations. Commissioning must require high performance standards. Standards must be legally monitored. Quality must be emphasized, and tenders must guard against privileging low bid, minimum standard work. Employers must implement net zero practices on their work sites and create demand for workers with climate training. More broadly, the overall working culture on building sites must support low energy construction practices. The VET system cannot do all of this. But what it can do is to prepare the workforce for its future role in delivering net zero construction.

2.0 Background to the Project

In August 2020, Canada's Building Trades Unions (CBTU) applied to the federal government's Union Training and Innovation Program (UTIP) for project funding to explore ways in which climate literacy could be introduced into Canada's apprenticeship and working trades' vocational education and training (VET) system. This was to assist the Canadian construction industry and its trades to address its challenges in developing a climate-informed, skilled workforce capable of delivering low carbon, net zero building and infrastructure projects. In March 2021, the Government confirmed it was willing to support the proposed 4.5-year project based on the detailed workplan contained in CBTU's submission. CBTU then established an Advisory Committee drawn from its 14 member unions to oversee the project.

In addition to overseeing and administering the project, CBTU arranged for three organizations to support it. One was a small team of academics and policy experts referred to as the Climate and Industry Research Team (CIRT) to which it assigned the task of providing the research for the project, including a literature review and environmental scan. It asked a second organization, SkillPlan to carry out a needs assessment and develop climate literacy curriculum to be used in developing training pilots for the construction industry. Based on the experience gained from the pilots, it was then to ramp up the training curriculum for inclusion in selected apprenticeship and journey worker upgrade programs across the country. CBTU brought in a third organization, the Social Demonstration and Research Corporation (SRDC) to work with CIRT and SkillPlan on the needs analysis, develop and carry out a detailed evaluation of the pilots and provide feedback and recommendations on improving the training modules, including an assessment of the overall impact of the initiative on climate literacy. The three organizations were to work closely with CBTU throughout the project, sharing information and collaborating on their respective tasks.[1]

CBTU's submission to the federal government under the UTIP program outlined a number of objectives for the project. These were designed to 'integrate climate literacy into construction

[1] The literature on climate science in the building sector uses a variety of different terms to describe the way in which buildings and infrastructure is being modified to meet climate objectives. These include: low carbon; low energy; zero carbon; nearly zero; net zero; net zero ready; high performance; green; sustainable and several others. There is no widely accepted single term used in the literature to describe buildings that meet climate change objectives. There are differences among the terms such as between low energy and low carbon, a distinction explained in more detail in a subsequent footnote. In practice, different studies and reports adopt one, or another, of these terms to describe broadly similar outcomes. Consequently, we are left with a somewhat messy proliferation of different descriptors for similar phenomena. As the term net zero has become more widely used in Canada in recent years, we shall generally use it as a generic term to describe the core elements of a low carbon/low energy approach, recognizing that in some contexts, such as citing documents, other descriptors may be more precise or appropriate.

to prepare the unionized workforce to better meet Canada's climate change commitment'.[2] These included:

- Achieving a highly skilled, well-trained, climate-aware construction workforce capable of fully implementing low carbon building standards.
- Effectively integrating climate awareness and, more broadly, an understanding of climate science into the construction trades training curricula, on-line, in the classroom, and on the job.
- Encouraging an understanding of buildings as an integrated system and not simply a collection of separate contracts or projects.
- Facilitating a deeper understanding in each trade of the contribution of other trades to the overall success of a building/construction project, an objective that is essential in achieving successful, low carbon construction.
- Recognizing that competent, low carbon construction requires adequate, targeted investment in training to developing a climate literate workforce, through apprenticeship training and programs that enable existing workers to acquire and/or upgrade needed knowledge and skills.

The project's long-term goals are to develop and test generic climate literacy awareness modules that can be used in the training programs of all construction trades for instructors, apprentices and working journeypersons. In addition, it is to develop 14 trades-specific climate literacy modules for both apprentices and journeypersons. As these would be delivered by training instructors, the project would develop a separate package of curriculum resources to assist them in teaching the modules. The project's climate literacy curricula would be suitable for apprenticeship programs across Canada. Its content might also be relevant for inclusion in Canada's Red Seal Standards for construction workers.

The CBTU submission also noted several related goals, including how to promote an awareness of the importance of the building industry in achieving Canada's climate objectives and the positive role the building trades can play in this process. It recognized the existence of a 'performance gap' between the specifications of low carbon buildings and the resulting 'as built' structures, a gap which needed to be closed. It acknowledged that there were barriers to the effective creation of a 'climate literate' workforce that Canada had to overcome if it were to achieve its climate objectives in the coming years. [3] Consistent with

[2] CBTU. (2021). Building it Green Project Charter. Ottawa: July 13.

[3] The deliverables of the project include:

- Research results of environmental scan and literature review
- Needs analysis framework, results and report
- 14 trade specific climate literary online modules for apprentice
- 14 trade specific climate literary online modules for journeypersons
- 1 generic online awareness module for all 14 trades
- General jobsite literacy orientation of the trade specific climate literacy
- Online train the trainer for climate literacy modules
- Marketing tools for employers, trainers, apprentices, and journeypersons

Canada's goal of providing opportunities for under-representative groups, the project also would examine ways to ensure that indigenous and racialized groups were included in the training programs it developed.

The submission assumed that many of the existing skills of the construction workforce were the same skills needed to achieve high performance, net zero buildings and infrastructure. What was missing in VET programs was an explanation of the reasons why Canada's buildings and infrastructure needed to be constructed in a much more exacting way to mitigate climate change and, consequently, to meet the demanding design specifications of low energy construction practice. This would also involve a culture shift in the industry towards understanding of the linkage between climate change and the increasingly strong push through building and energy codes to incorporate climate related objectives in new and refurbished building and infrastructure projects.[4]

CIRT's role in the project was to identify good examples of climate literacy training programs and curriculum modules in trades training programs both in Canada and internationally. These could provide illustrations of best practices and climate curriculum content that could inform Canada's VET programs. Part of the literature review and environmental scan was also to assess barriers and challenges in promoting a climate literate workforce and a 'greener' workforce culture.

CIRT is a small group of academics with backgrounds in trades training from Europe, the U.S., Canada and Quebec and one trades specialist with extensive connections with the building trades unions, employers and training facilities in North America. The individuals were well known in the field and had earlier produced numerous studies on low carbon construction apprenticeship and VET training issues. Members of the European team had carried out major studies on training programs over the previous three decades, including a detailed 10-country study of low carbon training programs funded by a major grant from the European Union in collaboration with the Building and Woodworkers International Union

- Impact Assessment
- Virtual Conference on climate literacy to 5 regions
- Evaluation of the climate literacy modules, related processes and effectiveness
- Digital repository of the of the research, modules and training tools that is publicly accessible and could act as a library for future work in 'greening' the construction industry.

[4] It is necessary to distinguish between lowering the carbon footprint or, more broadly, greenhouse gas (GHG) emissions of buildings and lowering their energy use. The carbon footprint can include all those inputs that involve GHG emissions during the life cycle of a building project, including carbon embedded in sourcing resources and manufacturing materials, their transportation, the fossil fuels burned during construction and their subsequent operational use over time in heating or cooling the resulting building or infrastructure. Energy use is the total of all the different kinds of energy used throughout the process. While most energy used today is still generated from fossil fuels, some is from renewable sources such as hydro, wind, solar, geothermal and nuclear. Energy use can increase without increasing GHG emissions if the additional energy is renewable. In practice there is normally a high degree of correlation between GHG emissions and energy use, although this may change in the future as the share of renewable energy increases.

(BWI).[5] In the U.S., the team member, a Fulbright Scholar and certified electrician, had written extensively on apprenticeship programs over several decades and had been particularly interested in how U.S. union apprenticeship systems were supporting the inclusion of women and other under-represented groups in their VET programs. The project benefited from her extensive connections with the building trades unions there.

The two English Canadian members had been participants in four major Social Science and Humanities Research (SSHRC) projects on labour and climate change between 2007 and 2021, including: Work in a Warming World and Adapting Canadian Work and Workplaces to Climate Change.[6] In Quebec, the lead academic researcher had spent the last 10 years analysing industrial relations in the Quebec construction industry. He was assisted by one of his PhD students. Many of the studies and papers of team members are included in the bibliographies of the European, U.S. and Quebec reports. These have been provided separately and are part of CIRT's overall research submission to CBTU. The content of this report reflects CIRT's findings and analysis and is not to be interpreted as CBTU policy.

CBTU's decision to apply for funding for this project on climate literacy reflected its view that climate change is happening and that it will have a growing impact on society, the construction industry and its skilled trades workforce. It also reflected CBTU's belief that there was a need to provide trades instructors, apprentices and journey workers with more extensive knowledge of climate issues so that they would be aware of the many climate-induced changes that are now impacting the industry, including the underlying climate science that explains why these changes are happening.

As a key goal of the project is to identify what the trades workforce needs to know about climate change, CIRT believed it made sense to focus, initially, on what the climate science is telling us about the nature of the changes we will be facing in the coming years. The following section outlines the key scientific findings and their implications for the future.

[5] Clarke, Linda, Melahat Sahin-Dikmen and Christopher Winch. (2020). Overcoming Diverse Approaches to Vocational Education and Training to Combat Climate Change: The Case of Low Energy Construction in Europe. Oxford Review of Education. June 12. https://doi.org/10.1080/03054985.2020.1745167; Clarke, Linda., Gleeson, Colin et. al. (2019). Inclusive Vocational Education and Training for Low Energy Construction (VET4LEC) (Final Report) CLR. https://www.fiec.eu/our-projects/completed-projetcs/vet4lec

[6] York University has archived the entire collection of research papers produced by these two research projects. Adapting Canadian Work and Workplaces to Respond to Climate Change (ACW) (yorku.ca)

3.0 The Science

There is a broad consensus among scientists that climate change is now the most significant challenge facing our species. The adverse impacts of climate change have been extensively researched and published in the academic literature by a range of scientific organizations or collaborations, including the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environmental Program, NASA, the World Meteorological Organization (WMO), the American Academy of Sciences (AAS), the National Oceanic and Atmospheric Association (NOAAS) and thousands of universities around the globe. Scientists have documented a significant increase in global temperatures over the past two centuries and, particularly, over the past 50 years, compared with pre-industrial temperatures.

This is due to the release of heat trapping greenhouse gas emissions (GHGs). These are principally carbon but include methane and various other gasses which contribute to rising global temperatures. GHGs allow more of the sun's energy to stay on our planet, gradually heating it. The most recent studies by the IPCC indicate that global temperatures have already increased by 1.1 degrees Celsius above pre-industrial levels and that they are likely to rise to 1.5 degrees by 2040 – perhaps much sooner – if the global community does not take strong measures to limit carbon releases into the atmosphere. However, these figures average both ocean and land temperature increases. The current average global increase on land is 1.6 degrees. In some parts of the planet, such as Canada's north, the increase has been significantly higher.

The IPCC states that "…It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred." It notes that the scale of the changes is "unprecedented". More worrisome, the rate of increase is accelerating, with an IPCC mid-range estimate indicating 2.0 degrees by 2060 and 2.7 degrees by the end of the century. [7] Some climate scientists believe the IPCC estimate is too conservative and think that this increase will be considerably higher.[8] In its most recent estimate of the global increase in temperatures, the World Meteorological Organization stated that "…There is a 66% likelihood that the annual average near-surface global temperature between 2023 and 2027 will be more than 1.5°C above pre-industrial levels for at least one year."[9]

[7] IPCC. (2021). Summary for Policymakers: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate. https://www.ipcc.ch/report/ar6/wg1/#FullReport

[8] Hansen, James E., Makiko Sato et. al. (2022). Global Warming in the Pipeliine. Atmospheric and Oceanic Physics. December. https://arxiv.org/ftp/arxiv/papers/2212/2212.04474.pdf

[9] World Meteorological Organization. (2023). Press Release Number: 17052023, May 17. https://public.wmo.int/en/media/press-release/global-temperatures-set-reach-new-records-next-five-years#:~:text=There%20is%20a%2066%25%20likelihood,for%20at%20least%20one%20year

These are global figures. According to Environment and Climate Change Canada's publication Temperature Change in Canada, the yearly increase to 2021 has been 2.1 degrees Celsius above its 1961 to 1990 reference average temperatures benchmark.[10] Seasonal average temperatures have varied even more, with winter temperatures 3.5 degrees Celsius above the long-term average, while spring, summer and fall have been below it. Average temperature increases have been much greater in the far north with readings as much as 5 degrees above the reference Canadian temperature benchmark. Within the long-term trend, there have also been significant yearly fluctuations as well with winter average temperatures differing as much as 4.4 degrees from high to low over the past decade.[11]

The process of documenting global warming dates back at least half a century as scientists began to study how the release of carbon into the atmosphere might be affecting global temperatures. The issue came to more widespread public attention as the result of the testimony of NASA scientist, Dr. James Hansen to the U.S. Congress in 1988.[12] That same year, the United Nations joined with the World Meteorological Organization to establish the IPCC to bring together the world's top scientists to carry out research on changes to the earth's climate.

In 1992, under the leadership of the UN, governments from around the world negotiated the first climate change treaty, the United Nations Framework Convention on Climate Change (UNFCCC). This treaty went beyond supporting research and for the first time committed the world's governments to taking steps to curb increases in GHG emissions. This was followed by a 1997 amendment to the treaty known as the Kyoto Protocol which further extended international commitments in addressing climate challenge. Two years earlier the UN had convened the first meeting of the Conference of the Parties to the Convention (COP) in Berlin in 1995. Every year since there has been a further meeting, the most recent being COP27 in Egypt in the late fall of 2022.

In 2015 at COP21, the world's governments negotiated another landmark climate treaty - the Paris Agreement which was adopted by 196 governments.[13] Signatory governments agreed to meet specific GHG reduction targets over the coming decades, including timelines and reporting mechanisms to assess progress. The goal was to keep global temperature increases below 2 degrees Celsius, compared to pre-industrial levels, while making best efforts to keep below 1.5 degrees as the latter would result in far less damage to human society.

[10] Environment and Climate Change Canada. (2022). Temperature Change in Canada. https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/temperature-change/2022/temperature-change-en.pdf
[11] Ibid.
[12] Hansen, James. (1988). Congressional Testimony of Dr. James Hansen to the U.S. Senate Committee on Energy and Natural Resources. Washington: June 23. https://www.sealevel.info/1988_Hansen_Senate_Testimony.html
[13] United Nations Framework Convention on Climate Change. (2015) Paris Agreement. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

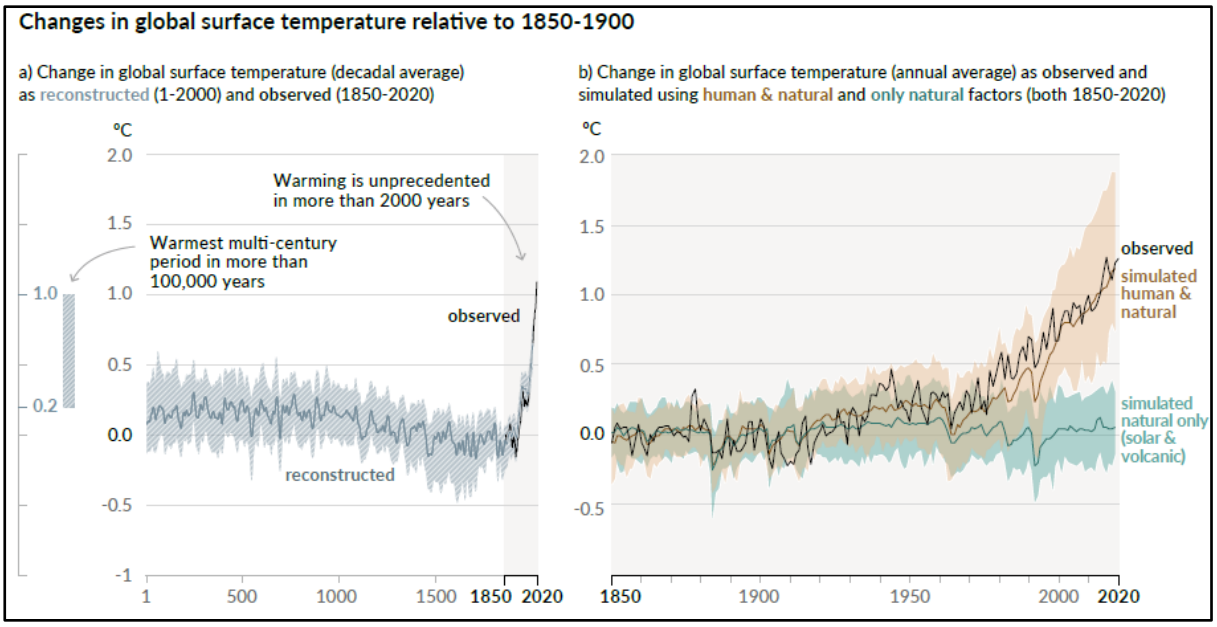
Canada has been involved in this process from its beginning and is a signatory to the UNFCCC, the 1997 Kyoto Protocol (although briefly pulling out under the Harper Government) and to the 2015 Paris Agreement. As with many other countries, Canada's level of commitment has increased in parallel with the international treaty process and the emerging science demonstrating the adverse impacts climate change will have if GHG emissions are not curbed. Since signing the Paris Agreement, the federal government has adopted a wide range of increasingly stringent policies to enable it to meet its international commitments.

In its 2021 study of the physical science basis of climate change, the IPCC has documented the impact that rising global temperatures have already had on the planet. Peer reviewed by literally hundreds of the world's top scientists the 3,949-page report outlines the wide range of adverse changes we are now witnessing. It concludes that "It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean cryosphere and biosphere have occurred."[14] The following charts from the 2021 IPCC report documents the change in global temperatures since the 1850 – 1900 benchmark period.[15]

[14] Ibid.

[15] The IPCC directly addresses the diminishing credibility of climate sceptics by stating very clearly that climate change is caused by human activity, an assertion backed by the massive amount of cumulative scientific evidence behind its detailed examination of the causes of climate change. In making this point, it is reflecting the overwhelming scientific consensus of literally thousands of scientists including many not involved directly in its own research. The scientific consensus was further confirmed in a recent Cornell University study. Based on a randomized sample of 3,000 articles from a data set of 88,125 climate articles, it found that 99.85% supported the view that climate change is caused by human activity.
The conclusions of the IPCC are supported by the research of numerous other scientific agencies, universities and research institutes. These include NASA, the United Nations Environmental Program, the World Meteorological Organization, the American Academy of Sciences, the National Oceanic and Atmospheric Association and thousands of universities around the globe. At this stage, the debate about whether climate change is happening and whether it is caused by human actions is effectively closed. We know the answer to both questions. See, for example,. Lynas, Mark, Benjamin Houlton and Simon Perry. (2021). Greater than 99% consensus on human caused climate change in the peer reviewed scientific literature. Environmental Research Letters October 19. https://iopscience.iop.org/article/10.1088/1748-9326/ac2966

[15] In a different study NASA indicates that over 97% of scientists actively publishing believe that global warming is caused by human activity. NASA (2021). https://climate.nasa.gov/scientific-consensus/



Source: IPCC ARC WGI 2021 Figure SPM1

The IPCC has developed a range of models to predict the likely increase in global temperatures in the near, medium and long term up to the year 2100. The mid-range forecast indicates that absent major reductions in emissions we may see global temperatures rising by 1.5 degrees by 2040, 2.0 degrees by 2060 and 2.7 degrees by the end of the century. A more pessimistic model indicates that the averages could be 1.6, 2.4 and 4.4 degrees. The worst case could by an increase of as much as 5.7 degrees by 2100. Many scientists believe that this would be nothing short of catastrophic for our species. [16]

In addition to rising global temperatures, the IPCC documents that precipitation has increased significantly, particularly since the 1980s. Glaciers have retreated, artic sea ice has thinned and the Greenland ice sheet has contracted. The upper ocean is notably warmer and more acidic, while average sea level has increased by one fifth of a meter since 1901 and is rising at an increasingly rapid pace. Temperature increases on land, at 1.6 degrees Celsius, have been higher than the combined 1.1-degree average of land and ocean.

International Sources of Information on Climate Change

- Intergovernmental Panel on Climate Change. https://www.ipcc.ch/
- International Energy Agency https://www.iea.org/
- NASA https://climate.nasa.gov/
- Union of Concerned Scientists . https://www.ucsusa.org/
- United Nations Environmental Program. www.unep.org
- United Nations Framework Convention on Climate Change. https://unfccc.int/
- US Global Climate Research program. https://www.globalchange.gov/
- World Meteorological Organization. https://public.wmo.int/en

[16] Ibid Ch. 11. See also Hansen (2022), op.cit.

Much of the publicized climate research focuses on increases in average global temperatures. But, as noted, the experience in parts of Canada is already considerably worse than the global average. The following table from Environment and Climate Canada projects the likely impacts of increasing global warming levels in Canada's regions from 1degree (which as noted we have already passed) to 3 degrees. At 2 degrees, globally, the increase in Canada will average 3 degrees with the north reaching 3.7. At 3 degrees, the impacts will be even more dramatic as the following table illustrates.

Table 2.2: Projected changes in annual mean temperature for Table C-2 locations in six Canadian regions (see Figure 2.5) and Canada as a whole for +1°C, +2°C, and +3°C global warming levels with respect to the 1986-2016 baseline period. Values represent the ensemble projection (25th percentile, 75th percentile) calculated from CanRCM4 LE.

Change in Surface Mean Air Temp. [°C]	Global warming level		
Region	**+1°C**	**+2°C**	**+3°C**
British Columbia	1.4 (1.3, 1.4)	2.7 (2.6, 2.8)	4.1 (4.0, 4.2)
Prairies	1.4 (1.3, 1.6)	2.9 (2.8, 3.1)	4.5 (4.3, 4.5)
Ontario	1.6 (1.5, 1.6)	2.9 (2.9, 3.0)	4.3 (4.2, 4.4)
Quebec	1.6 (1.5, 1.7)	3.1 (3.0, 3.2)	4.6 (4.5, 4.6)
Atlantic	1.5 (1.4, 1.6)	2.8 (2.8, 2.9)	4.2 (4.1, 4.3)
North	1.9 (1.8, 2.0)	3.7 (3.6, 3.8)	5.5 (5.4, 5.7)
Canada	1.6 (1.5, 1.6)	3.0 (2.9, 3.0)	4.3 (4.3, 4.4)

Environment and Climate Change Canada 2020 Climate Resilient Buildings and Core Public Infrastructure p. 23 https://publications.gc.ca/site/eng/9.893021/publication.html

As Canadians are now aware, climate change has already resulted in an increasing number of extreme weather events, including heatwaves, virulent storms, atmospheric rivers, hurricanes, floods, multi-year droughts and the melting of permafrost in the artic. In 2021, British Columbia experienced a June heat dome that produced a record temperature of 49.6 degrees in the town of Lytton, an unprecedented event in the country's history. Several days later the town burned to the ground.[17] BC's Extreme Heat Death Panel calculated that there were an additional 619 deaths resulting from the heat wave. During the summer, the province also experienced major wildfires. In November, it witnessed flooding that destroyed bridges and roads some of which are still not repaired. In sum the weather events that year in BC resulted in property damage estimated at between $10.6 and $17.1 billion.[18]

In 2022, the Maritime provinces witnessed the category 4 hurricane Fiona with winds of up to 165 kilometres per hour causing unprecedented damage to buildings and infrastructure, some

[17] Lee, Marc and Ben Parfitt. (2022). A Climate Reckoning: The Economic Costs of BC's Extreme Weather in 2021. Canadian Centre for Policy Alternatives. Vancouver. November. A Climate Reckoning | Canadian Centre for Policy Alternatives
[18] Ibid.

of which had been in place for centuries. In Ontario and Quebec, a May 2022 'derecho' cut a wide swath of damage from Quebec City to Windsor, cutting power lines and flooding major areas of some cities. That same year, Montreal faced a 'humongous' rainstorm in June dumping a months' worth of water in a few hours.

Senior climatologist with Environment and Climate Change Canada, David Phillips commented in reviewing Canada's worst weather events of 2022 that the year was one of "too much weather". He went on to say:

"The evidence is becoming more conclusive that anthropogenic warming is playing a significant part in more frequent and extreme weather, leading to more weather disasters at home and abroad. Climate change is about rare weather events becoming frequent, seasons becoming different lengths… You have to wonder…what will it be like in 30 years when we warm up three more degrees."[19]

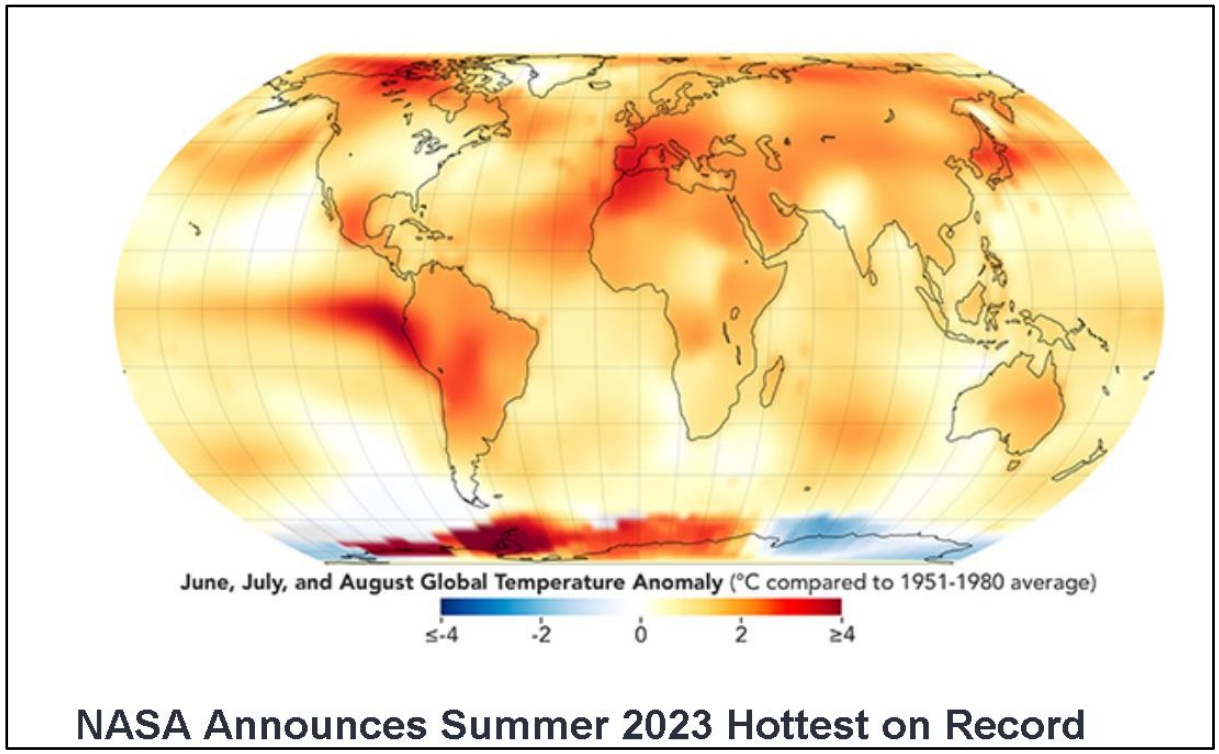
In the late spring and early summer of 2023, Canada experienced the worst forest fires in living memory. What was different was the scale of the fires and their distribution across the country. Canada's western provinces experienced extensive wildfires that resulted in evacuations of significant parts of northern BC, Alberta and parts of Saskatchewan and which continued through the summer. Cities such as Calgary were covered with a veil of hazardous smoke. Simultaneously, major Ontario cities, such as Ottawa, had air quality advisories telling residents it was not safe to be active outdoors due to the toxic smoke from forest fires. There were also huge fires covering large swaths of Quebec. Nova Scotia experienced its worst ever forest fires, forcing people on the outskirts of Halifax to flee their homes. The province declared a state of emergency and thousands were evacuated. The preceding evidence underscores the reality that extreme weather events triggered by climate change have increasingly become the norm in Canada.

The IPCC estimates that these kinds of adverse events will be much more common and much more severe in the coming years.[20] The extent of the impacts will depend, critically, on how much global temperatures increase. However, the increasing number and severity of adverse weather events may not be gradual, but abrupt. Its modelling indicates that the frequency and impact of such events is often non-linear, that is they compound with every increment of temperature rise. Rather than turning a dial with a smooth, step by step increase in adverse events, some changes are more like flicking a switch. Moreover, some of these climate induced changes also appear to be irreversible.

The data on average temperature increases does not fully capture the impact of climate change on our environment because averages often obscure the effects of localized extreme events. For example, temperature increases in urban areas during heat waves can be several – or sometimes many - degrees Celsius warmer than the adjacent area, resulting in 'urban heat

[19] David Phillips. December 21 as quoted in DH Canada. https://dailyhive.com/canada/canada-top-weather-stories-2022
[20] IPCC. 2021. op. cit.

islands' from reduced ventilation, heat trapped by buildings, heat produced by building operations and the characteristics of widely used building materials such as concrete and asphalt which absorb and retain heat. Lack of greenery to absorb heat compounds the effect. Similarly, average rainfall figures do not capture what happens when an atmospheric river dumps several months of average rainfall in a few hours.



Climate change is triggering significant adverse health impacts, both to workers and to the broader population. [21] Temperature rises, and the expanding number - and severity - of adverse climate events, are resulting in more illnesses and deaths. For example, BC's heat dome in 2021 was responsible for the loss of an estimated 619 lives.[22] Higher summer temperatures are making housing that lacks air conditioning a major health threat especially for the elderly and those with health vulnerabilities, something that is disproportionately affecting low-income residents.

Climate change also impacts the integrity of buildings and infrastructure. Fierce storms, heavy precipitation, hurricanes. floods, heat triggered fires and other extreme weather events can – and do – cause extensive damage to critical infrastructure of roads, airports, railways,

[21] Canadian Institute for Climate Choices. (2021). The Health Costs of Climate Change: How Canada Can Adapt, Prepare and Save Lives. June. https://climateinstitute.ca/reports/the-health-costs-of-climate-change/
[22] Lee, Marc and Ben Parfitt. (2022). A Climate Reckoning: The Economic Costs of BC's Extreme Weather in 2021. Canadian Centre for Policy Alternatives, Vancouver. file:///J:/1%201%20Skillplan%20Proposal%20Dec%2019%202022/ccpa-bc_Economic%20Costs%20of%20BC's%20Extreme%20Weather%20in%202021.pdf. The authors calculate that the adverse weather events of 2021 cost the BC economy between $10.6 billion and $17.1 billion amounting to between 3 to 5 percent of provincial GDP.

subways, power stations, transmission lines, electrical transformers, dikes, sewers and water systems. Floods wash out bridges, destroy farm buildings, drown animals, and pollute agricultural areas with livestock effluents. They also release fertilizers and chemicals, necessitating costly clean ups, impacting public health and the health of the workers involved in responding to the disasters. Landslides block highways and railways while destroying homes, commercial and industrial buildings. Impacts often compound, when several different extreme events overlap, such as when high temperatures lead to heat-induced health effects while increasing the incidence and severity of forest fires. Compound weather events are now a growing sub field of climate science. [23]

This point is emphasized in the federal government's national issues report on the state of climate change in Canada:

"Climate change is threatening Canada's ageing infrastructure…Safe and reliable infrastructure and resilient buildings are essential to life in cities and towns. The projected changes in climate will increase risk for Canada's ageing infrastructure, causing structural damage, compromising system reliability and threatening health and safety." [24]

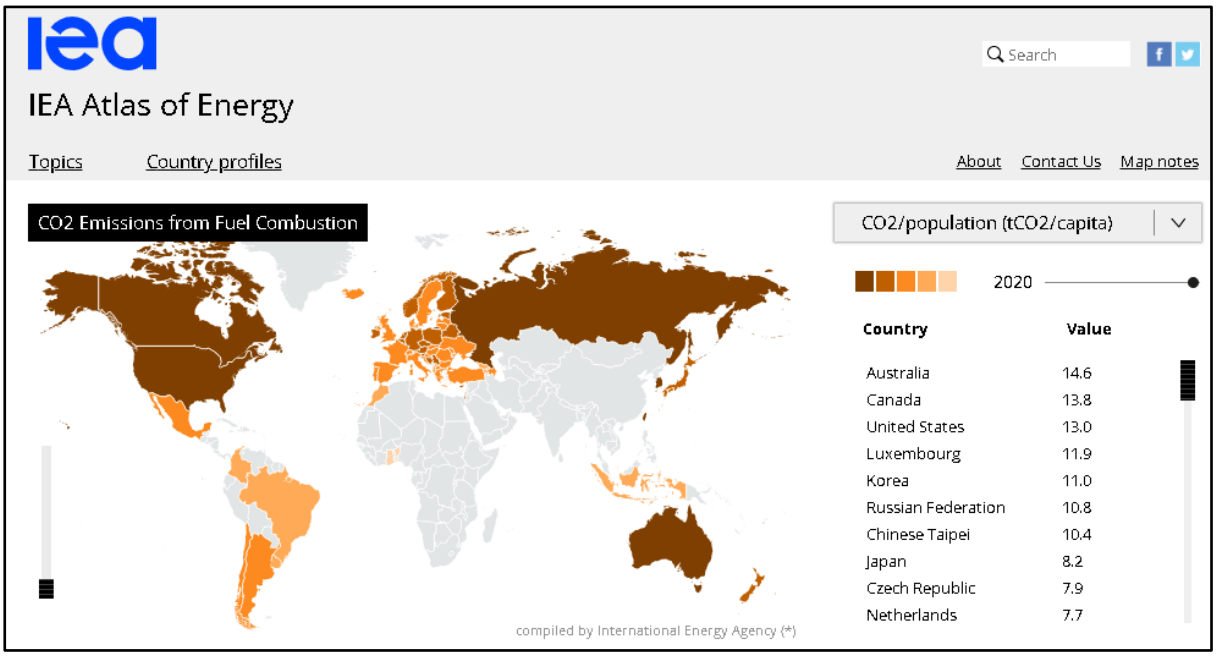
The social impacts are also significant. The burden of climate change is unequal. Marginalized and low-income populations are less able to deal with its impacts both because their health is already weaker and because they do not have the resources to compensate for the changes they are experiencing. It is having a particularly strong impact on Indigenous communities. According to a recently released Health Canada study:

"Growing climate change impacts worsen socio-economic conditions harmful to health, such as poverty, and amplify health inequities. Combined with increasing rates of chronic diseases, social isolation and an aging population, climate change augments impacts on health. People disproportionately affected by climate change include children; pregnant people; First Nations, Inuit, and Métis peoples; people with chronic illnesses; outdoor workers; low-income individuals; and people with disabilities."[25]

Climate change is a global problem and requires global solutions. But it is also a problem for which individual countries have responsibility as well. Canada as a wealthy, developed country with a high average standard of living, has a particular responsibility to show leadership in addressing climate change. Despite its small population, Canada ranked seventh in the list of most significant carbon emitting countries in 2020 according to the International

[23] Ibid. Ch. 11.
[24] Canada. (2021). Canada in a Changing Climate: National Issues Report. Ottawa: National Resource Canada. p. 30. https://www.nrcan.gc.ca/maps-tools-and-publications/publications/climate-change-publications/canada-changing-climate-reports/canada-changing-climate-national-issues/21097
[25] Health Canada. (2022). Health of Canadians in a Changing Environment: Advancing Our Knowledge for Action. Ottawa. https://changingclimate.ca/health-in-a-changing-climate/

Energy Agency.[26] On a per capita basis Canada ranked second in carbon emissions only slightly behind Australia and slightly above the U.S. Given Canada's relatively small population compared with many other countries, its 670 Mt of GHG emissions in 2021 make it an outlier compared to many European countries whose per capita emissions are approximately half of Canada's despite similar per capita GDPs.



Source: IEA web site http://energyatlas.iea.org/#!/tellmap/1378539487

In response to the scientific evidence about climate change, in June 2019, Canada's Parliament declared a climate emergency.[27] It asserted that:

"…Canada is in a national climate emergency which requires, as a response, that Canada commit to meeting its national emissions target under the Paris Agreement and to making deeper reductions in line with the Agreement's objective of holding global warming below two degrees Celsius and pursuing efforts to keep global warming below 1.5 degrees Celsius."

In recognition of the seriousness of the crisis, the federal government has made significant international commitments on climate change. In the 2015 Paris Agreement it agreed to reduce GHG emissions by 30% by 2030 compared to 2005 and net zero emissions by 2050.[28] It significantly increased its commitment in the summer of 2021 in anticipation of the international Conference of the Parties (COP) 26 meeting in Glasgow. Canada is now

[26] International Energy Agency. (IEA). (2022). from web site. http://energyatlas.iea.org/#!/tellmap/1378539487. See also: BP Statistical Review of World Energy 2022. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf
[27] Canadian Broadcasting Corporation. (2019). House of Commons Declares a Climate Emergency Ahead of Pipeline Decision. June 18. https://www.cbc.ca/news/politics/climate-emergency-motion-1.5179802
[28] Canadian Institute for Climate Choices. (2021) Canada's Net Zero Future: Finding Our Way in the Global Transition. op. cit.

committed to GHG reductions of between 40% and 45% by 2030 compared to 2005 and net zero by 2050.[29] While not directly bound by international treaties, both provincial governments and many municipalities have also made comparable - or even stronger - commitments to lowering the GHG emissions within their jurisdictions.

Canada now has policies enacted by all levels of government to encourage – or require - changes that will lower energy use and GHG emissions. Much of this was anticipated in the Pan Canadian Framework on Clean Growth and Climate Change, which all but one of Canada's provinces endorsed when it was negotiated in 2016.[30] These policies include escalating carbon taxes on fossil fuels, GHG reduction targets for specific industries and economic sectors, climate conditions on government subsidies, increasingly tough building and energy codes, major educational initiatives and extensive subsidy programs, such as in the April 2023 federal budget, to incent more climate friendly behaviours.

In sum, the federal government and most provincial and municipal governments in Canada have recognized the seriousness of the climate crisis and have taken major steps to address its impacts. These steps are scheduled to achieve increasingly ambitious targets for reducing GHG emissions in the coming years – targets that impact the entire economy and which will bring about major changes in how Canadians work and live in the coming years. The construction industry is already being affected significantly by these changes.

Key Canadian Sources of Information on Climate Change

- Climate Change Canada. https://www.canada.ca/en/services/environment/weather/climatechange.html
- Canadian Institute for Climate Choices. https://climatechoices.ca/
- David Suzuki Foundation. https://davidsuzuki.org
- Environment and Climate Change Canada https://www.canada.ca/en/environment-climate-change.html
- National Research Council. https://www.nrcan.gc.ca
- Nature Conservancy of Canada. https://natureconservancy.ca

4.0 Impact of Climate Change on the Building Sector

[29] Environment and Natural Resources Canada web site. 2022. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview.html

[30] Canada. (2016). Pan-Canadian Framework on Clean Growth and Climate Change. https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

"The building sector is the sector with the most potential to reduce greenhouse gas emissions."[31]

Climate science provides us with the knowledge that the planet is heating and that temperature increases are having a profound and negative impact on our environment, threatening our very way of life if efforts to mitigate the change are not successful in the coming years. It also is the basis of the policies governments at all levels in Canada are implementing to mitigate, that is to reduce, emissions and to adapt to its adverse impacts. However, what is particularly important for this project is the relevance of the science to the construction industry, the buildings and infrastructure it produces and the workforce engaged in this process.

The impact of climate change on the building industry is complex and multi-faceted. Aside from its direct temperature and weather impacts, the most significant is its role as a driver of government policy change, in terms of commitments to reduce GHG emissions throughout the economy, invest in adaptation upgrades to make our buildings and infrastructure more resilient and, in shaping government policy towards the construction industry and its workforce. Policy is what is driving change. And policy is a response to the science.

As noted, the federal government has made significant international commitments. Canada's climate legislation reflects these commitments as well as the federal government's recognition, in response to the science, that Canada must put its house in order through a variety of policy, financial and legislative initiatives. Provinces and local governments have also taken parallel measures to varying degrees. Construction is now a key climate policy focus of all levels of government.

The principal reason climate change has become a growing factor shaping government policy in construction is that the productive activities of the sector and the buildings and infrastructure it produces have such a large carbon and energy footprint. This occurs both during construction and in the subsequent operational phase of the resulting structures. In its 2014 report on climate mitigation, the IPCC devoted a major chapter - Chapter 9 - specifically on the role of buildings and construction as contributors to global warming and hence a target for policy change.

"(B)uildings represent a critical piece of a low-carbon future and a global challenge for integration with sustainable development... Buildings embody the biggest unmet need for basic energy services…much existing energy use in buildings in developed countries is very wasteful and inefficient. Existing and future buildings will determine a large proportion of global energy demand. [32]

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31 United Nations Framework Convention on Climate Change (UNFCC), (2020). Climate Change News. Sept. 4.
https://unfccc.int/news/un-climate-change-meetings-highlight-cool-solutions-for-buildings

[32] IPCC. 2014. op. cit. p. 691.

In Canada, the building and construction sector is one of the three largest sources of energy use and GHG emissions, placing third after fossil fuel production and transportation. The sector includes 16 million residential and 482,00 commercial and public buildings. In 2020 construction work and the buildings it produces accounted for 88 Mt of Canada's total carbon emissions. Approximately 13% of Canada's emissions come from heating, air conditioning, and other building operation services normally based on burning fossil fuels. Another 5% are from GHGs generated in the production of electricity for use in buildings which is largely based on fossil fuels in some provinces, resulting in 18% coming from the construction sector.[33] The manufacture of and transport of building materials and other components of the construction process, as well as the disposal of construction waste and the decommissioning of buildings and infrastructure adds to the emissions total, which the Canadian Green Building Council estimates to be 28%.[34]

The size of the climate footprint of the building sector explains why governments at all levels now believe that it must be a central part of the solution to climate change.[35i36] And they have opened their policy toolkit to see that this happens. Policy is now the driving force for climate focused change in the industry. Its impact will grow significantly in the coming years as global temperatures continue to increase and the uncomfortable reality that despite past commitments, Canada's GHG emissions from the construction and building sector have not changed measurably over the past 20 years. Consequently, much more must now be done to make up for the lost time.[37]

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[33] Natural Resources Canada. (2022). The Canada Green Buildings Strategy. https://natural-resources.canada.ca/sites/nrcan/files/engagements/green-building-strategy/CGBS%20Discussion%20Paper%20-%20EN.pdf; Environment and Climate Change Canada. (2021). National Inventory Report 1990 – 2019 Greenhouse Gases Sources and Sinks in Canada. https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/ghg-emissions/2021/greenhouse-gas-emissions-en.pdf; p. 18; Canada Green Jobs Strategy. https://natural-resources.canada.ca/energy-efficiency/green-buildings/24572

[34] Canada Green Building Council. (2023). Submission to the Prebudget Consulation Finance Canada. CGBC Feb. 10. https://www.cagbc.org/news-resources/cagbc-news/2023-prebudget-submission/

[35] Senate of Canada. (2018). Report of the Standing Senate Committee on Energy, the Environment and Natural Resources. https://sencanada.ca/en/newsroom/enev-reducing-ghg-canada-buildings/ encanada.ca/content/sen/committee/421/ENEV/reports/ENEV_Buildings_FINAL_e.pdf https://sencanada.ca/en/newsroom/enev-reducing-ghg-canada-buildings/; Environment and Climate Change Canada. (2020) A Healthy Environment and a Health y Economy: Canada's Strengthened Climate Plan to Create Jobs and Support People, Communities and the planet. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html

The reason the share of emissions in buildings in Canada is considerably lower than in other developed countries is that Canada is a major producer and exporter of fossil fuels. In addition, Canada's geography and relatively low population density means that transportation is also a major user of fossil fuels. Absent these factors, the share of GHG emissions from buildings would, arguably, be broadly similar to that of other developed countries, that is in the range of 30% to 35% and likely on the higher end, given the heating demands of Canada's relatively cold climate.

[36] Estimates of GHG emissions and energy use vary considerably among various domestic and international organizations. For example, in its 2019 report on Canada, the IEA indicates that buildings contribute "about a quarter" of energy use, a figure considerably different from several of the estimates noted above in the paper. This reflects what is included or excluded from the estimates. Regardless, building energy use and GHG emissions constitute a major part of Canada's climate footprint.

[37] Ibid. p. 16.

An important consideration in assessing the climate impact of buildings and infrastructure is their relative permanence. Most of Canada's current building stock of residential, commercial and industrial buildings, as well as other infrastructure, will still be in place in 2050. As the IPCC notes, the long life of buildings means that they will continue to use energy and contribute to GHG emissions for many decades into the future. [38]

"Buildings and their energy supply infrastructure are some of the longest-lived components of the economy. Buildings constructed and retrofitted in the next few years to decades will determine emissions for many decades, without major opportunities for further change. Therefore, the sector is particularly prone to lock-in…[39]"

This explains the urgency behind government steps to reduce energy use in new buildings, while dramatically lowering its use in existing buildings through major retrofits.

Governments in Canada have adopted a mix of policy tools to reduce building emissions. These include more stringent building and energy codes, zoning and planning regulations, subsidies, tax breaks, research funding and support for public education programs. They have also used their own procurement of buildings to set an example of the standards they wish to implement. These measures have been informed by the knowledge, based on extensive research, that major reductions in emissions are both possible and reasonably affordable.[40] To cite the 2014 IPCC report again:

"…buildings offer immediately available, highly cost-effective opportunities to reduce (growth in) energy demand, while contributing to meeting other key sustainable development goals including poverty alleviation, energy security, and improved employment." [41]

Hence, the focus on buildings and infrastructure is not only because of their large climate footprint. It is because there is strong evidence that significant progress can be made in reducing the climate impact.[42] The IPCC's 2014 examination of the potential of buildings to meet climate objectives noted that between 50% and 90% of the improvements needed could be carried out using existing technologies if they were more widely applied. Moreover, this could be achieved at reasonable cost.[43]

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[38] IPCC 2014. op. cit.
[39] IPCC 2014. op. cit. p. 697.
[40] Intergovernmental Panel on Climate Change. (IPCC). (2014). Climate Change 2014: Mitigation of Climate Change: Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Ch. 9: Buildings; See also the information in the 2018 Senate of Canada Report op. cit.
[41] IPCC. (2014). op. cit.; Bernhardt, Rob. (2021) Addressing the Cost of Efficiency. https://energystepcode.ca/app/uploads/sites/257/2021/05/Cost-of-Efficiency-Report-2021-final.pdf;
[42] Urge-Vorsatz, Diana, Radhika Khosla, Rob Bernhardt et. al. (2020). Advances to a Net-Zero Global Building Sector. Annual Review of Environment and Resources. https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-012420-045843. This paper reviews the costs of a large number of low carbon projects compared with conventional practice and concludes that the differences documented are largely marginal.
[43] IPCC (2014). op cit.

Chapter 9 of the 2022 IPCC Report Mitigation of Climate Change also deals with buildings and reaches broadly similar conclusions, adding new evidence to the 2014 IPCC analysis. It notes that major reductions in building energy use are feasible and affordable both for new buildings and those being retrofitted. In addition, these measures have significant co-benefits. They make buildings and infrastructure healthier, more comfortable, and safer for occupants while reducing adverse impacts on the environment.[44]

The feasibility of major cost-effective energy savings in Canadian buildings has been asserted by one of the most well-known researchers in the field, Rob Bernhardt, formerly head of Passive House Canada in his review of our energy reduction options:

"Buildings, especially their heating and cooling, are among the few areas of energy use where a several-fold decrease in emissions and energy consumption is possible while maintaining or improving the level of energy services provided. As this end use comprises an important share of global energy demand, low-energy buildings are key to a climate-neutral future."[45]

A 2021 study by the Canadian Institute for Climate Choices maintains that we do not need to wait for new technological advances to move to net zero by 2050. It argues that this can be accomplished with existing technologies at reasonable cost.

"Our analysis finds that Canada's built environment could reach net zero emissions by relying only on technologies and measures that are commercially available today. While a significant portion of these solutions would still need to clear major hurdles on the path to widespread adoption, many of these could be overcome with sufficiently stringent and coordinated government policies. We find that Canada's buildings sector could reach net zero without relying on negative emissions or technologies still in early-stage development."
[46]

The energy and GHG emissions from heating, cooling and providing the energy for building services are a major contributor to Canada's climate footprint. These operational life cycle emissions are increasingly being included as an essential part of assessing the success of net zero construction projects. It is still common commissioning practice for developers to base their building purchase decisions on the option with the lowest capital cost of construction.

However, relying solely on the up-front costs of construction for procurement decisions provides a misleading perspective on the true climate and energy costs of building options.

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[44] IPCC. (2022). Climate Change 2022: Mitigation of Climate Change. Working Group III Contribution to the Sixth Assessment Report. Chapter 9: Buildings. Climate Change 2022: Mitigation of Climate Change (ipcc.ch); ASHRAE Multidisciplinary Task Force. (2020). Damp Buildings, Human Health and HVAC Design. https://www.ashrae.org/file%20library/technical%20resources/bookstore/dampbldgs-humanhealth-hvacdesign.pdf

[45] Urge-Vorsatz et. al. op. cit.

[46] Canadian Institute for Climate Choices. (2021). Canada's Net Zero Future. https://climateinstitute.ca/reports/canadas-net-zero-future/

When life cycle operational expenditures are fully tabulated, many net zero projects are not significantly more expensive than conventional projects and a surprising number are considerably cheaper. A Canada Green Building Council Study found that 17 out of 50 types of office buildings of various ages already had a positive net present value for deep retrofits. And as governments increase the price of carbon over time by raising carbon taxes, operational costs increase significantly further advantaging deep retrofits.[47] Incorporating this insight means that there will be more jobs for the construction workforce because it reduces one of the major financial barriers to accelerating the pace of climate focused building work,

A commitment to lowering energy use and GHG emissions in buildings was a key component of Canada's 2015 Paris Agreement and the subsequent federal-provincial Pan-Canadian Framework on Climate Change. Since then, there has been a veritable snowstorm of policies and legislation at all levels of government to mitigate or adapt to climate change.

To give itself a major tool to implement its ambitious agenda, the federal government passed the Canadian Net-Zero Emissions Accountability Act in June 2021. This Act provides the Government with the legal framework for implementing significant additional climate commitments beyond Paris.[48] Among other objectives, the Government expects the building and construction sector to make a major contribution to its overall climate change objectives of lowering GHG emissions by 40 to 45% by 2030 and net zero by 2050, an extremely ambitious target. In the construction sector the goal is a 37% reduction in GHGs by 2030 from the 2005 average. [49]

The federal government explicitly states that much of its agenda will be policy driven. This will occur by implementing more stringent regulations and, particularly, tougher building and energy codes. It views tougher codes as key policy tools in reducing the GHG emissions and energy consumed in buildings and infrastructure projects.[50]

Under the Constitution, the regulation of buildings and infrastructure falls largely within the jurisdiction of the provinces as it is considered a matter of local concern. However, the

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[47] Canada Green Building Council. (2021). Decarbonizing Canada's Large Buildings: Summary Report. Ottawa. https://portal.cagbc.org/cagbcdocs/advocacy/2021_CaGBC_Decarbonization-Retrofit-Costing-Study_2DEC21_EN.pdf

[48] Canada. (2021). An Act respecting transparency and accountability in Canada's efforts to achieve net-zero greenhouse gas emissions by the year 2050 https://www.parl.ca/LegisInfo/en/bill/43-2/C-12 (referred to as the Canadian Net-Zero Emissions Accountability Act).

[49] Office of the Prime Minister (2021) Mandate Letter to Minister Guilbeault, Minister of the Environment. Dec. 16. https://pm.gc.ca/en/mandate-letters/2021/12/16/minister-environment-and-climate-change-mandate-letter See also the advice to the Minister by the advisory body: Net Zero Advisory Body. (2023). Advice for Canada's 2030 Emissions Reduction Plan. Ottawa. https://nzab2050.ca/publications/news_feed/submission-for-canada-s-2030-emissions-reduction-plan

[50] Canada has a number of different codes that regulate the building process. These include: the National Building Code, National Energy Code for Buildings, National Plumbing Code, Canadian National Electrical Code National Fire Code and the National Farm Building Code. However, there are many others, such as the, the Highway Bridge Design Code that regulate specific aspects of Canada's buildings and infrastructure. There is a good summary of the codes on the National Research Council's Codes Canada web site: https://nrc.canada.ca/en/certifications-evaluations-standards/codes-canada/codes-development-process/how-national-codes-are-developed

federal government plays a key role in this process by developing the national model building, energy, fire and other regulatory codes. These, in turn, form the basis of the codes adopted by provinces to regulate their building industries. The development of the codes was originally based on concerns about public safety such as ensuring the structural integrity of buildings and minimizing the risk of fire and electrical hazards. But they are now emerging as central policy tools in meeting Canada's climate objectives.

In the December 2021 Mandate Letter to the new Minister of the Environment, the Prime Minister signalled that he expects significant revisions to the 2024 building and energy codes to comply with his climate change agenda. [51] This is to include establishing criteria for defining net zero emission buildings, clarifying the role of energy efficiency in building regulations and developing new measures to assess and report embedded carbon. The federal government believes it should exercise leadership by implementing higher standards in the buildings it occupies. To do so it has adopted a net zero target for new public buildings by 2027 and all new buildings by 2030. As it noted in its Canada 2030 Emissions Reduction Plan:

"Strong building codes set the baseline for building performance and lock in best practices in construction. The Government of Canada actively works with industry as well as provincial and territorial governments on the development of increasingly stringent, performance-based model building codes, including to introduce net-zero energy-ready model codes for new construction and the code for retrofits to existing buildings. Wide-scale adoption of these codes will go a long way to improving the performance of Canada's building stock." [52]

The Minister's Advisory Committee is also recommending accelerating the timing of revisions to the national codes, while ensuring that the revised codes sunset the use of fossil fuels in new buildings and require all federal building procurement to include net zero requirements.

Comparable policies are already being adopted in various U.S. cities and states. Some have gone much further, by passing bills that have established timelines for banning outright the use of gas for heating and other uses in existing residential and commercial buildings.[53]

To facilitate the shift to a net zero economy, in February 2023 the federal government introduced the Sustainable Jobs Plan for 2023 – 2025. It built on the work of its earlier Task

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[51] Haley, Brendan. (2021). Federal Mandate Letters Signal Changes to building Codes, Deep Retrofits and Electric Vehicles. Efficiency Canada. December. 17. https://www.efficiencycanada.org/federal-mandate-letters/

[52] Canada. (2022). Canada's 2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Stronger Economy Environment and Climate Change Canada. Gatineau. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030/plan/chapter-2.html#toc5. See also the Natural Resources Canada discussion on future building code proposals at: NetZero: future building standards (nrcan.gc.ca)

[53] Net Zero Advisory Body, op. cit. Also: Phillips, Anna. (2023). New York Set to Pass First Statewide Law Banning Gas in New Construction. Washington Post. April 28. https://www.washingtonpost.com/climate-environment/2023/04/27/new-york-natural-gas-ban/

Force for Canadian Coal Power Workers and Communities as well as a report from the Commissioner of Environment and Sustainable Development on ways to implement the transition to a low carbon economy. In June 2023 it introduced the Canadian Sustainable Jobs Act. This Act has been designed to provide a framework and guiding principles for its climate actions in the following years. According to its press release, the Act will:

"Facilitate and promote the creation of sustainable jobs and support workers and communities in Canada in line as the world advances toward a net-zero future." and "put workers and communities at the center of federal policy and decision-making by establishing a framework for accountability, a governance structure and engagement mechanisms to guide effective federal action." [54]

The Act creates a Sustainable Jobs Partnership Council to provide recommendations to the Government and a Sustainable Jobs Action Plan to be renewed every five years. The initial Action Plan contains a 10-point list of measures, including establishing a Sustainable Jobs Secretariat and a Sustainable Jobs Partnership Council, as well as a number of specific initiatives on labour and skills development issues.

Across Canada most provincial and territorial governments have also adopted aggressive climate policy measures with net zero by 2050 being a widely agreed goal. Having signed on to the 2016 Pan Canadian Framework, provinces have developed their own climate plans which include aggressive targets and provisions for implementing these practices in their building and construction sectors.[55] There are variations, with provinces such as Alberta and Saskatchewan, being reluctant to endorse the federal government's full climate agenda. But the long-term trend towards incorporating climate objectives at the provincial level remains clear, with provinces such as BC leading the way.[56]

Canadian cities, including Vancouver, Montreal, Guelph, Hamilton, Toronto, Halifax and many others have adopted ambitious climate plans, some having shorter timelines than those adopted by the federal government.[57] Municipalities are using their building codes, zoning

[54] Canada. (2023). Canadian Sustainable Jobs Act. https://www.canada.ca/en/natural-resources-canada/news/2023/06/backgrounder-canadian-sustainable-jobs-act.html
[55] Canada. (2016). Pan-Canadian Framework on Clean Growth and Climate Change. https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html
[56] British Columbia. (2019). Lessons from the BC Energy Step Code: How British Columbia Became the First North American Jurisdiction to Create a Regulated Pathway to Net-Zero Energy-Ready Buildings. Victoria: June. bcenergystepcode_lessons_learned_final.pdf (gov.bc.ca)
[57] Toronto. (2021). Transform TO to Net Zero Strategy: A Climate Action Pathway to 2030 and Beyond. November. https://www.toronto.ca/legdocs/mmis/2021/ie/bgrd/backgroundfile-173758.pdf ; Toronto. (2021). Net Zero Buildings Strategy: Report for Action. Deputy City Manager, Corporate Services. June 18. Net Zero Existing Buildings Strategy (toronto.ca); Vancouver. (2020). Climate Emergency Action Plan. October 22. https://council.vancouver.ca/20201103/documents/p1.pdf. Guelph. (2021). Energy and Climate Change Plan. https://guelph.ca/living/environment/energy/; Halifax. (2021). HaliFACT: Acting on Climate Together. https://www.halifax.ca/about-halifax/energy-environment/halifact-2050-acting-climate-together; Hamilton. (2021) Climate Science Report for the City of Hamilton. https://engage.hamilton.ca/climate-change-adaptation. Montreal (2021) Montreal Climate Plan: Objective Carbon Neutral by 2050. https://montreal.ca/en/articles/montreal-climate-plan-objective-carbon-neutral-2050-7613. Vancouver. (2022).

regulations, recycling requirements, waste management regulations and other policy tools to push the industry to comply with their climate goals. For example, Vancouver's Annual Greenhouse Gas and Energy Limits Bylaw No. 13472 requires existing large building owners to cut emissions by 50% by 2030 and 100% by 2050. They will also have to submit very detailed annual energy and carbon reports starting in 2024.[58] This reflects the fact that 55% of the city's carbon emissions come from buildings. Vancouver has developed new workforce training programs to enable the trades to meet its new municipal building regulations such as the package of courses now offered by the British Columbia Institute of Technology (BCIT) specifically for meeting Vancouver's new step code requirements.[59]

While much media attention focuses on what can be done to make new construction achieve aggressive low energy targets, governments recognize that an even larger challenge is how to refurbish the many millions of existing buildings in the coming years to meet Canada's climate targets. Over 80% of building operational emissions are from space and water heating powered by fossil fuels.[60] Current buildings will still account for four fifths of the building stock in 2030 underscoring how incredibly ambitious the federal government's target of a 40% to 45% reduction in GHGs by this date. The Pembina Institute estimates that to meet its climate targets Canada will have to retrofit 600,000 buildings and 30 million square metres of commercial facilities by 2040. If carried out, this would create an estimated 200,000 new and ongoing construction jobs. [61].[62]

Initial government policies focused primarily on mitigating the energy use and GHG emissions directly used in the construction process and in the ongoing operation of buildings for heating, air conditioning, lighting, electronics and other internal services. However, in recent years the focus has expanded to include the embodied carbon found in the extraction and processing of raw materials and the manufacturing activities used in the building process.[63] Measuring the carbon and energy consumed by buildings now encompass a whole life cycle approach. This uses a life cycle inventory (LCI) approach to measurement.[64] It takes account of the carbon produced in all the inputs to the construction process. This

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Annual Greenhouse Gas and Energy Limits By-Law No. 13472.
https://bylaws.vancouver.ca/consolidated/13472.PDF

[58] Vancouver (2022) op. cit.

[59] See, for example: https://www.bcit.ca/courses/vancouver-building-by-law-bldg-1845/

[60] Canada's 2030 Emissions Reduction Plan. op. cit. p. 32.

[61] Pembina Institute and Green Budget Coalition. (2022). Recommendations for Budget 2023. (ch. 2: Canada's Renovation Wave: A Plan for Jobs and Climate) https://www.pembina.org/reports/green-budget-coalitions-recommendations-for-budget-2023.pdf

[62] At the time of writing, it is hard to see how the construction sector will be able to reduce emissions from buildings by 40% - 45% in the next 7 years, but the target provides a powerful reason for governments to focus increasing attention on the issue in the near future.

[63] Rock, Martin, Marcella Saade et. al. (2020). Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. Applied Energy. Vol. 258 ; Urge-Vorsatz et. al. (2020) op. cit; Saade, Marclla, Martin Rock et. al. (2018). Strategies to Improve the Energy Performance of Buildings: A Review of their Life Cycle Impact. Buildings. Vol.8 Issue 8, August.

[64] World Building Council. (WBC). (2019). Bringing Embodied Carbon Upfront: Coordinated Action for the Building and Construction Sector to Tackle Embodied Carbon, London.
file:///J:/1%201%20Skillplan%20Proposal%20Dec%2019%202022/Canada%20Green%20Building%20Council/WorldGBC_Bringing_Embodied_Carbon_Upfront%20(1).pdf

includes the input of raw materials, the manufacturing of building materials, the transportation to and from building sites, the use of equipment during construction, the operational use of energy during a project's lifetime and the carbon lost (or saved) in the decommissioning process.[65] Reducing embodied carbon – decarbonization - is increasingly part of the strategy for reducing the GHG impacts of construction.[66] In the words of Pomponi et. al.:

"Embodied energy and CO2e emissions are the hidden, "behind-the-scenes" energy and emissions that are used or generated during the extraction and production of raw materials, the manufacture of the building components, the construction and deconstruction of the building, and the transportation between each phase."[67]

As building and energy regulations gradually reduce the use of fossil fuels in heating and air conditioning, embodied carbon will become, proportionately, a much larger target of public climate policies.

For example, the City of Vancouver now assumes that in the future over half of the emissions from new buildings will be from embodied carbon, as opposed to lifetime operational emissions from burning fossil fuels.[68] In addition, carbon generated in the production of building materials happens today, while operational GHGs occur over the life of buildings and will likely decline in future as buildings become more energy efficient due to tighter regulations providing a reason for focusing more attention on this issue. The need to reduce embodied carbon is increasingly being reflected in building and energy code proposals that anticipate what will be needed in the future to achieve net zero carbon buildings.

To accelerate their push to decarbonize the building process and reduce energy consumption governments are actively considering bringing in new measurement tools, such as energy performance certificates. These will provide contractors, owners, renters and prospective purchasers with the carbon and energy profile of buildings. Comparable regulations have been in place in the EU for over a decade. Subsidies for building fabric insulation, ground and air source heat pumps and solar PV facilities are also part of the growing list of government measures designed to reduce emissions and energy use. The Canada Greener

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[65] UN Environmental Program. (2020). Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low Carbon Future. Nairobi. https://wedocs.unep.org/bitstream/handle/20.500.11822/34351/RECCR.pdf?sequence=1&isAllowed=y. Magwood, Chris. (2019) Opportunities for Carbon Dioxide Removal and Storage in Building Materials. MA Thesis. Peterborough, Ont. Trent University

[66] ASHRAE. (2022). Position Document on Building Decarbonization. June 26, 2022. https://www.ashrae.org/about/position-documents; The European Commission has addressed this by adopting a Life Cycle Assessment approach which attempts to measure the overall impact of buildings, including the energy and GHG emissions associated with the various manufacturing and related inputs to the building process as well as the effects associated with decommissioning.

[67] Pomponi et. al. (2021). Decoupling density from tallness in analysing the life cycle greenhouse gas emissions of cities. Urban Sustainability Article No. 33. https://doi.org/10.1038/s42949-021-00034-w

[68] Caradonna, Jeremy. (2021). BCIT Centre for Ecocities: Exploring Buildings' Embedded Emissions. Feb 23. https://www.bcit.ca/files/centre-for-ecocities/embodied-emissions-webinar-slides-022321.pdf

Homes Grant and its provincial and municipal counterparts reflect this development and require measuring the energy consumption of homes as a condition of receiving the grants.[69] These initiatives have been accompanied by new energy auditor training and certification programs.

Canada's international commitments and domestic legislation have focused significantly on mitigating climate change by reducing GHG emissions and energy use. However, as the impact of global warming has become increasingly clear, the issue of adaptation in addition to mitigation has moved to the forefront of government policy agendas. As noted earlier, one of the consequences of rising temperatures is their impact on our built environment. Climate scientists are projecting that further increases in surface temperatures will result in much greater damage in the coming years. We will see more – and more intense – temperature fluctuations, hurricanes, heat waves, atmospheric rivers, virulent storms, floods, fires, droughts, melting permafrost and other damaging events.[70] As a recent report from Environment and Climate Change Canada noted in relation to the threat to the built environment:

"The threat includes the possibility of increases in the frequency and intensity of certain extreme weather events, such as rainstorms and flooding, and other hazards that could result in infrastructure damage and failure. There are limitations in the current approaches used for the design and rehabilitation of Canada's buildings and core public infrastructure (B&CPI) as they are based on historical climatic loads. These loads may not be representative of those that could be experienced in a future, warmer, climate. Failure to account for changes in climatic loads could therefore lead to more frequent early failure of elements of Canada's B&CPI. The consequences of infrastructure failures can be quite significant, including fatalities, injuries, and illnesses, disruption or loss of service, increased costs to infrastructure owners, unforeseen costs to infrastructure users, and considerable negative socioeconomic impacts to the municipal, provincial/territorial and federal governments"[71]

Unfortunately, much of our existing infrastructure was not designed to deal with the additional stresses that climate-initiated events are placing on our buildings, roads, bridges, power lines, dams, water treatment plants, sewer systems and many other components of our

[69] See the Natural Resources Canada web site for details of the federal program. https://www.nrcan.gc.ca/energy-efficiency/homes/canada-greener-homes-initiative/canada-greener-homes-grant/canada-greener-homes-grant/23441.

[70] Council of Canadian Academies. (2018). Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential. Ottawa. https://www.cca-reports.ca/reports/prioritizing-climate-change-risks/

[71] Environment and Climate Change Canada. (2020). Climate Resilient Buildings and Core Public Infrastructure https://publications.gc.ca/collections/collection_2021/eccc/En4-415-2020-eng.pdf; IPCC (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Summary for Policy Makers. Contribution of Working Group II to the Sixth Assessment Report of the IPCC1. https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

built environment.[72] Consequently, governments are enacting a range of new policies designed to make buildings and infrastructure more resilient. These policies recognize that building standards that worked well before the impact of climate change are no longer fit for purpose.[73]

Research presented in the extensive federal government's 2021 study, Canada in a Changing Climate: National Issues Report, indicates that many adaptation investments are usually cost effective over the long term, particularly considering the costs of failing to make them, leaving buildings and infrastructure exposed to major hazards. A recent review of the benefit cost ratio (BCR) of 60 interventions concluded that 75% provided more benefits than costs, in some cases outweighing costs by as much as $5.60 for every dollar spent on adaptation. [74] Hoicka and Das in a recent paper on retrofits in Canada argue that the potential energy savings from a comprehensive retrofit program have been largely underestimated. In their words:

"Our viewpoint argues that climate response strategies in Canada have underemphasized and underestimated the potential contribution deep energy retrofits can make to greenhouse gas (GHG) emissions reductions, leading to inadequate responses in the building sector, and that Canada can (and should) be ambitious with building retrofits over the next decade. GHG savings from building retrofits can be realized more quickly than GHG reductions from other sectors, and either deliver net cost savings or are cost-effective when compared to other mitigation measures. Retrofits can also provide social and economic benefits, such as improved health and comfort, and lower energy costs." [75]

In June 2023, the federal government announced a National Climate Adaptation Strategy in which it outlines both the impacts of climate change on Canada's economy and society and the measures the Government is implementing to address these impacts. [76]

The growing intensity and destructiveness of climate induced weather events has impacted Canada's insurance industry. Costs for compensating building owners and construction firms

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[72] Task Force for a Resilient Recovery (2020) Bridge to the future: Final Report for the Task Force for a Resilent Recovery. September. https://www.recoverytaskforce.ca/wp-content/uploads/2020/09/TFRR-Final-Report_EN.pdf

[73] Baum, Kathryn Blaze and Tu Thanh Ha. (2023) Why Your Home Isn't Built to Last Against Extreme Weather. The Globe and Mail. January 27. https://www.theglobeandmail.com/canada/article-houses-extreme-weather-building-codes/ ;

[74] Canada. (2021). Canada in a Changing Climate: National Issues Report. ed. Warren, F. and Lulham N. Ottawa: National Resource Canada. https://www.nrcan.gc.ca/maps-tools-and-publications/publications/climate-change-publications/canada-changing-climate-reports/canada-changing-climate-national-issues/21097. pp. 418, 419.

[75] Hoicka, C.E., Das, R. (2020) Deep energy retrofits of buildings to accelerate the 1.5°C energy transition in Canada. Technical Paper. The Canadian Geographer. Vol. 65, No1. Ambitious deep energy retrofits of buildings to accelerate the 1.5°C energy transition in Canada (wiley.com)

[76] Canada. (2023) Canada's National Adaptation Strategy: Building Resilient Communities and a Strong Economy. E nvironment and Climate Change Canada. June. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html

for adverse weather events have increased dramatically in recent years. Insurance premiums have risen accordingly. Insurers are now much more careful about providing policies for buildings or infrastructure that is vulnerable to major climate events, leaving many developers and building owners with limited options for obtaining property insurance.[77]

Inability to purchase insurance has correspondingly negative impacts on the asset value of the properties affected. Canada has not yet faced the U.S. experience where firms such as Allstate and State Farm have simply stopped selling some types of property insurance in states such as California.[78] However, as the country faces increasingly violent weather events, the Canadian construction industry will face substantially increased insurance premiums and an increasing number of firms will face greater difficulty in obtaining insurance for their building projects.

The need to adapt our infrastructure to the anticipated increase in damaging weather events is impacting the construction industry in a variety of other ways as well. Much of the infrastructure of our built environment is being re-assessed to determine how it can best stand up to the additional strains associated with more extreme weather. Building codes are being modified - arguably not fast enough - to make buildings more resilient and capable of dealing with higher temperatures, storms, floods and many other weather events. Municipal zoning is being modified to limit the construction of buildings and infrastructure in vulnerable locations. Standards for transit systems, roads, water and sewer systems and other parts of our infrastructure are being upgraded. Workplace health and safety protocols are being modified to reflect the changing work environment climate change is producing. All these changes are impacting the way construction is being carried out, resulting in changes to the work the trades perform.

Critics argue, with considerable justification, that government policy changes are still far too slow in coming, given the urgency of responding to the climate crisis. But tougher regulations to strengthen our infrastructure and make buildings more resilient and safer from extreme weather events are now firmly on the policy agenda.[79] While the growing government focus on adaptation differs from mitigation, the effect is to add to the total impact that climate change is now having on our built environment, the construction industry and its workforce. Governments are also now trying to ensure that their adaptation policies are consistent with their mitigation objectives adding to the complexity of determining how best to respond to the changes resulting from climate change.

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[77] Wagner, Katherine. (2022) Designing Insurance for Climate Change. University of British Columbia Paper. September. https://www.krhwagner.com/papers/ClimateChangeInsurance.pdf

[78] Federal Insurance Office, U.S. Department of the Treasury. (2023) Insurance Supervision and Regulation of Climate-Related Risks. June. https://www.washingtonpost.com/documents/93a8fb9c-74a8-40ae-88f8-db64790ee250.pdf?itid=lk_inline_manual_12.; Joselow, Maxine. (2023). Climate Change is Fueling an Insurance Crisis. There is no Easy Fix. The Washington Post. June 27. https://www.washingtonpost.com/politics/2023/06/27/climate-change-is-fueling-an-insurance-crisis-there-no-easy-fix/

[79] Haley and Torey (2021); Canada Green Building Council. (2023). Submission to the Prebudget Consulation Finance Canada. CGBC Feb. 10. https://www.cagbc.org/news-resources/cagbc-news/2023-prebudget-submission/.

The need to adapt our built environment to the increasing demands created by climate change will also mean much more work for the building trades in the coming years. Both governments and the private sector will be forced to make significant new investments to cope with climate induced demands. But it will also mean that the performance standards required of the workforce will increase as well, underscoring the need for additional technical and climate focused training to ensure that the trades have the capacity to meet the new demands associated with constructing, or up upgrading, resilient buildings and infrastructure.

5.0 Health and Climate Change

One of the most significant impacts of climate change is its effects on the health of Canadians. The CBTU application for this project noted that climate change was exacerbating a variety of specific health issues in the construction sector, affecting those who live and work in buildings as well as the workers who construct and repair them. The adverse health impacts of climate change have been extensively researched in recent years, both internationally, and in Canada. [80] [81]

Internationally, they have been documented in recent IPCC reports and in medical journals such as the New England Journal of Medicine, the British Medical Journal and the Lancet. The latter has devoted major segments of its publication to this issue over the past three years. [82] Domestically, the Canadian Association of Physicians for the Environment has been increasingly concerned about the adverse health impacts of climate change and,

[80] Health Canada. (2022). Health of Canadians in a Changing Environment: Advancing Our Knowledge for Action. Ottawa. op. cit.; IPCC. (2022). Climate Change 2022: Mitigation of Climate Change. Working Group III Contribution to the Sixth Assessment Report. Climate Change 2022: Mitigation of Climate Change (ipcc.ch). See esp. ch. 9; Lancet. (2020). The 2020 Report of the Lancet Countdown on Health and Climate Change: Responding to Converging Crises. The Lancet Countdown on health and climate change; Lancet. (2022) The 2022 Europe Report of the Lancet Countdown on Health and Climate Change: Towards a Climate Resilient Future. The 2022 Europe report of the Lancet Countdown on health and climate change: towards a climate resilient future; Lancet. (2022) The 2022 Report of the Lancet Countdown on Health and Climate Change: Health at the Mercy of Fossil Fuels. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels

[81] United States Global Research Program (USGCRP). (2016). The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins. U.S. Global Change Research Program, Washington, DC. https://health2016.globalchange.gov/

[82] IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Summary for Policy Makers. Contribution of Working Group II to the Sixth Assessment Report of the IPCC1. op. cit; Lancet. (2020). The 2020 Report of the Lancet Countdown on Health and Climate Change: Responding to Converging Crises. The Lancet Countdown on health and climate change; Lancet. (2022). The 2022 Report of the Lancet Countdown on Health and Climate Change: Health at the Mercy of Fossil Fuels. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels; See also, for example, United States Global Research Program. (2016). The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. https://health2016.globalchange.gov/downloads And, see the extensive discussion on the web site of the U.S. National Institute for Occupational Health and Safety. https://www.cdc.gov/niosh/topics/climate/how.html

consequently, has become a strong advocate for action to address these impacts, raising the alarm that the consequences are far greater than widely acknowledged.[83]

Perhaps the most comprehensive domestic study is the 2022 report prepared for Health Canada entitled "Health of Canadians in a Changing Climate".[84] Its ten chapters cover a wide range of health impacts in considerable depth, including the "complex pathways through which climate change affects health and the key health risks facing Canadians" (p. 9). Its comprehensive health survey looks at impacts on indigenous people, the effects of natural hazards (fires, floods, heatwaves etc.) mental health issues, effects of air pollution, water contamination and the spread of infectious diseases. It also discusses the how climate change is affecting health equity and, in particular, how vulnerable communities are disproportionately affected, both because they lack resources to protect themselves from its negative impacts and because their living and working conditions are already poor.[85]

The increase in weather events such as hurricanes, atmospheric rivers, violent storms, flooding, forest fires, heat waves and droughts directly threatens the safety and health of many Canadians. Wildfires produce toxic smoke while floods are often accompanied by major pollution as overflowing sewage systems. The warming climate has facilitated the northward expansion of a variety of insect species that bring with them new diseases.

That buildings and infrastructure have safety and health impacts is, of course not new. The impacts have been well-known for millennia. Historically, governments implemented building and fire codes to protect the safety of those living and working in buildings, including construction workers (although often not nearly as effectively as they should have). Building codes and municipal health regulations have addressed issues such as electrical safety, gas safety, structural integrity, sanitation, and other hazards. The health consequences of dampness, mould, poor air circulation, toxic chemicals, inadequate heating and many other effects on building occupants is well established in the medical literature.[86]

As the BC 'leaky condo' experience demonstrated decades ago, poorly built condominiums can have a major adverse impact on the health of those unfortunate enough to live in them, as the Barrett enquiry revealed.[87] Badly installed - or missing – insulation, single pane windows,

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[83] See, the web site of the Canadian Association of Physicians for the Environment for various papers on the issue. https://cape.ca/

[84] Berry, P., & Schnitter, R. (Eds.). (2022). Health of Canadians in a Changing Climate: Advancing our Knowledge for Action. Ottawa, ON: Government of Canada. https://changingclimate.ca/health-in-a-changing-climate/. p. 9.

[85] Ibid., p. 10.

[86] United States Global Research Program. (2016). The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. https://health2016.globalchange.gov/downloads

[87] Barrett, D. (1998). Commission of Inquiry into the Quality of Condominium Construction in British Columbia." (Barrett Commission). Victoria, BC. June. http://www.qp.gov.bc.ca/condo/; Barrett, D. (2000). The renewal of trust in residential construction part II: commission of inquiry into the quality of condominium construction in British Columbia. Submitted to The Lieutenant-Governor in Council Government of British Columbia. Victoria, BC. http://www.qp.gov.bc.ca/condo/c1_ii.htm. That this is important was underscored by one of the early experiences associated with lowering the energy use in buildings: the negative experience of sealing the building envelope to minimize energy losses without considering the need for proper air circulation,

gaps in window and door enclosures and other sources of drafts can make it impossible to control indoor temperatures and humidity effectively.[88] Improperly installed furnaces and gas appliances can release carbon monoxide and other noxious chemicals. Poor construction materials can threaten occupant health from off-gassing from formaldehyde or other volatile organic compounds (VOCs).[89] Lack of attention to the hazards of asbestos during renovations can expose occupants to this cancer-causing mineral. Failure to realize the health risks of radon gas means occupants can be subject to yet another cancer risk.

The adverse health impact of poor indoor air quality (IAQ) is substantial and well documented. According to one study, people now spend and average of 87% of their time indoors. [90] Contaminated air is a major issue in hospitals, clinics and nursing homes where people are particularly vulnerable to its hazards.[91] But clean air is necessary in all the buildings in which people live and work. The absence of good air filtration and ventilation has been highlighted by the experience of Covid-19 when unfiltered air recirculating in buildings facilitated the spread of the pandemic.[92] [93] This remains an enormous health issue and one that governments have failed to address satisfactorily.

The health impacts of climate change on buildings also have important equity dimensions. The brunt of poorly constructed and maintained buildings falls disproportionately on vulnerable populations, including Indigenous people, those on low-income, immigrants and racialized minorities. People in these categories are far more likely to live or work in buildings that have the health and safety hazards noted above. They also have far less

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humidity and temperature control. The result was the 'sick building syndrome' as contaminated air negatively affected the health of building occupants.

[88] American Council for an Energy Efficient Economy. (2019). Protecting the Health of Vulnerable Populations with In-Home Energy Efficiency. https://www.aceee.org/research-report/h1901

[89] Yang, Shen, Vencent Perret et. al. (2020). Volatile Organic Compounds in 169 Energy Efficient Dwellings in Switzerland. Indoor Air. Vol 30, No. 3, pp. 481 – 491. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7231238/

[90] Babich, F.; Demanega, I. et. al. (2020) A. Low Polluting Building Materials and Ventilation for Good Air Quality in Residential Buildings: A Cost–Benefit Study. Atmosphere. Vol. 11. https://www.mdpi.com/2073-4433/11/1/102

[91] See the extensive research on the web site of the U.S. Environmental Protection Agency. https://www.epa.gov/indoor-air-quality-iaq?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=

[92] Ghaffarianhoseini, Amirhosein, Husam Al Waer et. al. (2018). Sick Building Syndrome: Are We Doing Enough?. Architectural Science Review and University of Dundee. https://discovery.dundee.ac.uk/ws/files/27071877/Author_Accepted_Manuscript.pdf; Tufecki, Zeynep. (2020). We Need to Talk About Ventilation. (2020). The Atlantic Magazine. July 30; Wang, Mengmeng, Lili Li, et. al. Building and Health: Mapping the Knowledge Development of Sick Building Syndrome. (2022). Buildings. Vol. 12, No. 3. https://www.mdpi.com/2075-5309/12/3/287

[93] It is true that some early efforts to reduce energy consumption in buildings resulted in sealing the building envelope, reducing ventilation from fresh air from outside. This also permitted various toxic chemicals and organic hazards to concentrate in the air circulating within buildings, resulting in a term the WHO coined in 1986: 'sick building syndrome.' For the last four decades its impact has been extensively researched and the adverse consequences on building occupants well documented. More recent an alysis has recognized that a tightly sealed building envelope must be accompanied by a ventilation system that ensures a satisfactory flow of uncontaminated fresh air to protect the health of building occupants. Proper ventilation is now considered in the design of low energy buildings. But knowledge of this is important for those designing and building net zero buildings and particularly those installing ventilation equipment to ensure that it minimizes adverse health consequences.

capacity to ameliorate these conditions. Similarly, temporary foreign workers employed on farms are increasingly exposed to excessive heat in cultivating and harvesting crops. They face major barriers to improving their working conditions due to their precarious status in Canada.

During BC's 2021 'heat dome,' temperatures in the poorer areas of downtown Vancouver were much higher than in more affluent areas on the West Side of the city. High indoor temperatures were believed to be responsible for many of the deaths as elderly, disabled and otherwise vulnerable people without air conditioning, living in small, over crowed apartments or rooming houses were unable to escape from the lethal heat.[94]

Poor construction and maintenance of buildings adversely affect the social determinants of health in other ways.[95] Vulnerable populations are more often located in high-risk areas subject to flooding, storm damage, heat islands in cities and other risky locations. They lack financial and other resources necessary to renovate, or upgrade, buildings to heat, or cool, them properly. Most renters have little capacity to make their apartments, or other rental properties, more energy efficient or resilient because they do not own them and normally have no guarantee that they will continue to live in them, a significant deterrent to investing their own money in upgrades.

The shift to higher standards of construction, a fundamental prerequisite of net zero building practice, thus has important health benefits for building occupants. It also has the added advantage of addressing some of the economic disparities associated with poor housing such as excessive heating bills. The increased sensitivity to ecological and environmental concerns, which is increasingly a part of low carbon construction practice, encourages the building industry and its workforce to take account of the potential of buildings to create healthier, less stressful and more comfortable dwellings. [96]

Climate induced changes to replace coal, propane, natural gas or oil with electricity for heating, cooling and hot water eliminate a major source of airborne toxics within buildings. Higher building quality standards means less exposure to chemical, organic and inorganic hazards from poorly installed building components and shoddy building practices. Building occupants, living, or working in a building with good air quality, temperature control and regulated humidity are more comfortable, find their work more satisfying and according to some studies, more productive.[97] These are important co-benefits of the shift toward 'greener'

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[94] Egilson, Michael (Chair). (2022) Extreme Heat and Human Mortality: A Review of Heat Related Deaths in BC in Summer 2021. Death Review Panel, BC Coroner's Service. https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf?trk=public_post_comment-text: Marc Lee and Ben Parfitt. (2022). A Climate Reckoning: The Economic Costs of BC's Extreme Weather in 2021. Canadian Centre for Policy Alternatives. Vancouver: November. https://policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2022/11/ccpa-bc_Climate-Reckoning_SUMMARY_web.pdf

[95] Canadian Institute for Climate Choices. (2021). The Health Costs of Climate Change: How Canada Can Adapt, Prepare and Save Lives. op. cit.; Canadian Association of Physicians for the Environment. (2020) Healthy Recovery Plan: For a Safe and Sustainable Future. https://cape.ca/healthyrecovery/

[96] Health Canada. (2022). Health of Canadians in a Changing Environment: Advancing Our Knowledge for Action. op. cit.

[97] Chatterjee, Souran and Diana Urge-Vorsatz. (2021) Measuring the Productivity Impacts of Energy Efficiency: The Case of High-Efficiency Buildings. Journal of Cleaner Production. 318.

construction design and building practices. [98] They also can provide a source of job satisfaction for construction workers when they know that their work is significantly improving the lives of people in their communities.

Turning to the impact on construction workers, climate change is triggering a range of adverse on-the-job health impacts. These depend on the kind of construction work they perform, their geographic location, the nature of their building projects and their specific trade, among many other factors.[99] Some impacts stem directly from poorer working conditions resulting from more extreme temperature and weather impacts. Others result from the riskier conditions construction workers face when dealing with emergency repairs to buildings and infrastructure damaged by forest fires, hurricanes and floods. The increasing number of unpredictable weather events due to climate change is making some jobs much more stressful, negatively affecting workplace health and safety.[100]

A detailed literature review of the impact of climate change on occupational health in Quebec, followed by workshops and consultations with OHS experts, identified numerous ways in which workers will be affected by climate change in the coming years. It summarized its findings as follows: "This (research) process highlighted five categories of hazards that are likely to impact OHS in northern industrialized countries: heat waves/increased temperatures, air pollutants, UV radiation, extreme weather events, vector borne/zoonotic diseases.[101] (p.68)"

Higher temperatures during the summer, as experienced in much of the Canadian West in the summer of 2021, in BC, Alberta, the Prairies and Ontario in the spring and summer of 2023 and in Quebec in 2010, 2018 and in the spring and summer of 2023, to cite just a few examples, affect the ability to work outdoors, exposing trades workers to dehydration, heat stroke, asthma attacks and cardiovascular risks.[102] Increasing wildfires expose heavy equipment operators, construction labourers and other members of the building trades to life

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[98] Smart Prosperity Institute. (2021). The Benefits of Cleaner Air: Unpacking the Process for Estimates of Health Co-Benefits of Low Carbon Infrastructure Through Reduced Air Pollution. October. https://institute.smartprosperity.ca/sites/default/files/EN_Report%232_CoBenefits_Final.pdf

[99] Levy, Bary and Cora Roelofs. (2019) Impacts of Climate Change on Workers' Health and Safety. Oxford Research Encyclopedia, Global Health. https://oxfordre.com/publichealth/view/10.1093/acrefore/9780190632366.001.0001/acrefore-9780190632366-e-39?print=pdf; Lancet. (2020). The 2020 Report of the Lancet Countdown on Health and Climate Change: Responding to Converging Crises. The Lancet Countdown on health and climate changeLancet. (2022) The 2022 Report of the Lancet Countdown on Health and Climate Change: Health at the Mercy of Fossil Fuels. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels

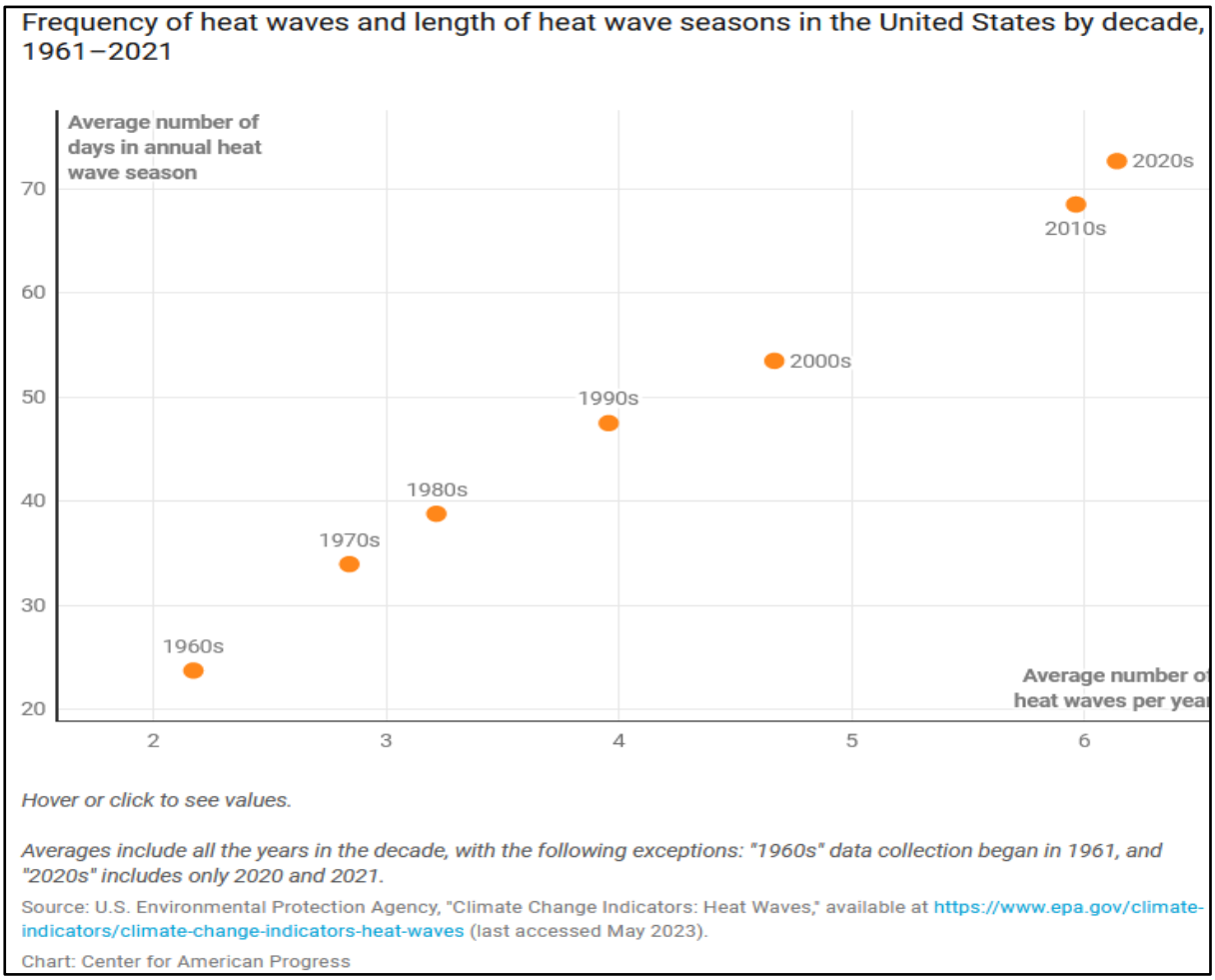
[100] Xiang, Jiaujun, Peng Bi, et. al. (2014). Health Impacts of Workplace Heat Exposure: An Epidemiological Review. Industrial Health, Vol. 52

[101] Adam-Poupart, Ariane, Framce Labreche et. al. (2013). Climate Change and Occupational Health and Safety in a Temperate Climate: Potential Impacts and Research Priorities in Quebec, Canada. Industrial Health. Vol. 51, pp 68 – 78.

[102] Berry and Schnitter, op. cit; Egilson, Michael (Chair). (2022). Extreme Heat and Human Mortality: A Review of Heat Related Deaths in BC in Summer 2021. Death Review Panel, BC Coroners Service. https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf?trk=public_post_comment-text

threatening heat and toxic smoke inhalation while limiting the ability of those with asthma and other lung conditions to continue working.[103] [104]

That we are experiencing more and more frequent heat waves is confirmed by international data. The chart below shows the growing number and intensity of US heat waves.



https://www.americanprogress.org/article/the-health-care-costs-of-extreme-heat/?utm_medium=email&utm_source=amprog_en&utm_campaign=default&utm_content=eml+nwl+01+20230707+inprogress-weekly+inp+1+x

[103] United States Global Research Program. (2016) The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. https://health2016.globalchange.gov/downloads ; Levy, Barry and Cora Roelofs. (2019) Impacts of Climate Change on Workers' Health and Safety. Oxford Research Encyclopedia, Global Health. https://oxfordre.com/publichealth/view/10.1093/acrefore/9780190632366.001.0001/acrefore-9780190632366-e-39?print=pdf

[104] Bush, E. and Lemmen, D.S., ed. (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p; Warren, F. and Lulham, N., ed. (2021). Canada in a Changing Climate: National Issues Report; Government of Canada, Ottawa, ON; . Global Climate and Health Alliance. (2021). The Limits of Liveability: the Emerging Threat of Smoke Impacts on Health from Forest Fires and Climate Change. https://cape.ca/wp-content/uploads/2021/06/016062021_GCHA_bushfire_report_limits_livability_health.pdf https://www.nrcan.gc.ca/sites/nrcan/files/GNBC/Chapter%201_Introduction_Final_EN.pdf ; Zuidema, Christopher, Elena Austin et. al. (2022). Potential Impacts of Washington State's Wildfire Worker Protection Rule on Construction Workers. Annals of Work Exposure and Health. Vol. 66, No. 4

Climate driven fluctuations in temperature over short periods of time – such as when there is a temperature swing of up to 50 degrees Celsius, or more, within a few days - also affect how workers prepare for outside work on construction sites, including what clothing to wear, protocols for managing machinery and equipment and how to cope with major disruptions to site conditions.

An Oregon study found that rising outdoor temperatures significantly increased the reported injury rate of construction workers. Extreme temperatures were associated with the highest rates of injury.[105] Those working indoors on buildings under construction or retrofitting existing buildings without air conditioning, or proper ventilation, also face more hazardous working conditions, especially in urban heat islands which often have extreme temperatures. Extreme heat is particularly worrisome for construction contractors and their workers when they are attempting to meet tight completion deadlines and avoid penalties. Scheduling pressures can encourage continuing to work when temperatures are excessive, pushing workers to take unreasonable risks with their health.

Climate change has increased the number and severity of wildfires, exposing construction workers to hazards associated with fighting them. Workers on building projects proximate to the fires also face hazards from inhaling toxic smoke. A Washington State study of the impact of breathing smoke from wildfires noted the following health risks:

"Outdoor workers—such as those in construction industries—may be at increased risk due to several exposure-related factors potentially contributing to a higher dose of wildfire-related PM2.5 (particulate matter – ed.) compared to the general public. First, many construction workers spend a considerable amount of time outside. Second, these workers may have a higher level of physical exertion, leading to higher respiration rates and tidal volumes and subsequent minute ventilation. Third, with physical exertion, workers may be more likely to breathe orally bypassing nasal filtration mechanisms." (p. 421)[106]

In recognition of the health impacts of climate change, US President Biden has announced a major OSHA initiative to respond to the impact the emergence of extreme weather events and particularly extreme heat. He noted that in 2021 the Pacific heat wave had resulted in hundreds of excess deaths and that millions of workers were now being exposed to extreme heat at their workplaces. His approach is outlined in a White House press release.

"President Biden is launching a coordinated, interagency effort to respond to extreme heat that threatens the lives and livelihoods of Americans, especially workers, children, and seniors. While climate-related disasters like hurricanes, wildfires, and floods produce dramatic images of devastation, extreme heat often takes place out of sight and out of the

[105] Levy, Bary and Cora Roelofs. (2019). Impacts of Climate Change on Workers' Health and Safety. Oxford Research Encyclopedia, Global Health; See the extensive discussion on the web site of the U.S. National Institute for Occupational Health and Safety. https://www.cdc.gov/niosh/topics/climate/how.html
[106] Zuidema, Christopher, Elena Austin et. al. (2022). Potential Impacts of Washington State's Wildfire Worker Protection Rule on Construction Workers. Annals of Work Exposure and Health. Vol. 66, No. 4

news. But heat is the nation's leading weather-related killer." [107]

The US Department of Labour has initiated a "multi-pronged initiative on occupational heat exposure to protect outside workers, including agricultural, construction and delivery workers." [108] Noting that construction workers are at particularly high risk, the initiative will include the development of new workplace standards to mitigate the impact of extreme heat related hazards on their working conditions.

Extreme weather events such as violent storms, hurricanes, floods and atmospheric rivers expose construction workers to additional risks because emergency response teams are expected to repair bridges, roads, dykes and wash-outs quickly to restore electricity, water, transportation and other essential services. Excessive rainfall turns building sites into seas of mud, sometimes polluted with sewage from overflowing treatment ponds or sewer pipes as the estimated $18 billion Fraser Valley flood disaster demonstrated in November 2021. Storm damage to hydro lines requires line workers, electricians, heavy equipment operators and other trades to work in risky, often unsafe conditions under extreme pressure to get the lights back on. Increased temperatures can also amplify the impact of exposures from construction dust, chemicals and other building site materials on workers' health. [109]

Warming average temperatures in some areas of the country are resulting in a rise in vector borne diseases and zoonotic risks such as tick-borne Lyme disease, Anaplasmosis and mosquito-transmitted West Nile virus, exposing those working outdoors to new medical hazards. [110] As average winter temperatures increase, some common US vector borne diseases are spreading north because it is not cold enough to prevent insect survival in the milder winters. These developments underscore how climate change is directly impacting the safety and health of the trades workforce, raising the need for additional OH&S measures, including legislation, to protect workers.

The policy responses of governments to these health-related climate induced changes increasingly involve changes to building, energy and fire code regulations to address occupant health impacts. New regulatory amendments are driving changes to building

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[107] The White House Fact Sheet. Washington: September 20, 2021. https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/20/fact-sheet-biden-administration-mobilizes-to-protect-workers-and-communities-from-extreme-heat/

[108] Ibid.

[109] Chen, Kunyang, Jiayuan Wang et. al. (2021). Critical Evaluation of Construction and Demolition Waste and Associated Environmental Impacts: A Scientometric Analysis. Journal of Cleaner Production. Vol. 287.

[110] Adam-Poupart et. al. op. cit; Rocklov, Joacim and Robert Dubrow. (2020) Climate Change: An Enduring Challenge for Vector Borne Disease Prevention and Control. Nature Immuniology. Vol. 24, May. Pp 479 – 483. https://www.nature.com/articles/s41590-020-0648-y; Ogden, N.H. and P Gachon. (2019) Climate Change and Infectious Diseases: What Can We Expect? Canadian Communicable Disease Report. Vol. 45., No. 4. CCDR-45-76.pdf (nih.gov)
Council of Canadian Academies. (2018). Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential. Ottawa. https://www.cca-reports.ca/reports/prioritizing-climate-change-risks/

specifications which, in turn, require alterations in training, skill requirements and working practices for the trades workforce.

To summarize this section, buildings and infrastructure are the third largest contributor to climate change in Canada. There is substantial evidence that governments can reduce the energy and carbon footprint of the sector dramatically by enacting tough climate mitigation and adaptation policies. Governments are expanding the reach of their regulatory policies to include environmental, ecological and health impacts. These policy-driven changes are affecting the construction industry in many ways, including the design of buildings and infrastructure, energy use, GHG emissions and the building, energy and fire code standards required to achieve more resilient, healthier and safer construction outputs. In the process they are also affecting the work that the construction trades perform, and the skills required to do it. Climate change is also producing new health and safety risks for construction workers.

Promoting climate literacy offers an important way to alert the construction workforce about the impact climate change will have on their work and their working conditions in the coming years, as well as preparing workers for these changes. It can also inform them of the numerous ways in which high performance, climate informed construction work can improve the health, comfort and overall living standards of the people who work and live in the buildings they produce. In the process, it can generate increasing awareness of the positive impact of their work not only in addressing the climate crisis, but also improving the lives of those who benefit from the buildings and infrastructure the create.

6.0 Workforce Policies

The climate policy agendas of all levels of government are driving major changes in the construction industry. Part of this push involves labour. Governments are attempting to expand Canada's VET capacity to create a workforce capable of meeting ambitious climate objectives in the building sector. They recognize that net zero will require major investments in workforce training. But they are less clear about the extent to which this will require a fundamental transformation of the industry itself. They have made use of traditional policy tools such as tax credits and financial incentives for employers to take on more apprentices. But they have not recognized the need for changes to the VET system itself or the extent of the regulatory changes needed to enable the industry to meet climate goals.

At the federal level, the government's Canada Green Building Strategy 2022 (CGBS) paper asserts that Canada will need to create 1.5 million new climate-focused construction jobs by 2030. It also argues that the rate of retrofitting must increase from its current 1% per year rate to between 3% and 5%, annually, in the period to 2050 to refurbish most of the country's 16

million residences and 482,000 commercial and institutional buildings.[111] This scale of retrofitting is huge, requiring a "dramatic increase in the number of green building jobs across Canada," according to the CGBS. It further notes that "Given the number of retrofits required and retirement predictions for the construction industry, a tremendous increase in the number of workers is required – in addition to the current workforce whose skills will be upgraded." [112]

The government assumes that organized labour will play a role in delivering its training agenda. One of its initiatives is the Union Training and Innovation Program (UTIP). Started in the 2017-2018 fiscal year, it now provides $50 million, annually, to fund a training equipment program which pays half the capital costs of upgrades to union training facilities. The other component of the UTIP funding is allocated to a "union-based apprenticeship training, innovation and enhanced partnership program" to support expanding Red Seal trades training. [113] The reference to Red Seal signals that funding under this program may give priority to full apprenticeships rather than short-term micro courses to fill skill niches that employers identify.

In 2022, the Government announced there would also be a new 'sustainable jobs stream…" to support unions in leading the development of green skills training for workers in the trades."[114] In its 2023 budget, the Government confirmed it is setting up a new Sustainable Jobs Training Centre, an initiative recommended in the earlier CGBS policy paper. Through these initiatives it plans to train an additional 20,000 journey workers and apprentices. Supporting the workforce requirements of the future low carbon economy is a priority of both the original UTIP program and the new jobs stream.

While not specifically targeted at the trades, the Government's 2023 budget is also allocating over $800 million over 3-years for a Youth Employment and Skills Strategy Program which includes a Canada Summer Jobs program and a First Nations Youth Employment pilot.[115] These training initiatives indicate that it is serious about finding ways to increase the participation of young people in the workforce.

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[111] Canada. (2022). The Canada Green Building Strategy. Natural Resources Canada Discussion Paper. July. https://www.nrcan.gc.ca/sites/nrcan/files/engagements/green-building-strategy/CGBS Discussion Paper - EN.pdf

[112] Ibid., p. 19.

[113] 2023 March 28, budget. https://www.canada.ca/en/services/jobs/training/initiatives/sustainable-jobs/plan.html#s5d

[114] See the press release outlining the next steps in the Sustainable Jobs program, February 21, 2023. https://www.canada.ca/en/services/jobs/training/initiatives/sustainable-jobs/plan.html#s5d; Canada. (2023) Sustainable Jobs Plan. Ottawa. March 8. https://www.canada.ca/en/services/jobs/training/initiatives/sustainable-jobs/plan.html#s4a

[115] Canada. (2023) Sustainable Jobs Plan: An Interim Plan for 2023 detailing concrete federal actions to advance economic prosperity and sustainable jobs in every region of the country. Minister of Natural Resources. https://www.canada.ca/en/services/jobs/training/initiatives/sustainable-jobs/plan.html

In the March 2023 budget, the federal government announced $56 billion in new spending spread over a number of years on climate related programs.[116] Much of this – approximately $35 billion - is for 'green' investment tax incentives spread over a number of years, some of which are to advance carbon capture, hydrogen production and related initiatives. [117] Of interest to labour is that it has made a condition of the most generous level of investment tax incentives for carbon capture and for clean electricity that companies must pay the prevailing union wage as identified in collective agreements in the industry, or sector. This includes pensions and benefits as well as the wage itself.[118] Recipients must also support apprenticeships by requiring that they must constitute at least 10% of the hours worked by tradespersons.[119] However these conditions only apply for companies seeking to receive the tax credits, raising the question of whether similar conditions should be applied to a much broader range of government financial help to industry as well as to government procurement.

The amounts allocated specifically to workforce development cited previously appear very generous. However, in relation to the size of the tax concessions and other subsidies included in the federal government's multi-year climate initiative, as well as the enormous training requirements needed to achieve the government's climate goals in the coming years, they seem quite modest. Given the size of the challenge to 'green' all new construction and to retrofit the millions of buildings needed to meet its targets, the financial allocations planned for training and workforce development to cover Canada's buildings and infrastructure are currently inadequate to do the job.

With respect to introducing climate literacy into the trades training system, the UTIP program has provided funding for specific climate-related training projects, such as CBTU's 'Build it Green initiative' (which is funding this initiative to explore introducing climate literacy into Canada's trades training programs). The government has also provided a significant grant to the Colleges and Institutes Canada to explore climate literacy in college instructor training programs though another program.[120]These are positive steps although arguably not nearly enough given the size of the challenge the industry faces.

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[116] Canada. (2023) Budget 2023: A Made-In-Canada Plan. Ottawa. https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf; A Summary is found at: https://www.canada.ca/en/department-finance/news/2023/03/a-made-in-canada-plan-affordable-energy-good-jobs-and-a-growing-clean-economy.html

[117] CCPA Monitor. (2023). A Hit and Mis Budget. Ottawa: March 28. https://monitormag.ca/articles/a-hit-and-miss-budget-canadas-2023-federal-budget-moves-on-climate-and-dental-but-avoids-almost-everything-else/. One of the challenges of determining how much new money is being allocated to the programs being announced is that the government rolls in previous funding commitments as well as giving totals that include planned expenditures that will occur several years into the future. Determining how much is being allocated in the fiscal year of a specific budget is challenging. However, there is no question that the government is spending a lot of new money on its initiatives that it identifies as its climate commitments.

[118] March 2023 Federal Budget Summary. https://www.budget.canada.ca/2023/report-rapport/chap3-en.html#a11

[119] The preceding programs are in addition to the ongoing Labour Market Transfer Agreements with the provincial and territorial governments which now amount to about $3 billion annually. These agreements give the federal government significant influence in shaping how provinces handle their training and labour market programs.

[120] See the description on its web site: https://www.collegesinstitutes.ca/programs/impact-edi/

Aside from whether the funding earmarked will be adequate to train the needed workforce, it is not clear to what extent the government's approach will address existing weaknesses in Canada's apprenticeship system. The question is whether the training it funds will support the changes to Canada's VET system necessary for the workforce to carry out successful net zero construction. As noted, both the 2023 budget and the UTIP program reference the Red Seal Standards which is a step forward. However, as we discuss in more depth later in this document, it was only during the summer of 2023 that the Red Seal Standards included a statement discussing the impact of climate change on the industry and its workers and indicating the need for climate literacy to be part of the trades curriculum. While a very important step forward, the intent of this statement still needs to be incorporated into the curriculum of each trade and the corresponding lesson plans of VET instructors.

Considering the scope of the work required to meet the government's climate targets, as noted earlier, implementing them in the construction industry will require a trades workforce with highly flexible skills and deep knowledge of the principles of building science to handle the challenges involved.[121] While this applies to new construction, it is of even more relevance to achieving the very large retrofitting challenge.

Large industrial, commercial and institutional facilities are major targets for deep retrofit projects due to the scale of GHG reductions and energy savings available. While many of these projects will be overseen by architects, engineers and other industry professionals, the skilled trades will play a major role as they are the ones with the knowledge, skills and competencies required to implement the plans developed by the professionals.

However, much retrofitting will take place in smaller buildings, including the wide variety of modest commercial, apartment and residential structures. Given the smaller scale, a great deal of this work will be carried out entirely by the skilled trades. This is because owners of smaller projects may not be able to afford architects and engineers to oversee their retrofits and may not believe such professional assistance is required in any case. Many building owners will rely on advice from the trades concerning the most cost-effective approach to implementing deep retrofits. To provide this advice, journey workers will require a solid understanding of building science as well as the capacity to solve complex problems on work sites, without the support of professional architects or engineers. The VET system will need to be able to provide the skilled trades with the capacity to carry out this work.

The federal government's policy agenda will also require significant employer commitment to meeting its training objectives. However, a key question is whether the government's initiatives will be effective in addressing the elephant in the room: that responsibility for supervising apprentices on-site and providing training opportunities for journey workers to

[121] Racusin, Jacob Deva. (2017). Essential Building Science: Understanding Energy and Moisture in High Performance House Design. New Society Publishers. https://newsociety.ca/books/e/essential-building-science?sitedomain=ca

upgrade their knowledge, skills and competencies is in the hands of employers. At present governments at all levels (except perhaps Quebec) have limited influence over how employers provide training.[122] True, there are excellent employers who see that their apprentices have opportunities to learn the key features of their trades and to link what happens on work sites with the classroom components of their apprenticeships.[123] However, these remain a minority and the diligence of many others is problematic.

A major impediment to improving Canada's training system is the fact that the industry has so many very small employers and large numbers of self-employed workers. The break down between various categories of employers is shown below:

Construction Employer Establishments by Employment Size Category (Number of Employees) and Province/Territory

Province/Territory	Micro (1 – 4)	Small (5 – 99)	Medium (100 – 499)	Large (500+)
Alberta	13,272	6,587	298	26
British Columbia	16,186	9,616	204	9
Manitoba	2,434	2,081	42	2
New Brunswick	1,551	1,255	22	1
Newfoundland & Labrador	1,127	773	16	1
Northwest Territories	68	97	2	0
Nova Scotia	2,096	1,457	22	1
Nunavut	14	35	2	0
Ontario	30,654	19,097	482	34
Prince Edward Island	461	282	6	0
Quebec	19,762	12,445	288	13

[122] Meredith, John. (2011). Apprenticeship in Canada: Where is the Crisis? Journal of Vocational Education and Training. Vol 63, No. 3., pp. 323 – 344.
[123] Howe, Aaron S., Jocyce Lo et. al. (2023). Engaging Employers in Apprentice Training: Focus Group Insights from Small-to-Medium-Sized Employers in Ontario Canada.

Saskatchewan	2,606	1,737	35	0
Yukon	180	110	1	0
Canada	**90,411**	**55,572**	**1,420**	**87**
Percent distribution %	**61.3**	**37.7**	**1.0**	**0.1**

Source: *Statistics Canada, special tabulation, unpublished data, unclassified excluded, 2021. https://www.ic.gc.ca/app/scr/app/cis/businesses-entreprises/23*

As the data indicate, 61.3 percent of employers in the construction industry had 5 or fewer employees while another 37.7 had less than 100. This data only includes employers. It does not include the large number of self-employed construction workers who, as individuals, are normally unable to support training apprentices. It also does not include the large number of workers in the underground economy which accounts for an estimated one fifth of the construction workforce according to a recent Prism Economics study.[124]
Workplace training is disproportionately concentrated among very large employers who have both the capacity and the incentive to support apprenticeships. They need qualified workers and recognize that it is up to them to provide training to meet their labour requirements.

While some medium sized employers do train, most lack the staff required for mentoring. English Canada is very different from Quebec. In the latter province, the government has mandated the establishment of employer associations to represent their collective interests. This provides a vehicle through which the government can negotiate with employers on training issues and obtain a certain level of consent – or commitment – to supporting its VET policies through incorporating them on to joint committees with unions to oversee training. There is no comparable arrangement in English Canada although there are some more limited sectoral arrangements such as the Ontario Construction Secretariat which do play a role in promoting employer support for training.

The exception for medium employers in English Canada is when they are part of a multi-employer collective agreement with a union. This type of agreement enables the union that indentures apprentices to pool the resources of a group of employers to provide employment continuity in the context of the fluctuations of project-based construction. It also means that the union that indentures apprentices has responsibility for overseeing their progress and for protecting their employment interests.

The effective regulation of the supervisory role of employers in the apprenticeship system merits much more attention that it currently receives. As 80% of the time of most apprentices is spent on construction sites, the extent and quality of the supervision they receive from their

[124] A report by Prism Economics for the BC Buildings Trades Council.
https://bcbuildingtrades.org/campaigns/underground-economy/
See also the Statistics Canada paper on this issue. https://www150.statcan.gc.ca/n1/daily-quotidien/230220/dq230220b-eng.htm

employers is critical to their development as qualified trades persons. Yet what happens on construction sites is often poorly regulated and the experience of apprentices varies dramatically from one employer to another. While one could argue that this was not such a critical issue in the period before the climate crisis, the fact that employers may not be providing the appropriate learning support is now of critical significance as it impedes the creation of the qualified workforce needed for the high performance standards of net zero construction.

One of the policy tools governments are using to encourage employers to hire apprentices is through providing tax credits for taking on apprentices. This is an approach adopted by both federal and provincial governments to varying degrees in recent years.[125] The federal government continued this practice in its 2023 budget which re-confirmed its commitment to providing a $5,000 grant to small and medium sized employers to take on a first year apprentice ($10,000 if the person is from an equity group) with a cap of $40,000 per employer.[126] Provincial governments similarly provide grants of varying amounts to employers to encourage them to support apprenticeship. These grants are popular with many employers.

However, in a paper written a decade ago, James Meredith argued that these kinds of "indiscriminate public subsidies" are likely to impede, rather than advance the governments' objectives of stimulating the growth of a qualified trades workforce because they enable employers to 'game' the system by taking advantage of the low pay of first year apprentices and then laying them off to avoid paying them the higher rates for subsequent years of their apprenticeship. They then replace them with new first year apprentices.[127]

A similar criticism was made by the OECD in its 2017 study of apprenticeships.

"Financial incentives for apprenticeships are likely to have modest effects, and will usually involve substantial deadweight. There are also risks of unintended effects, such as encouraging the engagement of employers who are more interested in subsidies than skills development."[128]

In contrast to the regulation of other parts of the construction industry through building, energy and fire codes and municipal zoning, bylaws and regulations, the training that employers provide on-site to apprentices is not closely monitored by any level of government. Most construction employers are not enthusiastic about detailed government

[125] See, for example, the programs listed on the Eco Canada web site. https://eco.ca/apprenticeship-service-program/?utm_source=google&utm_medium=cpc&utm_campaign=18670030281&utm_term=apprenticeship%20funding&utm_content=646874037825&gclid=CjwKCAjw3POhBhBQEiwAqTCuBmB8zVeUeK2Wlxad5hatR2NcSY_QEMciifRflCxSW2noAaznPqB_HhoCnFQQAvD_BwE

[126] Canadian Apprenticeship Forum. (2022). Canadian Apprentice Service Overview. Ottawa: https://www.canada.ca/en/employment-social-development/programs/apprentice-service-program.html

[127] Meredith, op. cit. p. 324.

[128] Małgorzata Kuczera. (2017) Incentives for Apprenticeship. Paris: OECD Education Working Paper No. 152. https://www.dcdualvet.org/wp-content/uploads/2017_OECD_Incentives-for-apprenticeship.pdf

regulation of their employment practices. In response, government support programs normally rely on the carrot of incentives rather than the stick of detailed regulation. Consequently, they have limited capacity to oversee the quality of on-site training that participating employers provide to apprentices, raising questions about the value-for-money of the funds provided, as well as 'free rider' concerns for those who would employ apprentices without subsidies. Meredith's point that there is a large gap in our research about the extent and quality of employer contributions to apprenticeships still resonates:

"In fact, the actual amount and the nature of training effort by employers of apprentices is an important question for empirical research, but one on which neither the existing survey data nor provincial administrative records can shed much light. As workplace training is not regulated, there is neither a pool of compliance data nor even any rubric for identifying or measuring inputs"[129]

The on-site experience of apprentices appears to vary enormously, depending on the level of commitment of their employers to providing them with work experience that fulfils the goal of producing a well-rounded, competent trades worker. Some contractors may specialize in a very narrow range of work within the trade limiting opportunities to learn its other dimensions. Apprentices may also be assigned to repetitive work that gives them little opportunity to acquire the core knowledge and skills of their trade. And some find their journey worker mentors do not have the time - or are not encouraged by their employers - to help them learn the trade. Sharpe and Gibson note this issue in their study of apprenticeship in Canada:

"Many employers have expressed the concern that apprenticeship with a single firm often leads to an overly narrow skills set, particularly when smaller firms might specialize in a specific aspect of the trade. Indeed, this possibility is mentioned in the scholarly literature, where a single firm may invest in overly specific skills that are not socially optimal. NATS data confirms that the majority of apprentices (62 per cent) had only one employer during their apprenticeship,"[130]

While Sharpe and Gibson in their 2005 paper indicated that apprentices were generally satisfied with their on-the-job experience, a more recent 2018 Canadian Apprenticeship Forum research project found quite high levels of dissatisfaction among apprentices and early career journey workers concerning their on-site experience. They indicated that they were not receiving sufficient support in the on-the-job component of their apprenticeship.[131] Many felt they had little opportunity to discuss their progress with their employers. Others felt that the tasks they were given did not give them the opportunity to learn the full scope of their trade.

[129] Ibid.
[130] Sharpe, Andrew and James Gibson. (2005). The Apprenticeship System in Canada: Trends and Issues. Ottawa: Centre for the Study of Living Standards. CSLS Research Report 2005 – 04. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e4c2719af8c74e06f03686ce74f025c5377f9e48
[131] Canadian Apprenticeship Forum. (2018) Quality of Workplace Training: Apprentice Perspectives. Ottawa. April.

There was too little structure in their work assignments. The responsibilities of their journey worker mentors were not adequately spelled out, leaving both apprentices and mentors without a clear understanding of their respective roles. The CAF research findings point to the need for much more regulation of the 80% of the time apprentices spend in the on-the-job component of their training to ensure that they have the capacity to implement net zero construction effectively.[132]

One reason for this is that since the turn of the century several provincial governments, such as BC under the Liberal provincial government and later Ontario under the Ford Conservative administration, have sought to reduce governments' role and shift more responsibility and authority over apprenticeship to employers. This has involved cutting back or eliminating programs in which ministry staff met with apprentices on work sites to inform them of their rights and responsibilities and to ensure that they obtain at least a basic level of support from their employers. While this earlier government involvement was still very 'light touch' in that it did not involve detailed evaluations of employer support programs, it did signal to employers that the governments were concerned about ensuring that the apprenticeship experience was positive for those enrolled in the program.

While there are numerous organizations representing the economic and political interests of construction employers in English Canada, most have little or no capacity to make binding commitments on behalf of their members to implement high quality on-the-job training programs. This contrasts with the relatively successful experience in Scandinavia, Germany and Belgium – to cite some relevant examples – where employers, collectively. play a major role in supporting the VET systems that train their respective workforces. The commitment of employer organizations and their ability to enlist the cooperation of their member employers makes it possible for them to implement system-wide VET programs. These organizations recognize that it is in the interests of all employers to have an effective training system for their industry, a goal which all employers have an obligation to do their part. Free riding is discouraged.

Canadian federal and provincial governments need to consider ways in which they can bring employers to the table for purposes of obtaining greater commitment to supporting VET programs. The Quebec model, which does organize employers, arguably, would be politically difficult to implement in English Canada. However, given the limited success of financial incentives, governments need to explore other approaches to encouraging – or requiring – employers to join employer organizations established specifically to promote their support for training.[133] Admittedly, this is complex and difficult in an industry that prides itself on its free market approach to supplying construction services and generally opposes government interference. But there is clearly a need, given the climate crisis, to find ways to obtain much more commitment from employers to VET programs.

[132] Clarke and Winch, op. cit. 2022.
[133] See the discussion of the system of involving employers in the separate chapter of this document on VET in Quebec.

Implementing climate literacy effectively also involves investing in training apprentices for an occupation that assumes a long-term career in the industry – a career which provides them with the opportunity to develop knowledge, skills and broadly-based competencies which they will use throughout their working lives. This is quite different from learning a narrow set of skills to perform niche construction functions as part of a precarious workforce. Knowledge of the basic principles of building science, an attitude that reflects a commitment to quality work, flexible, problem-solving capacity and pride in a job well done are the attributes needed to implement high performance, net zero construction.

From the perspective of workers, a key objective of government training support should be to provide the kind of decent jobs that the UNEP, ILO, and other labour organizations believe must be part of efforts to 'green' the economy.[134] Improving the quality of work experience and creating jobs that are satisfying and which are recognized as contributing to society's climate challenge should be integral to the support the government provides as part of its VET agenda.

Governments continue to emphasize that they support apprenticeship and wish to reverse recent declines in enrolment by supporting employers, financially. But past initiatives have had a mixed record in this regard. There is relatively little solid evidence confirming the effectiveness of these incentives in promoting better interactions between classroom and work placements or the performance of employers on work sites.[135] A proxy of the system's limitations is the continuing high non-completion rate of workers who start apprenticeship programs – more than half in most trades according to a number of studies by the Canadian Apprenticeship Forum.

Researchers have identified a variety of reasons for this. These include seasonal and cyclical employment fluctuations in the industry, costs incurred by both employers and workers, difficulties experienced by apprentices in finding employers and recognition by apprentices that construction work is not something for which they are suited. Nevertheless, the continuing high level of non-completions underscores the inadequacy of efforts to address it.[136]A similar non completion rate would not be tolerated in college or university undergraduate programs. This document cannot solve the issue, but it can note that a higher completion rate would make a significant contribution to providing the kind of climate literate workforce needed to achieve Canada's climate goals.

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[134] United Nations Employment Program (UNEP) 2018. Green Jobs: Towards Decent Work in a Sustainable, Low Carbon World. https://wedocs.unep.org/bitstream/handle/20.500.11822/8825/UNEPGreenJobs_report08.pdf?sequence=3&amp%3BisAllowed=

[135] Meredith. op. cit.

[136] Sharpe and Gibson. op. cit. Hansen, Rick. And Catherine Hondzel. (2015). The Apprenticeship Retention Program: Evaluation and Implications for Ontario. Toronto: Higher Education Quality Council of Ontario. https://heqco.ca/wp-content/uploads/2020/03/Apprentice_Retention_Prog-ENG.pdf

Another policy tool available to governments at all levels to promote climate literacy in the building industry is to include stringent climate requirements in their procurement of construction services. As the largest purchaser, cumulatively, of construction services in Canada, governments award contracts for a wide range of building and infrastructure projects. They also influence the decisions of developers who build facilities they plan to lease to governments. Governments can – and do - impose conditions on contracts they award.

In recent years governments have modified some public procurement contracts to include requirements that successful bidders will meet a variety of social and environmental objectives. In some contracts, they specify bidders will support a proportion of apprenticeships and employ a percentage of women, Indigenous people and others historically excluded from the construction workforce, a practice common in community benefits agreements (CBAs). In a few they require successful bidders to employ qualified trades workers or pay union, or equivalent, wage and benefit rates and document that they are doing so. They also have included mechanisms to monitor employers' labour policies to ensure that they follow industry best health and safety practices. While many of these obligations are, arguably, rather 'soft' in that enforcement is largely based on best efforts of those winning the contracts, nevertheless the example of including such requirements in public procurement contracts is well established.

Governments now need to include provisions in their contracts requiring employers to support workforce climate literacy objectives as part of their contractual obligations. While the specific contract language will vary depending on the project involved, as well as other factors specific to the contract, requiring employers to operate in a way that supports sound environmental and training practices can address the gap between what is taught in the classroom and what takes place on job sites. Of course, this requires governments to establish mechanisms to monitor on-site practices, something which they would have to commit to doing.

This could, for example, involve setting aside time for members of the workforce to participate in climate literacy programs either on job sites or in separate training facilities. It could involve establishing employer reporting requirements that document practices that advance climate objectives on building sites. And it could permit public or union auditors the right to worksite visits to interview members of the workforce about the extent to which the working environment supports climate change objectives.

To advance their climate targets, governments can also adopt more demanding requirements in the procurement contracts they award. These should establish higher standards of contract performance and provisions for monitoring the quality of the work being done. Measurement of GHGs, energy use and embedded carbon is increasingly feasible – and affordable - with the technologies coming on stream, so governments have the tools to ensure that contractors meet the commitments they make. Higher standards will require contractors to employ workers that have the requisite knowledge skills and competencies. It will push the industry

to create demand for a more highly trained workforce, something which is necessary for effective net zero construction.

An impediment to the more effective use of procurement to achieve public policy objectives is the way Canada's recent trade obligations have narrowed the scope of government options. A major goal of trade agreements is preventing governments from using public policy tools which agreement proponents believe are protectionist barriers to competition. The agreements restrict the ability of governments to implement policies that give priority to local and regional economic, social and labour concerns. They are designed to guarantee corporations from any signatory country full access to government procurement markets. Corporate rights are enforced by the inclusion of a variety of obligations governments must implement concerning what must be included in contract tenders, how tenders are evaluated and the rights of unsuccessful bidders to challenge contract awards. Since the first Canada-U.S. Free Trade Agreement, the federal government and provinces have standardized their tender documents to comply with the obligations of WTO, CETA, CUSMA, the Canadian Trade Agreement and numerous regional FTAs.

The treaties require governments to take the lowest bid from whichever company submits it. Low price becomes the default choice. That these agreements have adverse environmental impacts has become increasingly apparent in recent years, as have their negative impacts in restricting the ability of governments to support local employment, training and economic development initiatives through policies such as requiring local offsets or rejecting bids from firms that fail to meet progressive labour, equity, community and social development standards.[137] Fearing a possible trade dispute, governments are too often inclined to avoid including tougher environmental conditions in their procurement tenders, even where the agreements still allow them to do so. Fear of a possible trade challenge has a 'chilling effect' on procurement policies, encouraging governments to abandon this valuable policy tool.

In the context of addressing climate change, governments increasingly need to consider how their purchasing practices are impacting their ability to achieve their GHG and energy objectives. This means taking account of the overall impacts of purchasing decisions beyond a narrow, lowest-price perspective. Yet the templates on which governments are now required to tender out their construction purchases generally do not take account of these broader climate and environmental considerations. Minimally, governments now need to ensure that they use whatever scope they have within these agreements to maximize the climate benefits from their purchasing decisions, including ensuring that training and employment issues are fully considered.

[137] It is precisely because of the adverse environmental impacts of the Energy Charter Treaty that the EU has recently announce that it is withdrawing entirely from the treaty.

7.0 Industry Responses to Climate Change

Canada's construction industry has responded to the emerging climate crisis in a variety of ways, depending on the kind of work companies engage in, its economic impact on their sector and the extent to which government regulatory changes are affecting their operations. There is widespread recognition by many of the largest construction firms that climate change is responsible for driving the policy changes governments are demanding. Most major companies publicly state that they are committed to addressing the climate crisis and are modifying their operations to enable them to meet the higher standards that net zero construction requires. There are few climate deniers in the industry these days: no one is disputing that climate change is happening or that its impacts will be increasingly significant.

A quick review of the web sites of Canada's largest construction companies reveals that they recognize the importance of climate change and have made varying levels of commitment to sustainable construction practices.[138] Most large companies are involved in building projects that are net zero, often in partnership with governments or with major developers. They also indicate their familiarity with key building standards such as Passive House, LEED, Energy Star, Living Building Challenge, Zero Carbon. BOMA BEST and so forth, which they implement on their projects when those who commission buildings specify these standards.[139]

Industry publications and the journals of architects, engineers and planners reveal extensive discussion of the way in which construction practices are changing. These are in response to the climate crisis itself, to the numerous regulatory changes governments have been imposing on the industry, to changes in technology and building materials and to the changes in developer and owner commissioning requirements.

In the fall 2022 issue of BuildForce Canada's magazine, entitled Toward Net Zero, the organization's Executive Director discussed the drive to net zero and why the magazine is devoting an entire issue to Canada's climate challenge.

"*This issue of the magazine is dedicated to the topic of climate change and moving toward a net-zero reality. The shift toward a lower-carbon economy is happening and we have a real opportunity to be a part of this monumental change. The work our sector needs to do to*

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[138] This list according to annual turnover includes: PCL ($7.6B) Ellis Don ($4.9B) Aecon ($3.9B) Graham ($3.9B) Kewit ($3B) Ledcor ($3B) Pomerleau ($2,9B) Bird ($2.2 B) Broccolini ($1.2B) Flynn ($1.1B) Source: 40 Largest construction companies in Canada - Bridgit (gobridgit.com). For an example of what one company is doing, see the account by Ellis Don of its support for an "industry led action plan in support of Canada's international climate change commitments." The Carbon Impact Action Plan is designed to explore carbon reduction strategies in large scale projects and involves participants from a significant number of major corporations. See: https://www.ellisdon.com/news/ellisdon-launches-the-carbon-impact-initiative-action-plan-in-support-of-canadas-international-climate-change-commitments

[139] Verra provides an excellent survey of the various types of building rating systems. Vierra, Stehpanie. (2016.) Green Building Standards and Certification Systems. https://globalgbc.org/wp-content/uploads/2022/07/034_green-building-standards-and-certification-system.pdf

retrofit the existing build to be net zero and create a new build to higher standards is immense." [140]

Almost all the dozen articles in the magazine address the theme of net zero and the need for major improvements in how the industry reduces its GHG emissions and energy use. In addition, The Mechanical Contractors Association of Canada, the Canadian Construction Association, the Canadian Home Builders Association, and several individual companies have included articles, or advertisements, in the magazine, indicating that they are addressing climate issues. Earlier issues of the BuildForce annual magazine since its inauguration in 2016 contained only a very few references to sustainability and net zero. However, the fall 2022 issue represents a major shift in its focus. BuildForce is signalling that climate change is now a central issue for the industry.

Across Canada, industry trade shows are highlighting how the industry is responding to climate change. These shows bring together manufacturers, contractors, engineers, software vendors and many other stakeholders in the industry. Dozens of firms are advertising how their particular products or services are designed to address climate goals in booths at Buildex Vancouver, ACQ in Quebec City, CEGQ in Gatineau, OCA in Ottawa, Canstech in Halifax, CMPX, the Building Show and Skyline in Toronto, Batimatech in Montreal, Buildex in Calgary and others in major cities across Canada. Climate change is ubiquitous in the promotional material they provide to convention visitors.

Canada's financial institutions have also stated that they recognize that climate change is happening, that it poses a major threat to our economy and society. They customarily assert that they are taking measures to address it in their lending and investment policies. Typical of this is a recent report by the Royal Bank that lists initiatives it is currently taking to reduce the climate footprint of its banking activities.[141] Canada's other major banks have similar climate policies, outlining how they believe they are reducing the carbon footprint of their buildings and operations and shifting their lending practices to support the implementation of Canada's climate commitments.

However, public commitments by some of the industry's major players are not the same as industry transformation. True, some of the larger companies are making serious efforts to 'green' their construction practices. Public recognition of the importance of climate change is valuable. But according to the Canada Green Building Council, there were only 248 new LEED certified projects in 2022.[142] And while the 5.3 million square meters of building space is significant, it is only a small portion of what got built that year.

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[140] BuildForce Canada. (2022). Toward Net Zero: Construction is Instrumental in Canada's Climate Plans and Targets. Ottawa: https://www.buildforce.ca/en/magazine

[141] Royal Bank of Canada. (2021). The $2 Trillion Transition: Canada's Road to Net Zero. https://thoughtleadership.rbc.com/the-2-trillion-transition/

[142] Canada Green Building Council. (2023) Canada Ranks 3rd in the World for LEED Certified Buildings in 20222. Ottawa: February 7. https://www.cagbc.org/news-resources/cagbc-news/canada-ranks-3rd-in-the-world-for-leed-certified-buildings-in-2022/

There is also considerable push back in much of the industry by those who do not see the need for increased government regulation and who favour a market based, voluntary compliance model for addressing climate change.[143] While acknowledging that climate change is a serious issue, many in the industry still believe the unregulated market can address climate issues and consequently oppose government policies that require higher, legally enforced building and energy code standards or establishment of qualification requirements for workers such as increasing the number of compulsory trades.[144] The mainstream industry still relies on a low bid, low wage, competitive tendering model that tends to push down quality in the drive to cut costs.

The organization of much of the industry, with its extensive sub-contracting and piece work-based contract silos presents a basic challenge to the more integrated, 'whole building' approach that evidence shows is essential for effective net zero construction. And the industry – except for some of the large contractors working on major infrastructure projects or certain regions, such as the GTA – continues to rely far too heavily on a low skill, low wage approach for much of its on-site work.[145]

Moreover, the extent to which net zero objectives are incorporated into building practice is still very dependent on the specifications of those who purchase buildings and infrastructure. This is a major impediment to expanding the industry's delivery of low carbon construction outputs. Despite the growing popularity of net zero in industry narratives about how it is modernizing building practices to accommodate climate change, most new buildings and retrofits are still not commissioned with the objective of meeting the most advanced net zero carbon and energy footprint.

While some progressive companies are demonstrating the feasibility of net zero, for the majority of the industry it is the building and energy codes that are responsible for the climate change improvements, not voluntary commitments to climate objectives. As noted elsewhere in this report, there is still a widespread view among those commissioning building and infrastructure projects that it is far too expensive to build to net zero standards. While some major companies are talking the talk – and some are delivering – too many of the mid-size and smaller companies are not walking the walk. And some of the largest companies still rely on extensive sub-contracting of parts of their projects which undermines the development of a whole building approach that incorporates teamwork and collaboration among all those involved in the construction process.

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[143] See, for example, the policies of the Canadian Construction Association which oppose greater government regulation and favor a 'free market' approach to the industry. https://www.cca-acc.com/about-us/policy-statements/ . According to the Ottawa Construction News journal, CCA opposes the use of a Project Labour Agreement for the new $2.8 billion Ottawa Hospital Civic Campus (April 30. 2023. https://ottawaconstructionnews.com/featured/cca-joins-open-shop-contractors-in-opposing-2-8-billion-ottawa-hospital-civic-campus-pla/

[144] See the position of the Progressive Contractors Association which supports an open shop model of construction and seeks to repeal legislation that it believes is too favourable to unions. https://www.pcac.ca/action-advocacy/

[145] Meredith, John. (2011). Apprenticeship in Canada: Where is the Crisis? Journal of Vocational Education and Training. Vol 63, No. 3., pp. 323 – 344.

Over-reliance on sub-contracting is compounded by the pervasiveness of low bid price competition in the industry to the exclusion of high-quality performance. Up-front cost remains a key factor that prospective investors, or developers, use to decide what to specify in commissioning a project. Low bid competition, which is still pervasive in the industry, pressures contractors to cut corners wherever possible. Too often climate issues remain a low priority.[146]

Another barrier to incorporating higher standards is the split incentive issue where tenants rather than owners pay the operating costs so those commissioning rental buildings see no benefit in spending money on ways to lower long-term energy use in a building whose energy costs will be paid for by tenants. In the absence of legally required energy performance certificates which document the energy consumption and anticipated costs of occupying a building, prospective tenants have little guidance about energy efficiency or costs they will incur. Canada is far behind the EU which required member states to implement performance certificates over a decade ago.

The need to change commissioning practices to promote low or zero carbon outcomes is extensively covered in the literature about how to move towards environmentally sustainable buildings. As noted in our earlier discussion, numerous modelling studies have quantified – and discounted - the long-term cost differences of conventional versus net zero practice, by providing evidence that high performance buildings are not significantly more expensive and, sometimes, considerably less expensive than their traditional counterparts when energy use over the life span of buildings is taken into account.[147]

Obviously, the nature and characteristics of individual buildings, as well as a range of economic factors such as interest rates, projected rate of return on investment, carbon taxes and other variables come into play in these calculations. But advocates of more rigorous net zero commissioning practice and deep retrofits have a point: in the long-term the carbon and energy footprint of buildings will have to be much lower to comply with ever tighter policy requirements. Consequently, it makes sense to move aggressively now to avoid having to carry out additional deeper retrofits down the road. Commissioning practices that consider the overall impact of both initial capital costs and long-term operational costs must become the norm if government climate objectives are to be fulfilled.

[146] Darko, Amos and Albert Chan. (2017) Review of Barriers to Green Building Adoption. Sustainable Development. Vol. 25, pp. 167 – 179.

[147] There is a large volume of studies on this question by international organizations such as the IPCC, UNEP and Canadian based NGOs such as the Canada Green Building Council, Passive House Canada, Pacific Institute for Climate Solutions, Pembina Institute, The Atmospheric Fund and numerous others.

8.0 Characteristics of Net Zero Construction and Implications for Workforce VET

Public policies, in the form of more stringent building and energy codes, government subsidies and tax breaks, climate informed educational programs and compliance with the Paris Accord and other international agreements now focus on transforming how we construct our buildings and infrastructure. The need for change is also reflected in the growing adoption of voluntary building performance standards such as R-2000, Energy Star, BREAM, BOMA-BEST, LEED, Passive House, ASHRAE 90.1 and many others.[148] There is a broad consensus that net zero construction differs significantly from traditional building work.[149] Building practices that were acceptable before climate change became a pressing issue must now be overhauled to meet detailed, climate-informed design specifications, either in responses to increasingly ambitious building and energy codes or the adoption of voluntary 'green' building standards. Construction work must be done more precisely, carefully, and thoroughly to meet these more demanding specifications. Quality work is paramount to deliver the energy reductions and GHG savings governments seek to achieve.

Yet the adoption of the more stringent quality standards of net zero construction has not advanced quickly enough to meet Canada's climate targets. In its evaluation of the limitations of the qualifications and training of Canada's current workforce, Eco Canada argues that:

"Canada's building workforce does not have the widespread experience or skills required to perform their roles in a manner that achieves energy efficient goals. Until the essential

[148] Doan, Dat Tien, Ali Ghaffarianhoseini et. al. (2017) A Critical Comparison of Green Building Rating Systems. Building and Environment. No. 123 pp. 243-260. https://www.sciencedirect.com/science/article/abs/pii/S0360132317302937

[149] Gleeson, C.P. and Clarke, L. (2013). The neglected role of labour in low energy construction: 'thermal literacy' and the difference between design intention and performance. Work in a Warming World: Labour, Climate Change, and Social Struggle. Toronto, Canada. December. The neglected role of labour in low energy construction: 'thermal literacy' and the difference between design intention and performance ; ECO Canada (2016) Competencies for Environmental Professionals in Canada: National Occupational Standards. August. www.eco.ca; Canadian Standards Association. (2018). Market and Skills Development Needs Assessment for Low Carbon Building in Ontario Canada Green Building Council. (2019). Trading Up: Equipping Ontario Trades with the Skills of the Future. Ottawa. https://www.cagbc.org/tradingup ; Canada Green Building Council. (2020). Trading Up: How Alberta's Trades Can Build a Zero Carbon Future. Ottawa. Future Skills Centre and Conference Board of Canada. (2020) Rising Skills: A Toolbox Talk on Social and Emotional Skills in the Construction Trades. Toronto. December 14. https://fsc-ccf.ca/reports/ ; Pembina Institute. (2020). Training up for Deep Retrofits. July 29. https://www.pembina.org/pub/deep-retrofit-skills-training; Eco Canada. (2021). Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Workforce. February. Calgary. https://www.caba.org/wp-content/uploads/2021/10/IS-2021-205.pdf; Efficiency Canada. (n.d.) Workforce Requirements for Low-Carbon Building. Efficiency Canada - Infographic ; https://www.cagbc.org/CAGBC/Advocacy/trading_up.aspx ; Expert Group on Future Skills Needs. (2021). Skills for Zero Carbon: The Demand for Renewable Energy, Residential Retrofit and Electric Vehicle Deployment Skills to 2030. National Skills Council. November 2021. http://egfsn.ie/all-publications/2021/5119-dete-egfsn-skills-for-zero-carbon-web.pdf ;

occupations and skills become widespread, this workforce will not be fully prepared to support the development of energy efficient buildings."[150]

In its analysis of problems with the current training system, the Canada Green Building Council identifies the need to supplement technical skills with a deeper understanding of building science and the capacity to collaborate with others working on building sites.

"While the technical knowledge required differs between trades, a common core of knowledge is required to deliver zero carbon buildings successfully. Trades working on zero carbon building need technical skills in order to integrate high-performance, low-emissions technological components into complex buildings. They also need a solid understanding of building science and buildings as a system to deliver precise work on complicated components, such as building envelopes. Aside from technical skills, trades also require an array of "soft skills" in order to effectively operate in the collaborative, multi-disciplinary areas integral to high-performance buildings."[151]

A limitation of the current VET system is its tendency to focus primarily on providing the workforce with trade specific technical skills. Arguably, it pays too little attention to the fundamentals of building science and largely ignores climate science. It also neglects the importance of teamwork, communication and knowledge of the work of other occupations on building sites.

Of course, knowing how to exercise the range of specific technical skills needed carry out various components of the work of each trade remains essential. For it provides the foundation for quality construction work. No one questions that a solid grasp of technical skills is necessary for effective low carbon construction. But technical skills must be accompanied by a deeper understanding of the building process itself. To cite again an observation from Eco Canada's extensive survey of the views of construction professionals and skilled trades on the workforce competencies needed for net zero construction:

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

An energy efficiency mindset also means being able to think about "building-as-a-system" during and after construction, including how the building operates, its response to external environmental factors, how it's enjoyed by the tenants and how it holds up over time. This will help workers pivot from decision-making based on individual events, components or

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[150] Eco Canada. (2021). Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Workforce. February. Calgary. p.. 6. https://www.caba.org/wp-content/uploads/2021/10/IS-2021-205.pdf

[151] Canada Green Building Council. (2020). Trading Up: How Alberta's Trades Can Build a Zero Carbon Future. Ottawa. https://www.cagbc.org/news-resources/research-and-reports/trading-up-alberta/

individual datasets to a "building-as-a-system" approach that looks at how constituent parts are interrelated and work together within a larger building performance context.

An energy efficiency mindset and "building-as-a-system" thinking are achieved by taking an integrated, collaborative, multi-disciplinary approach to design, construction, operations and decommissioning.9 This requires a view of the big-picture and a combination of soft and technical skills, often acquired through experience or cross-training."[152]

Systems thinking involves the capacity to see how the various components of a project fit together as an integrated system in which each component contributes to the final product. Seeing a project as an integrated system involving a set of relationships among each of the components provides a very different perspective than a conventional approach which conceptualizes projects as a set of separate contracts or sub-contracts created largely in isolation from each other. System thinking also encourages building workers to consider how the various parts of a project fit together and how the work of each trade contributes to the overall goals of a project.

In the context of the climate emergency, the building trades require a broader understanding of the building process and how individual trades fit within it. A climate literate workforce needs to understand the 'why' of implementing low carbon construction objectives as well as the 'how' to perform the technical skills. It also needs to understand the reason it is now so important that net zero construction work be done properly – and to a high standard – if it is to achieve climate goals.[153] As one of the instructors interviewed in our initial interviews pointed out, we are teaching the 'how' but not the 'why'.

The need for basic changes to the way construction work is carried out was noted over decade ago by the European Union in its assessment of what was needed to enable its trades workforce to implement two of its key climate policies: the Energy Performance of Buildings Directive and the Renewable Energy Directive, both of which were linked to its larger goal of dramatically reducing GHG emissions and energy use.

The EU strategy to improve the energy performance of buildings has major implications for the Vocational Education and Training of the construction workforce because achieving the targets stipulated by Energy Performance of Building Directive and the Renewable Energy Directive (2009) depends on an adequately trained workforce. NZEB differs fundamentally from previous forms of construction as buildings must meet specific and stringent energy performance requirements for maximum energy use to be achieved through such measures as air-tight building envelopes, thermal bridge-free construction and on-site renewable energy sources, calling for a different set of knowledge, skills and competences (KSC) to be deployed in new buildings and the retrofitting of existing buildings.[154]

[152] Eco Canada. 2021. op. cit. p. 26.
[153] Clarke et. al. (2017) op. cit.
[154] Clarke et. al, (2019) op. cit.

The authors of a 2019 Canada Green Building report to the Ontario Government made a similar point about the need for a broader understanding of the connection between construction work, climate change and the importance of implementing high performance standards:

"…One of the main findings of this report is that technical skills alone will not satisfy the requirements of low-carbon buildings. Changes to the larger construction approach and acknowledgment of soft skills are necessary to deliver high-performing buildings. We therefore need to increase overall levels of "green literacy" or said another way, the ability to understand the broad implications of key building activities on the environment… The threshold for mistakes in high-performing buildings is slim and demands a higher level of sophistication and precision for the entire project team. "[155]

The report's authors argued that what is needed is a basic knowledge of climate change, a deeper understanding of building science and enhanced system thinking, which views construction projects as an integrated whole, not a group of separate contracts and sub-contracts.

VET programs must include information not only about the adverse consequences of inferior work but also about the contribution properly constructed buildings can make to achieving climate goals. And they must include appropriate training on low carbon construction methods, including the corresponding competencies needed to implement these methods.[156]

Net zero construction practice differs from conventional construction practice in significant ways. The most obvious is that projects are consciously planned to minimize GHG emissions, energy use and environmental impacts. Developers and others commissioning projects must explicitly include climate and environmental objectives into their building plans. Climate objectives thus become an integral part of how building projects are organized and delivered. This approach also includes specifying that the resources and materials used for the project must limit embodied carbon and avoid inferior substitutes. During the building process, site managers must minimize GHG emissions and energy use from the operation of machinery and equipment. Management of on-site materials, including their reuse, recycling or disposal need to meet stringent environmental criteria. The energy used in the finished building must meet the anticipated net zero targets during its operational life. In addition, the planning process must include the health impacts on construction workers and building occupants as well as the environmental and ecological footprint of the project on affected communities.

This translates into a range of specific objectives in terms of energy performance, GHG

[155] Canada Green Building Council. (2019). Trading Up: Equipping Ontario Trades with the Skills of the Future. Ottawa. p. 5. https://www.cagbc.org/tradingup.

[156] Clarke, Linda, Melahat Sahin-Dikmen and Christopher Winch. (2020) Overcoming Diverse Approaches to Vocational Education and Training to Combat Climate Change: The Case of Low Energy Construction in Europe. Oxford Review of Education. June 12. https://doi.org/10.1080/03054985.2020.1745167:

emissions, embedded carbon and environmental impacts. The external building fabric (envelope) must be airtight by being properly sealed and weather proofed to prevent penetration from outside air and moisture. The building fabric itself must be fully insulated, including external walls, roof, floor, windows and doors and thermal bridges minimized. The internal mechanical systems including (space) heating, cooling, water heating, lighting must be energy efficient and control moisture and temperature effectively. Efficient ventilation systems must be incorporated. [157]

Net zero construction requires viewing building projects as integrated units in which every component must fit properly with the others to achieve the desired climate objectives rather than a collection of separate contracts. Projects should incorporate the concept of 'circularity' which involves minimizing resource use, GHG emissions and energy consumption through the whole life cycle from project conception to decommissioning.[158] A circular economy limits the extraction of new GHG emitting resources, conserves energy and reduces the need to landfill waste from construction, renovation and demolition. It prioritizes conservation throughout the building cycle. Meeting these criteria involves a constant focus on quality building practice at every stage of the construction process.

The fact that net zero building and infrastructure practice differs significantly from conventional construction has major implications for the work of the trades and for the corresponding training and apprenticeship programs that provide workers with the knowledge, skills and competencies necessary to carry it out. As the previously cited quotations indicate, there is consensus in the literature that net zero construction requires a workforce that has a higher level of knowledge, skill and competency to implement its more demanding standards.[159]

Delivering low carbon construction is not primarily a question of workers learning new technical 'green' skills, important as this may be in some contexts.[160] The current Red Seal

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[157] CAGBC 2019; MacInnes, Shane and M-C MacPhee. (2021). Workforce 2030: Rapid Upskilling for Green Building: LEC Tradelinx Curriculum Audit. The Endeavour Centre. June. (unpublished paper); Canada Green Building Council. (2022). Decarbonizing Canada's Large Buildings: A Path Forward. https://www.cagbc.org/wp-content/uploads/2022/04/Decarbonizing-Canadas-Large-Buildings-Report-w.-Appendices-Final-Revised-Copy_with-formtting_2022-04-25.pdf; Nadal, Steven and Adian Hinge. (2023). Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. American Council for an Energy Efficiency Economy. https://www2.aceee.org/l/310911/2023-05-17/3s2mbbp

[158] Attica, Shady. and M Al-Obaidy. (n.d.) Design Criteria for Circular Buildings. Sustainable Building Design Lab, Dept. UEE, Faculty of Applied Science, University of Liege, 4000, Belgium. https://www.semanticscholar.org/paper/Design-criteria-for-circular-buildings-Attia-Al-Obaidy/3c5c0d13322162d862352b1af909d5801fa14119. See also: World Green Building Council. (n.d.) Why We Must Adopt Circularity in the Built Environment to Achieve a Regenerative Balance. Why we must adopt circularity in the built environment to achieve a regenerative balance - World Green Building Council (worldgbc.org)

[159] Commission for Environmental Cooperation. (2013). Improving Conditions for Green Building Construction in North America: Enhancing Capabilities of the Green Workforce. Montreal: December. http://www.cec.org/files/documents/publications/11387-improving-conditions-green-building-construction-in-north-america-enhancing-capabilities-en.pdf

[160] Clarke, Linda., Winch, Christopher. et. al. (2013). Trade-based skills versus occupational capacity: the example of bricklaying in Europe. Work, Employment and Society, 27(6), 932–951. https://doi.org/10.1177/0950017013481639

training system is generally successful in providing the technical skills workers in each trade require. Construction has always been characterized by ongoing change.[161] New skills are regularly – and successfully - added to existing trades in response to changes in technology, materials or equipment. In turn, skills that have become obsolete are dropped.

Successful net zero construction involves applying the knowledge, skills and competencies delivered by existing VET programs to the new demands of high-performance building to achieve climate and environmental objectives. It requires that workers know the reasons why net zero construction is now urgently required to address climate change and, consequently, why building quality is now such an important objective. It means understanding GHG, energy and environmental objectives of net zero construction and how these objectives affect the way buildings and infrastructure must now be constructed.

Understanding the overall objectives of net zero construction is important because the scheduling of work on building sites often means that trades do not directly interact with each other. The work of one trade is often completed before other trades arrive on the building site. So, understanding how it all 'fits together' is important because it explains the relationship of the work of each trade to the others and hence why it is important for the contribution of each trade to support the work of those with jobs that take place later (or earlier) in the construction schedule.

The current Red Seal program has been providing apprentices with most of the technical skills needed to implement low carbon construction.[162] It is teaching the 'how'. But only very recently has it started to provide apprentices and journey workers with the reason – the 'why' - that low carbon construction is now needed so urgently. It still needs to emphasize more strongly the potential contribution of the building industry - and particularly the skilled trades – in addressing the climate crisis.[163] These insights correspond to much of what CIRT learned from its interviews with a group of CBTU trades trainers in the fall of 2021. They noted the need to focus now on the 'why' in terms of the relevance of climate issues for the construction trades.

Construction is a social activity. A common theme in the research on how to improve climate literacy is that apprentices and journey workers need to improve their knowledge of the work of other occupations and, correspondingly, their ability to collaborate and communicate with other trades and professionals on building sites. Net zero building practice requires close and effective coordination among the different trades so that each trade's work complements - and does not undermine - the work of other trades. This requires an understanding by everyone of the overall climate and energy objective of a project and how the contribution of

[161] Gerhard Bosch and Peter Philips (eds), Building Chaos: an international comparison of deregulation in the construction industry, London: Routledge.
[162] Gunderson, Morley and Harry Kraskinsky. (2016). Apprenticeship in Canada: An Increasingly Viable Pathway. Challenge. Volume 59, 2016 - Issue 5 https://www.tandfonline.com/toc/mcha20/59/5?nav=tocList
[163] Commission for Environmental Cooperation. 2013. Improving Conditions for Green Building Construction in North America: Enhancing Capabilities of the Green Workforce. Montreal: December. http://www.cec.org/files/documents/publications/11387-improving-conditions-green-building-construction-in-north-america-enhancing-capabilities-en.pdf

each trade fits in with this larger objective. Teamwork and communication are needed attributes in net zero building practice.[164]

A related point about the social dimensions of work is that being a member of a group of construction workers who jointly produce a project that meets climate, environmental and community needs can be part of what makes construction work satisfying. It is not just the individual exercise of a skill or solving a problem that gives satisfaction – important as this may be. But it is also being part of a cooperative effort to build something worthwhile that also contributes to job satisfaction, especially when challenges have been overcome as part of a team effort.

The ability to solve problems is another key attribute of net zero construction practice. Trades workers need the capacity to solve new problems on the job in a manner that advances project design objectives. Building sites are not factories in which production can always be tightly controlled and work is largely predictable. Rather, each building project has its own individual characteristics, reflecting its design, location, size, materials used, schedules, staffing and a host of other factors. Problems can arise at every step of the construction process because every job is different. This requires construction workers to make choices about how their work can best implement project objectives.

Problem solving benefits from a solid grounding in building science and construction theory. Theoretical knowledge enables workers to deal with new situations effectively because they know how to apply their knowledge of the principles of building science to different on-site challenges. This is quite different from simply learning a technical skill, as the latter may not provide guidance on how to adapt to new circumstances, new building materials, technologies or building systems.[165] Understanding the principles on which specific skills are based provides the flexibility to deal with new conditions, something that is particularly important in net zero construction because much of what is required is different from conventional construction practice.[166]

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[164] Ramioul, Monique, Jos Benders and Jan Van Peteghem. (2016). Green Construction and Team Design: Low Road and High Road Teams to Build Energy-Friendly Houses. World Review of Entrepreneurship, Management and Sustainable Development. Vol. 12, No. 1; Clarke, Linda., Gleeson, Colin et. al. (2019a) Inclusive Vocational Education and Training for Low Energy Construction (VET4LEC) (Final Report) CLR. https://www.fiec.eu/our-projects/completed-projetcs/vet4lec; Clarke, Linda, Melahat Sahin-Dikmen et. al. (2020). Transforming Vocational Education and Training for Nearly Zero Energy Building. Building and Cities. pp. 650 - 661. https://journal-buildingscities.org/articles/10.5334/bc.56/; Clarke, Linda, Christopher Winch (2021) Vocational Education and Training for a Greener Construction Sector: Low Road or High Road Approaches to Apprenticeship? CDEFOP and University of Westminster. https://www.cedefop.europa.eu/files/Clarke%20Winch-%20Vocational%20education%20and%20training%20in%20construction%20-%20low%20road%20or%20high%20road%20approaches%20to%20apprenticeship.pdf

[165] Brockman, Michaela, Linda Clarke and Christopher Winch. (2008). Knowledge, Skills and Competence: European Divergence in Vocational Education and Training (VET) - The English, German and Dutch Cases. Oxford Review of Education. Vol. 34, No. 5. October.

[166] Clarke, Linda., Winch, Christopher. et. al. (2013). Trade-based skills versus occupational capacity: the example of bricklaying in Europe. Work, Employment and Society, 27(6), 932–951. https://doi.org/10.1177/0950017013481639

Practices that have been acceptable in conventional construction, where energy conservation is not a primary objective, are often unsuited to achieving stringent climate objectives. Failure to ensure that all elements of a project meet design specifications can seriously compromise its final performance. For example, it is necessary to recognize the importance of thermal bridging to avoid gaps in the building envelope which compromise energy performance. Punching holes in the fabric of a building to run pipes or electrical cables is no longer acceptable if it damages the integrity of the airtight seal. Plumbing must be done in a way that ensures sufficient room for the appropriate thickness of mechanical insulation. HVAC systems must be properly insulated especially where much of the piping and ductwork is hidden behind interior walls and invisible to future building owners. [167] Heat pumps must be properly calibrated to ensure they deliver their design specifications. [168]

Attitudes towards work also play a major role in achieving quality construction outcomes. This is an area that is particularly important in developing a climate literate workforce. It is human to want to believe that what we are doing is worthwhile. Exercising a technical skill or using theoretical knowledge of construction principles to solve a new problem is often a major source of individual accomplishment for a skilled trades worker. It is a major component of job satisfaction.

However, knowing that a construction project meets socially important climate and environmental objectives can also be a reason for wanting to do it well and, consequently, another source of job satisfaction. Seeing the positive impact of a well-built high-performance project on making building users safer, more comfortable, and better able to enjoy the facility can be a source of pride that the work was worth doing. Understanding that the energy performance of a building is addressing energy poverty by reducing heating costs can make the effort in ensuring that the system works properly feel worthwhile. Similarly, knowing that the environmental impact of the construction process has avoided damage to the local environment can be satisfying.

This is not to deny that there is always pressure to complete work quickly and to do only the minimum specified in contracts. There may be little or no additional income from the extra time and effort involved in ensuring that a job is done properly. But there will often be satisfaction in knowing that it has been done right even if it takes a few more minutes. Of course, there will always be compromises between getting a job done quickly by cutting corners and getting it done properly. Construction workers have to make these judgement

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[167] HB Lanarc (2010). "Pipes Need Jackets, Too: Improving the Performance of BC Buildings Through Mechanical Insulation Practice and Standards – A White Paper." Vancouver: Gleeson, C.P. 2014. Closing the gap between design and performance: the current debate. *CLR News*. (1), pp. 6-14. Closing the gap between design and performance: the current debate
http://www.mechanicalinsulators.com/research.htm.

[168] Gleeson, Colin (2016). "Residential heat pump installations: the role of vocational education and training." Building Research & Information. Vol. 44.Issue 4. Sept. 11.
http://www.tandfonline.com/doi/full/10.1080/09613218.2015.1082701. In comparing the success of heat pump installations in Germany and the UK, Gleeson found that the principal factor for the much lower performance of UK installations was the lack of training of the workforce. This was true even though they were installing the same equipment by the same manufacturers.

calls regularly. However, it does make a big difference if you know what is right for the climate and, consequently, believe it should be done properly where feasible. This means that jobs will more likely meet their specifications and fewer corners will be cut.

As the above suggests one consequence of the shift to high performance construction practice is that it opens the door to a discussion about making work more satisfying for construction workers. That one of the objectives of government programs to support workforce VET should be to improve the working lives of those expected to carry out the work would seem self-evident. However, this objective is not often mentioned in the rationale for expanding funding for apprenticeship training. Job satisfaction is normally understood only in the narrow perspective of whether the public investment will give workers a job with a pay cheque and the employer a source of qualified labour. Both are important objectives. But as a matter of public policy, making work more satisfying should also be a basic objective of investments in workforce development. [169]

One of the gaps in much of the Canadian literature on the knowledge, skills and competencies needed for net zero construction is that it does not emphasize the way in which this change can – and should - support the intellectual and social development of workers themselves. Obviously having a workforce that can deliver low carbon construction is essential. But the push for change ought to include a commitment to recognizing workers' need to develop and exercise their intelligence and human capacities.[170] This is a goal often articulated in professional education where occupations pride in performing work well is emphasized as part of the identity of the profession. It should have an equal place in trades VET. This entails understanding the limitations of adopting a purely functional or Taylorist approach which assesses net zero labour requirements and the corresponding training needs only on the basis of building outputs and without regard for the impact on workers themselves.[171]

Historically, craft workers have taken pride in the exercise of their skills and their control of the work process in which they normally played a central role. They took satisfaction from being able to point to a completed job and say that it represented something they accomplished due to their experience, knowledge and skill. Often this satisfaction came because they had overcome various challenges which otherwise might have compromised the outcome or because they had devised a new way to do the work. Having a sense of ownership in a job well done is an important - but too often overlooked - aspect of discussions about 'greening' the construction industry. But it is something whose importance needs to be an integral part of efforts to develop a workforce capable of addressing the climate challenge.

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[169] Clarke, Linda, Melahat Sahin-Dikmen and Christopher Winch. (2020) Overcoming Diverse Approaches to Vocational Education and Training to Combat Climate Change: The Case of Low Energy Construction in Europe. Oxford Review of Education. June 12. https://doi.org/10.1080/03054985.2020.1745167:

[170] Winch, Christopher. (2006). Georg Kerschensteiner – founding the Dual System in Germany. Oxford Review of Education. Vol. 32. No. 3. July.

[171] Taylor, Frederick Winslow (2011). *The Principles of Scientific Management*. New York: Harper and Brothers.

This also points to the importance of seeing construction work as an occupation and not just a job.[172] Climate-based workforce development should include promoting career paths for construction workers based on the assumption that they will be in the industry for their working lives. A successful apprenticeship is to be followed by many years of work in the trade during which there will be a continuous learning process in response to the constantly evolving demands of an industry characterized by continuous change. Upgrading knowledge, skills and competencies will continue through the careers of trades workers particularly as climate informed changes in technology and working practices are clearly going to be needed in the future.

It is notable that jurisdictions with a high standard of trades training and strong performance on climate issues, such as Germany, Belgium and the Scandinavian countries have, proportionately, far fewer unskilled workers than is the case in Canada.[173] They also have workforces with more extensive formal training and qualifications, as confirmed by the relatively high proportion of construction workers that have graduated from their VET programs, a point made in greater detail in the research performed by the CIRT European members and documented in their chapter. Countries like Germany also have higher occupational designations such as master trades qualification equivalent to university qualifications which trades can acquire through further study, enhancing the attractiveness of a career in the construction trades.

Another barrier to net zero construction practice is Canada's large underground economy.[174] Its existence means that much construction work is unregulated, both in terms meeting of building code standards – particularly in the residential sector - and in terms of employment obligations such as workforce health and safety, pensions, taxation, and statutory employment deductions such as WCB, EI and CPP. Contractors employ a variety of techniques to avoid regulation by paying workers in cash or categorizing them as 'independent' contractors when they are actually working under their direction like employees. A recent BC study found 19.3% of the province's construction workforce were in the underground economy in 2019.[175]

Workers in the underground economy include new immigrants, refugees or people without the legal right to work in Canada. Hence, they are easy to exploit. While most work on small

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[172] Winch, Christopher and Linda Clarke. 2003). 'Front Loaded' Vocational Education Verses Lifelong Learning. A Critique of Current UK Government Policy. Oxford Review of Education. Vol. 29, No. 2.
[173] Clarke, Linda, Christopher Winch (2021) Vocational Education and Training for a Greener Construction Sector: Low Road or High Road Approaches to Apprenticeship? CDEFOP and University of Westminster. https://www.cedefop.europa.eu/files/Clarke%20Winch-%20Vocational%20education%20and%20training%20in%20construction%20-%20low%20road%20or%20high%20road%20approaches%20to%20apprenticeship.pdf
[174] British Columbia Building Trades. (2022). Report on the Underground Economy. Vancouver. 2022-Underground-Economy-Report.pdf (bcbuildingtrades.org). The Canada Revenue Agency has a program to reduce the scope of the underground economy but clearly it is not succeeding to the extent that it should. https://www.canada.ca/en/revenue-agency/programs/about-canada-revenue-agency-cra/corporate-reports-information/underground-economy-strategy-2018-2021.html
[175] Ibid.

scale residential and apartment projects, some are also involved with sub-contracts in areas such as finishing trade work for larger projects.[176] Contractors participating in the underground economy enjoy a major cost advantage when competing with legitimate construction firms. As they can submit lower bids, based on cheaper labour, WCB, GST, PST and income tax costs, this pushes down construction standards in the industry by pressurizing legitimate contractors to cut corners to remain competitive.[177] As net zero construction requires much higher performance standards, this downward competitive pressure impedes the development of higher quality construction practices.

Another important consequence of the underground economy is that it does not contribute to the VET system despite its significant role in Canada's building sector. Workers in this sector do not usually have the support of employers who offer formal apprenticeships. Other informal types of on-the-job training are normally the minimum required to enable workers to perform simple, repetitive tasks. Underground workers are largely excluded from public training funding and other support programs because governments do not know they exist - at least legally. The contractors who employ them do not support the apprenticeship system or provide upgrade training for working journeypersons but poach qualified journey workers when they need them for purposes of meeting statutory building code requirements. The lack of effective regulation of the underground economy also means that construction standards are not monitored, and the quality of buildings not assessed.

The impact of the underground economy in avoiding effective regulation constitutes a major challenge to government GHG and energy reduction targets. Given the amount of construction work carried out in this sector and the share of the total construction workforce involved, it is difficult to see how its continued existence is compatible with achieving net zero targets. To date there seems to be very little evidence that the three levels of government have a coherent strategy for including the underground economy in their climate agendas. But without its inclusion it is very difficult to see how the rest of the industry can make up for the gap it creates.

9.0 Addressing the Performance Gap

One of the key challenges emerging from the increased focus on high performance buildings in recent years is the problem of the energy performance gap. This is the gap between the intended performance of buildings or infrastructure, as set out in the design specifications, and the actual, that is measured, performance once projects are completed.[178] Many projects

[176] Ibid.
[177] Calvert, John. (2014) Overcoming Systemic Barriers to "Greening" the Construction Industry: The Important Role of Building Workers in Implementing Climate Objectives at the Workplace. Alternative Routes. Vol. 25. Pp. 81 – 116.
[178] De Wilde, Pieter (2021). Performance Gaps: A Commentary. Academia Letters. March 2021. https://www.academia.edu/45611580/Building_Performance_Gaps_a_Commentary

designed to achieve net zero performance standards fail to do so because they are not properly built on site. In some cases, post construction assessments have found that newly constructed 'energy efficient' or LEED rated buildings actually perform no better – sometimes worse - than conventional structures.[179]

There are a variety of factors that contribute to the performance gap.[180] It can result from oversights in building plans, poorly written or inadequate specification details, use of inappropriate materials and/or unauthorized substitutions and failure to monitor and address building performance issues once construction is completed. It can also result from contractors following past practice rather than adapting to the new specification demands associated with low carbon construction. Extensive sub-contracting practices can also dilute responsibility for the overall outcome of a building project.[181]

However, there is also a large literature on the energy performance gap that identifies another factor contributing to it. It is the failure of the VET system to provide adequate training for the construction workforce in the requirements of net zero construction practice.[182] There is considerable evidence that much of the mainstream building industry currently does not have the capacity to implement net zero construction properly. A recent Canadian Standards Association report noted significant gaps in the ability of Canada's building industry to implement low carbon construction, highlighting the following issues:

- *Awareness and adoption of low carbon building is poor.*
- *Codes and standards do not all include requirements specific to low- carbon building.*
- *Low carbon building requirements are not mandated.*
- *A lack of access to the latest industry information (e.g., new or emerging technologies, system installation methods, best practice examples, etc.).*

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[179] Amiri, Ali, Juudit Ottelin and Jaana Sorvari. (2019) Are LEED-Certified Buildings Energy-Efficient in Practice? Sustainability. Vol 11 (6). https://www.mdpi.com/2071-1050/11/6/1672; De Castro, Danielle and Amy Kim. (2021). Adaptive or Absent: A Critical Review of Building System Resilience in the LEED Rating System. Sustainability. Vol. 13, (12). June 12. https://www.mdpi.com/2071-1050/13/12/6697/htm

[180] Innovate UK. (2016) Building Performance Evaluation Program: Findings from Domestic Projects. January. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/497758/Domestic_Building_Performance_full_report_2016.pdf; Darko, Amos and Albert Chan. (2017) Review of Barriers to Green Building Adoption. Sustainable Development. Vol. 25, pp. 167 – 179.

[181] McElroy, David and Jan Rosenow. (2019) Policy Implications for the Performance Gap of Low Carbon Building Technologies. Building Research and Information. Vol. 47, Issue 5.

[182] De Wilde, Pieter. (2014) The Gap Between Predicted and Measured Energy Performance of Buildings: A Framework for Investigation. Automation in Construction. Vol, 41, May; Cali, Davide, Tanja Osterhage, et. al. (2016) Energy Performance Gap in Refurbished German Dwellings: Lessons Learned from a Field Test. Energy and Buildings. Vol 127, 1146 – 1158; Clarke, Linda., Gleeson, Colin et. al. (2017). What kind of expertise is needed for low energy construction? Construction Management and Economics, 35/3(3), 78–89; Zou Patrick, Xiaoxiao Xu et. al. (2018). Review of 10 Years research on Building Energy Performance Gap: Life Cycle and Stakeholder Perspectives. Energy and Buildings. Vol. 178. pp. 165 – 181. International Partnerships for Energy Efficient Cooperation. (2019) Building Energy Performance Gap Issues. IPECC Building Energy Efficient Taskgroup. November. https://www.energy.gov.au/sites/default/files/the_building_energy_performance_gap-an_international_review-december_2019.pdf; De Wilde, Pieter (2021) Performance Gaps: A Commentary. Academia Letters. March 2021. https://www.academia.edu/45611580/Building_Performance_Gaps_a_Commentary.

- *A lack of access to training and curriculum with low carbon-specific content.*
- *Opportunities to apply low carbon skills in projects are rare.* [183]

The CSA report goes on to state that 'raising awareness' of the need for - and benefits of - low carbon construction is a key challenge for the industry and that "Current trade certification programs may not have enough room to incorporate low carbon study as part of the requirements."[184]

The difficulty of the traditional approach to construction in implementing net zero practice is reinforced by the economics of the industry.[185] Regardless of contractors' personal views on climate change, the way much of the industry is organized means that their economic interest is to deliver the minimum that will be required to meet the specifications in the tenders they win, even if they know that certain practices do not achieve the full potential of energy efficiency and lower GHG emissions. In a low bid environment where those commissioning buildings often do not have adequate tools to measure how well jobs are done, delivering higher quality than one's competitors is a recipe for a quick exit from the industry. Similarly, while developers increasingly promote certain aspects of their buildings as 'green' and often advertise their LEED or other environmental credentials, one does not need to be overly cynical to realize that many claims for environmentally responsible construction are marketing vehicles. [186]

Conventional construction is driven by the need to complete projects on time and on budget as the central priority. This is an understandable – and appropriate - goal for all construction projects, including net zero. However, in conventional construction, when achieving net zero is not a priority, gaps in meeting project specifications can often be overlooked if they are not too obvious (or not likely to show up until after the building warranty has expired). Measurement of energy performance is not yet common practice in Canada so the efficiency of the building is often a secondary consideration.

Canada still does not require buildings to be rated according to their GHG emissions and energy footprints. True, Natural Resources Canada does oversee the Energy Star rating system. But participation by builders and owners is voluntary. Mandatory performance

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[183] Expert Group on Future Skills Needs (2021) Skills for Zero Carbon: The Demand for Renewable Energy, Residential Retrofit and Electric Vehicle Deployment Skills to 2030. National Skills Council. November 2021. (introduction). http://egfsn.ie/all-publications/2021/5119-dete-egfsn-skills-for-zero-carbon-web_.pdf

[184] Ibid. p. 11.

[185] Gleeson. (2016) op. cit.

[186] LEED has also been criticized because it is possible to obtain a high rating despite having relatively poor energy performance. This is because points are given for a variety of project components which can add up to a high overall score, even if energy related aspects are poorly rated. Orr, Robert, (2014) The Problems with LEED. Project For Lean Urbanism: Centre for Applied Transect Studies. https://leanurbanism.org/wp-content/uploads/2014/06/Orr-LEED.pdf. Ade, Rochelle and Michael Rehm. (2020 The Unwritten History of Green Building Rating Tools: A Personal View from Some of the 'Founding Fathers' (2020). Building Research and Information. Vol. 48, No. 1. pp. 1 – 17; Castro, Danielle and Amy Kim. (2021) Adaptive or Absent: A Critical Review of Building System Resilience in the LEED Rating System. Sustainability. Vol. 13, (12). June 12. https://www.mdpi.com/2071-1050/13/12/6697/htm.

certificates on new and renovated buildings are still in the early drafting stage, even though they have been in place in Europe for well over a decade. Provinces and municipalities are only starting to require energy measurement in certain large buildings. Regulations for smaller commercial structures and residential construction remain at a very early stage of development. Consequently, poor performance caused by thermal bridges, failure to seal the building envelope properly, inadequate insulation, inefficient mechanical systems or gaps in other key areas of a project's construction is not a concern for contractors as long as they are not measured and building owners or tenants are unaware of - or unconcerned about - long-term operational costs. Legally required performance measures are urgently needed to push the industry towards greater building efficiency.

A characteristic of much conventional construction is the high degree of sub-contracting. While this is a way to stimulate cost cutting through competition among contractors, it can also diffuse responsibility for the overall climate outcome of a project and contribute to the performance gap. When contractors are only concerned about completing their limited component of a project, they are not accountable for the resulting energy and GHG outcomes, a problem exacerbated by the lack of post construction measurement. The energy used by the final project, ends up being no one's responsibility. While perhaps acceptable – although obviously not desirable - before climate became an issue, maintaining a fragmented building process through extensive sub-contracting now constitutes a significant barrier to realizing climate objectives.

Extensive sub-contracting can also impede workforce teamwork and communication that high performance construction requires. Instead of viewing a project in its entirety, individual contractors are only responsible for what their contract specifies. What others do is not their responsibility. Spending time on communications associated with overall building performance is not conducive to making money on the contract. Extensive sub-contracting also affects the ability of workers to acquire a broader understanding of their role in the building process and expand their overall knowledge of construction practice.

To address the performance gap and meet the demanding specifications of net zero construction, building work must be done in a much more precise and careful manner. Every component of the work must meet the specified performance standard. If part of the work fails to meet the standard, the overall energy performance of the building is compromised. Quality must take precedence. In commenting on the impact of the demanding new building requirements on EU training requirements, Clarke, Gleeson et. al. note that:

"The significance of the improved quality of training required is evident from the energy performance gap, which is the difference between the energy performance standards intended and actually achieved, as recognized in the 2016 Impact Assessment of the Energy Performance of Buildings Directive (Sunikka-Blank and Galvin 2012; EC 2016c). Net Zero Energy Building necessitates a construction industry capable of providing continuous

insulation, controlled ventilation, heating/cooling and hot water heating, thermal bridge-free and airtight buildings supported by renewable heat and power. [187]

The authors went on to state that:

"The assessment of buildings by their energy rating in kWh/m² implies a significant change from traditional construction evaluation methods where energy performance per se has been secondary to completion on time and on budget. Achieving such energy performance standards means a step change in the Knowledge Skills and Competencies of construction professionals and workers and a reconfiguration of: VET availability, scope and curriculum; occupational qualifications and access to continuing VET; site organisation, mechanisation and planning; and the employment model. It means greater communication between designers, builders and site occupations, team working, and a focus on the building as a single unit of envelope and services, installed and commissioned to meet an overall energy target."[188]

While the industry is constantly changing – this is a hallmark of construction – and is continuously adopting new technologies, new materials and working practices, progress in advancing workforce climate literacy has been very uneven in Canada and slow to emerge overall. As noted elsewhere in this study, some of the larger construction companies have embraced sustainable building practices and have tried to support their workforces to acquire the relevant knowledge and skills needed for net zero construction. Where union or joint union-employer training facilities exist, there has been some progress on this issue because they are concerned to ensure that the apprentices and journey workers access quality training and gain relevant on-the-job experience.[189]

However, this is still the exception. Outside Quebec, only a quarter of construction workers are union members with access to joint training programs. The majority of Canadian construction workers have few opportunities to acquire the relevant knowledge, skills and competencies needed for net zero construction - and to 'unlearn' practices that are antithetical to achieving high performance buildings. The mainstream industry still does not recognize that effective low carbon construction requires a different approach to the building process – one which focuses on quality of work and serious investment in a VET system capable of providing Canada with the qualified workforce it needs to achieve climate goals. [190]

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[187] Clarke (2019) Clarke, Linda., Gleeson, Colin et. al. (2019a) Inclusive Vocational Education and Training for Low Energy Construction (VET4LEC) (Final Report) CLR. P. 10. https://www.fiec.eu/our-projects/completed-projetcs/vet4lec

[188] Ibid. p. 10.

[189] O'Grady, John. (2005) Training Trust Funds: A Review of Their History, Legal Founations and Implications for Trade Union Training. Ottawa: Canadian Labour Congress. Microsoft Word - TTF Report - Final Draft.doc (ogrady.on.ca)

[190] Eco Canada. (2021). Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Workforce. February. Calgary. https://www.caba.org/wp-content/uploads/2021/10/IS-2021-205.pdf: Clarke, Linda., Gleeson, Colin, Christopher Winch and F. Duran-Palma. (2017). What kind of expertise is needed for low energy construction? Construction Management and Economics, 35/3(3), 78–89. https://doi.org/10.1080/01446193.2016.1248988

Competency in handling software for computer applications and apps for use on cell phones is now part of what employers on net zero projects expect of building trades workers. Building Information Modelling (BIM) Building Energy Simulation (BPS) and other sophisticated technologies are now widely used.[191] On larger projects, some skilled trades are being asked to participate as collaborators with professionals and other occupations on work sites to implement new approaches to low carbon construction practice. They are also expected to have a basic knowledge of issues such as project management/planning and scheduling requirements. These new demands are integral to the practice of net zero construction and are already affecting what building workers now do when working on high performance projects. These changes are also consistent with the view that net zero construction will require workers to have a solid knowledge of the basic principles of building science, as well as the capacity to communicate and collaborate effectively with others on construction sites. Incorporating climate literacy into the VET system has parallels with how other concerns have already been added to the curriculum.

An obvious example is the coverage of workplace health and safety. Over the past decade, the curriculum of the construction trades has been modified significantly to ensure that apprentices are aware of the hazards of construction work and the measures that they need to adopt to make their workplaces safer. This training also provides the trades with an understanding of the ways in which their work can be hazardous to themselves, their co-workers, bystanders, building occupants and the wider public, notably in the operation of equipment or in areas such as water, air and noise pollution. Hence, the curriculum provides information about the precautions to be taken in their work. Teaching compliance is not just a matter of inculcating adherence to a rigid set of rules. Rather, compliance is critically dependent on workers' understanding the reasons for health and safety regulations and the consequences of failing to follow them. Health and safety training has been normalized as a legitimate part of the curriculum and incorporated into what apprentices learn about what it means to be a competent, qualified trades person.

Similarly, the importance of building, energy, fire safety, electrical and other codes is covered in the current curricula for individual trades. The public benefits of the fire safety code is obvious, as is the importance of complying with it. The structural safety provisions embedded in the building codes are similarly understood. While there are circumstances where contractors ignore the codes through lack of awareness or to cut corners, nevertheless

[191] Bormann, Andre, Markus Konig et. al. (2018) Building Information Modelling Chapter 1 – Why? What? How? In Building Information Modelling – Technology Foundations and Industry Practice. Springer Publishers. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Building+Information+Management+in+Construction+industry&btnG=; Ahmed, Shakil. (2018) Barriers to Implementation of Building Information Modelling (BIM) to the Construction Industry: A Review. Journal of Civil Engineering and Construction. http://xpublication.com/index.php/jcec/article/view/106; Pan, Yiqun, Mingya Zhu, et. al. (2023). Building Energy Simulation and Its Application for Building Performance Optimization: A Review of Methods, Tools and Case Studies. Advances in Applied Energy. Vol. 10.

the culture on most building sites is one that accepts that in principle codes are necessary and should be followed. Again, adherence to the codes is not just a matter of following rules. It is also about understanding the purpose of the codes so that following them is seen to make sense. Contractors and workers recognize that they are in the public interest.

What is relevant for climate literacy in these examples is that both health and safety regulations and building codes are followed not only because they have legal backing, although legal requirements are obviously important. They are followed because the training enables construction workers to understand their purpose and, accordingly, the reasons why complying is necessary – and desirable. Understanding their public policy purpose is, arguably, no less important in obtaining compliance than fear of enforcement sanctions.

Similarly, in the context of climate change it is important for the purpose of the GHG and energy provisions of the building and energy codes to be explained effectively. To the extent that construction workers understand why the codes have been established - that is their purpose in mitigating and adapting to climate change - following them, like other codes, is more likely to be normalized as part of regular construction practice. Understanding the 'why' is important for compliance.

Similarly, encouraging apprentices to act responsibility, take care in their work and take pride in outcomes is a key part of successful net zero construction practice. This is particularly true when workers see they are not being followed on a building site. Challenging questionable practices is easier if it is based on the knowledge that following the codes or commissioning requirements is the right thing to do for the climate as well as for building occupants and the broader community. Effective net zero construction requires attitudes that support achieving its objectives. [192]

The preceding discussion highlights the importance of addressing the performance gap by enhancing the knowledge, skills and competencies construction workers need to perform this work successfully. It also indicates the need to promote attitudes that support achieving climate objectives. Implementing net zero standards requires corresponding changes to the culture of the workplace so that the industry can respond positively to the new demands associated with meeting climate targets.

10.0 Role and Impact of the Red Seal System

The apprenticeship system has the potential to be a major vehicle for introducing climate literacy into the construction trades. Canada's VET system is largely built around the Red Seal Occupational Standards (RSOS). These Standards largely determine the curricula

[192] Zero Carbon Hub. op. cit.; Killip Gavin, Alice Owen et. al. (2019); Exploring the Practices and Roles of UK Construction Manufacturers and Merchants in Relation to Housing Energy Retrofit. Journal of Cleaner Production. Nov. 11; Topouzi, Marina, Gavin Killip et. al. (2019) Deep Retrofit Approaches: Managing Risks to Minimize the Energy Performance Gap. ECEEE Summer Study Program: Make Building Policies Great Again. https://eprints.whiterose.ac.uk/143558/7/7-349-19_Topouzi.pdf

guidelines provinces provide to public colleges, union training programs and private training agencies. While each province has its own system for certifying trades qualifications, they normally use the Red Seal Standards as the model for their curricula.[193]

The positive value of the Red Seal Standards is that they provide a very detailed, national curriculum template. In applying the Red Seal Standards, each province has some scope to make adjustments, based on its unique situation. Construction varies from province to province, depending on the pattern of industrial development, climate, geography, extent of urbanization and a variety of other factors. For example, BC, Quebec and the Maritimes have weather patterns that are quite different from central Canada, so some skills, such as used in shipbuilding, are more relevant to their geographic location. Alberta, Saskatchewan and Newfoundland & Labrador require skills related to the oil patch. Consequently, individual provinces emphasize some aspects of the Red Seal curriculum more than others to ensure that their trades' graduates acquire the most relevant skills for their jurisdictions.

The authors of the Red Seal system have been seeking to harmonize qualification standards across the country since 2013.[194] While considerable progress has been made and there is a detailed timetable for various trades, harmonization has proved challenging because, as noted, the construction industries in each province vary due to geography, industrial profile, climate and numerous other factors which provinces have to accommodate in their provincial curricula. However, the policy goal of the Red Seal Secretariat has been to try to reduce these differences, incrementally, over time. In many trades, this has been largely achieved.[195]

Canada has over 400 designated trades, of which 55 are included in the Red Seal Standards. A designated trade is one whose skills and knowledge are what a qualified trades person is expected to know to practice the trade successfully, based on NOA criteria. Provincial governments determine the list of trades they will designate and this can vary across the country. Somewhat confusingly, provinces may use different names for essentially the same trade, although where the Red Seal applies this confusion has been largely addressed.

A designated trade can be either compulsory, or voluntary, depending on what provinces decide. A compulsory trade is one in which workers must have a Trades Qualification (TQ) or Certificate of Qualification (COQ) to practice in the industry.[196] However, the number of compulsory trades varies substantially from province to province reflecting, in part, the relative influence of employers and unions, as well as considerations of public safety and

[193] The term for a provincial trades qualification varies from province to province with some using the term Trades Qualification (TQ) and others Certificate of Qualification (COQ or CoQ). We have used COQ to refer to provincial qualification names in all provinces.
[194] See the discussion about harmonization on the Red Seal web site. https://www.red-seal.ca/eng/initiatives/h.1rm.4n.3z.1t.3.4n.shtml
[195] The list of completed and anticipated Red Seal harmonized trades is on the web site noted above.
[196] As is typical in a federal state, the names for each of the provincial certificates of qualification vary by province. See the description in the Registered Apprenticeship Information System (RAIS): https://www.statcan.gc.ca/en/statistical-programs/document/3154_D2_V5

consumer protection.[197] The rationale for provinces establishing compulsory trades is to give the industry and its customers the assurance that those holding the certifications are qualified and safe to do the work. As only those with the appropriate provincial COQ can legally practice a compulsory trade, this also provides an incentive for workers to apprentice for the trade, given that it limits who can perform the work, resulting in increased employment opportunities and job security for those with the qualification.[198]

A designated voluntary trade normally involves completing an apprenticeship and obtaining a COQ confirming that the individual is competent to perform the trade and use the trade's name on their resume. However, provinces do not require workers to have this credential to perform the work of the trade. Not surprisingly, the completion rate for apprentices in compulsory trades is higher than voluntary trades. Restricting the right to practice through compulsory trades limits who can work in the trade and requires contractors to hire workers with a COQ for work falling under the scope of the trade.[199]

Canada's Red Seal system is quite different from the US approach to regulating apprenticeship. The US does not have a comparable national set of curriculum standards which define what is included in the apprenticeship programs in every state. Approximately half the states adhere to federal guidelines for individual trades, while the other half have their own criteria for determining the qualifications and corresponding training requirements.

The U.S. system is more decentralized and fragmented, creating barriers for worker mobility. Public financial support for apprenticeship is only a small fraction of what Canadian governments provide to public colleges and union training centres. There is also considerable variation in the actual training that construction workers in the same trade receive depending on where the state in which they live. This is mediated somewhat by the role of construction unions in overseeing trades training in parts of the US where they have a significant presence and try to maintain comparable national standards for their respective trades. But there are also many states where unions play little or no role in training and regulation of qualifications is weak. The national standardization of the Red Seal provides significant advantages for Canada because workers in the same trade have undergone broadly similar training which is recognized throughout the country.

Because Red Seal certification is recognized by all provinces, it facilitates interprovincial mobility, a significant benefit for employers and construction workers.[200] The Red Seal

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[197] Mate, Gregory (2020) A Critical Analysis of Apprenticeship Programs in British Columbia. PhD thesis Faculty of Graduate and Postdoctoral Affairs, Carleton University.
[198] Gunderson, Morley and Harry Kraskinsky. (2015) Returns to Apprenticeship Based on the 2006 Canadian Census. Industrial and Labour Relations Review. Vol 68., No. 5. pp 1078 – 1101.
Gunderson, Morley and Harry Kraskinsky. (2016). Apprenticeship in Canada: An Increasingly Viable Pathway. Challenge. Volume 59, 2016 - Issue 5 https://www.tandfonline.com/toc/mcha20/59/5?nav=tocList.
[199] Hyeongsuk, Jin, Manon Langevin et. al. Factors Associated with the Completion of Apprenticeship in Canada. Statistics Canada. https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/collection_2020/statcan/75-006-x/75-006-2020-8-eng.pdf
[200] The exception is Quebec which has a more limited involvement in Red Seal harmonization.

written exam for each trade assesses what apprentices have learned in the classroom component of their apprenticeships. Understandably instructors face pressure to focus only on teaching the content of the Red Seal Standards so that their apprentices will have a high pass rate, a criterion that also measures the success of their training institution. The desire to pass the exam also encourages apprentices to concentrate on learning the skills set out in the Standards so that they will be successful. However, this can have the negative effect of dissuading instructors and apprentices from focusing on issues not covered by the Standards.[201]

Revisions to the Red Seal Standards for each trade are infrequent, normally only every 4 or 5 years, sometimes longer. A common complaint is that parts of the curriculum are outdated, a point raised by many of the instructors CIRT interviewed both in English Canada and Quebec. It is also slow to respond to the introduction of new working practices and changes in materials and technology. There is a good case for the schedule of revisions to be shortened significantly to ensure that what is taught in the classroom reflects current industry practice.

A commonly noted limitation of the Red Seal exam system - and its provincial certification equivalents - is that the multiple-choice written exam does not assess how well apprentices perform on job sites in exercising the skills of their respective trades. It only tests their ability to answer exam questions in a classroom setting – questions based on the written Standards posted on its web site (or provincial equivalents) and covered in the classroom component of their apprenticeship. For this reason, some critics argue that the evaluation system does not guarantee that an apprentice who passes the exam will be able to perform competently on construction sites.[202] Given the variability of employer training provided to apprentices and that the on-the-job component of apprenticeship normally represents 80% of their training, this is a significant concern. As Meredith notes: "As it is based entirely on the participating provinces' in-class curricula and exam item banks, the Red Seal cannot, strictly speaking, be interpreted as a standard of occupational competency, but only of testable subject knowledge." [203]

The Red Seal system allows provinces to permit construction workers who can demonstrate that they have been working in the industry for a period of time to 'challenge' the exam without participating in the customary four-year classroom component of the apprenticeship program. Of course, workplace experience can certainly be an indicator of the capacity to perform the competencies of a trade. Workers with a lengthy period of time on the job can also learn the textbook content required to pass the exam and demonstrate that they are knowledgeable about the various skills that are included in the Red Seal Standards.

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[201] Details of the Red Seal program are set out on its web site. https://www.red-seal.ca/eng/about/pr.4gr.1m.shtml. There are concerns about whether the 70% pass level in the multiple-choice exam sets a high enough bar and whether this should be the only assessment tool to determine whether apprentices are qualified. But the approach is well entrenched.
[202] Meredith, John. (2011). Apprenticeship in Canada: Where is the Crisis? Journal of Vocational Education and Training. Vol 63, No. 3..
[203] Meredith, op. cit. p. 135.

Challenging the exam can also be a way for trades workers who have apprenticed in other countries before moving to Canada to obtain their credentials without doing a formal apprenticeship.

However, a major drawback of challenging the Red Seal exam is that the number of years working in the industry does not necessarily equate to having learned the full scope of practice of a trade. Workers can end up doing the same type of construction work for a single employer – or the same type of employer - over a number of years. Consequently, they may not be exposed to a learning environment which enables them to acquire the knowledge, skills and competencies of a well-rounded and fully qualified trades person. Working only on a narrow range of construction tasks does not offer the opportunity to acquire the kind of broad experience needed.

It is also not clear whether – and to what extent – challenging the exam can make up for the actual classroom experience of learning from qualified trades instructors. Success on the exam may – or may not - indicate accurately whether the applicant has mastered the conceptual and knowledge content delivered in the face-to-face classroom setting. From the perspective of climate literacy this is a significant issue. It is problematic to assume that most employers will be able to provide their apprentices – or their journey workers – with an appropriate background in climate science or the impact of climate change on the construction industry. It is in the classroom that this material can best be delivered because this is where instructors are able to include it in the curriculum.

The classroom experience is also social. It facilitates discussion with instructors and among apprentices, something which cannot be readily duplicated by individual workers studying the textbooks on their own or taking one of the many on-line courses in exam preparation which can be simply an exercise in memorization. Participation in the classroom also provides an opportunity for apprentices to discuss the theory that underlies many of the practical skills that are included in the apprenticeship program. There is also a perception that obtaining a trades certification without the in-class experience may call into question the value of the classroom component of apprenticeship to workers considering an apprenticeship.

Enabling workers to 'challenge' the exam reflects the interests of employers who need workers with the appropriate COQ where the legislation requires it, but who prefer not to provide support for apprentices on their worksites. During periods of labour shortage, qualified workers are in demand and can command higher wages or choose employers with whom they prefer to work. Filling this labour shortage by encouraging workers to challenge the exam is a way for employers to expand the qualified labour pool and reduce upward pressure on wages. [204] However, it also reduces the incentive to take a formal apprenticeship.

[204] This has been a particular problem in the regulated Quebec system as employers have pushed to allow more workers to be allowed to work in certified occupations without the formal qualifications to address labour shortages, especially in certain rural or remote areas of the province or certain projects where there are labour shortages.

It is not clear why workers would take time off the job for classroom study if they can continue working and then crib for the exam once they have put in sufficient time working in the industry to qualify to challenge the exam.

There is an argument that to ensure that workers have the full range of knowledge, skills and competencies – and an understanding of climate issues - a minimum period of classroom time should be a requirement before being permitted to challenge the Red Seal exam. Prospective journey workers should have to demonstrate competency in the classroom setting, including in-class tests, as a condition of being able to challenge the Red Seal. This is particularly important because the background in both building and climate science, which is so important for high performance construction, is unlikely to be offered by most employers on job sites.

Most employers are not in a position to provide apprentices with an understanding of the impact of climate change on the industry or the contribution various trades can make to reducing Canada's climate footprint. This is something that the classroom component of the apprenticeship program is well suited to do. From the perspective of developing a more climate literate workforce, there is a strong argument that apprentices need to have the opportunity to learn about climate issues in this setting. While allowing workers to challenge the exam without any classroom exposure may be attractive to employers and to some apprentices it is not an effective way to deliver climate literacy.

Another concern is the variability of the training apprentices receive on job sites. The quality of the training apprentices receive is contingent on the capacity and commitment of their employers to provide them with appropriate learning opportunities and suitable mentorship from experienced and qualified journey workers.[205] There are wide variations in the experience apprentices gain at work, a problem exacerbated by the relatively limited capacity – and willingness - of the federal government and the provinces to monitor on-the-job training.

A 2018 survey conducted by the Canadian Apprenticeship Forum found that a substantial proportion of apprentices were unsatisfied with the support they received from their employers on the job. A more recent CAF study summarized the findings of the early research as follows:

"According to a 2018 survey, almost half of the apprentices surveyed reported not meaningfully engaging with their employers and/or journeypersons about their learning on-the-job. Most apprentices reported that their employers did not meet with them on a regular basis, either weekly, bi-weekly or monthly (61 per cent), and that they did not discuss a training plan with their employers (62 per cent). Just over half the apprentices reported their employers and/or journeypersons did not provide them with feedback about their progress

[205] Howe, Aaron S., Joyce Lo et. al. (2023). Engaging Employers in Apprentice Training: Focus Group Insights from Small-to-Medium-Sized Employers in Ontario Canada.

and slightly more (56 per cent) said that their skills strengths and weaknesses were not discussed."[206]

Strengthening the contribution of employers to VET is obviously desirable. In terms of the promotion of climate literacy, employers can provide valuable support by signalling that net zero construction practice is what they expect from those they hire. They are the ones that have the capacity to ensure that their worksites are 'green'. It is also important that the direction employers give to their apprentices on their work sites reinforces what apprentices are learning in the classroom about net zero construction practice and what working trades know to be appropriate. Admittedly this is a significant challenge. But it is one that governments need to address because apprentices' experience on the job should support what they learn in the classroom. This suggests that a key challenge in promoting climate literacy involves providing appropriate incentives, supports and resources to enable, encourage employers to do so.

In addition to the carrot of more supports for employers, governments may also need to use the stick of more detailed regulation of the work experience employers provide to apprentices. This means more 'hands on' involvement of government to monitor the quality and extent of what apprentices are learning on the job to ensure that it addresses the full scope of the trade. In the context of promoting climate literacy, monitoring the support apprentices receive from employers on work sites – something governments and unions used to do more extensively in the past - can provide a way to ensure that climate issues, as well as other VET objectives, are properly addressed.

However, until the capacity limitations of many employers to support climate awareness are resolved, the apprenticeship system will need to rely heavily on the classroom component to deliver climate literacy. And this will mean enhancing what is in the Red Seal Standards on the impact of climate change on the industry and the role that its workforce can – and should – play in achieving climate objectives in the building sector.

Until very recently, the Red Seal Standards said very little about climate change in the detailed and very extensive description of the skills construction apprentices need to master for their respective trades. The Standards for several trades had only a handful of references to conservation, sustainability, and environment (normally working environment) and said nothing explicit about climate change. They did include a few references to certain net zero building standards such as LEED, R-2000, ASHRAE 90.1 and Passive House. But there was very little climate related information– actually in most Red Seal Standards nothing at all –

[206] Canadian Apprenticeship Forum (2023) Digital Tools and Apprentice Learning On-the-Job: CAF-FCA Project Findings. Ottawa. https://caf-fca.org/research_reports/digital-tools-and-apprentice-learning-on-the-job-caf-fca-project-findings/ The quote is a summary of the findings of an earlier study: Canadian Apprenticeship Forum. (2018). Quality of Workforce Training: Apprentice Perspectives. Ottawa.

that, specifically, referenced climate science or explained why climate change is now a critical issue for the construction industry and the work of the skilled trades.[207]

As this report was being finalized, the Red Seal Secretariat released a statement entitled Roles and Opportunities for Skilled Trades in a Sustainable Future. Its content will be included in all future revisions of the Standards for each trade. The text includes the following:

Apprentices and tradespeople need to increase their climate literacy and reinforce their own understanding of energy issues and environmental practices. It is important for them to understand why these changes are happening and their effect on trades work. While individual tradespeople and apprentices may not be able to choose certain elements like; the architectural design of buildings, building material selection, regulatory requirements, use of electric vehicles and technologies, they must understand the impact of using these elements in their work. Impacts include using environmentally friendly products and following requirements related to the disposal and recycling of materials.

In apprenticeship, as well as in ongoing professional development, employers and instructors should encourage learning about these concepts, why they are important, how they are implemented, and the overarching targets they are aiming to achieve.

All in all, it's about doing the work better and building a better world.[208]

From the perspective of promoting climate literacy this new statement is welcome news. While it has taken a long time to include climate issues in the Red Seal Standards, the fact that this statement will now appear in the curriculum profiles for every trade opens the door to legitimizing climate as an area apprentices need to know about while enabling instructors to cover climate science in their classrooms.

Despite the fact that until the summer of 2023 the Red Seal curriculum did not explicitly address climate change, CIRT found that several Canadian and U.S. union training programs had already included elements of climate science, energy literacy, sustainability, resource conservation and environmental stewardship in their courses. The most notable were those involving Canadian and U.S. unions using the GPRO modules from the U.S. Urban Green Council, the modules used in some Canadian electrical training programs and the short courses developed by the Toronto and York Labour Council in conjunction with the building trades in that region.

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[207] This issue is dealt with in more detail in a 2021 paper prepared for the project and included in the Interim CIRT Report. It was based on a word search of the Red Seal Standards documents that looked at whether they included key climate and environment related issues. In almost all of the 37construction related Red Seal Standards it analysed, it found no direct climate change references. See the individual standards posted on the Red Seal Web site referenced in the previous footnotes.

[208] The statement is found on the Red Seal Web site at: https://www.red-seal.ca/eng/resources/roles.shtml

Several unions shared with us their internal curriculum documents which we reviewed to understand how they approached teaching climate and environmental issues. Our detailed analysis of this material is included in a separate appendix to this document. (As the survey was limited to union trainers, it did not include any climate modules included by the public college system in their training programs.)

Including climate change in the Red Seal Standards opens the door to covering the issue. However, there are still challenges. Instructors in union training facilities will still have to find ways to shoehorn climate related concepts into cracks in the curriculum, given that most recognize that the curriculum is already quite full.

They face challenges in delivering the existing material in the limited amount of classroom time available without adding new climate modules. In addition, in recent years the Red Seal system has rightly added new curriculum material on health and safety, indigenous perspectives, women in trades, workplace diversity and mental health.[209] Introducing new climate literacy material will thus be a challenge for the system in the coming years.

Ideally, adding more classroom training to address climate change would be a logical way to address this challenge. But there are major problems in doing so. Employers are reluctant to provide their apprentices with more time off the job, given the need to replace them for longer stretches if additional classroom hours were added.[210] Apprentices have concerns about lost income when in the classroom and taking longer to get their COQs. There are also significant financial implications for provincial governments in paying training schools for more classroom time and for both levels of government in providing EI and other financial support for apprentices.

Employers, unions, colleges and governments have discussed the issue extensively over the years. It has proved to be difficult to resolve. Trainers normally want more and employers - and some apprentices - less. In the context of the current labour shortage in construction, there is considerable pressure from many employers to shorten the time required to obtain a COQ or to waive part of the requirements. Arguably this would be a step backwards. There is a strong case for adding, rather than reducing, classroom time. This would provide room for new climate literacy material while strengthening other elements of the apprenticeship curriculum to address the more demanding requirements associated with net zero construction practice.

If the classroom hours set out in the Ellis Chart for each trade remain the same, given the growing climate crisis and the role the construction industry can play in addressing it, the introduction of elements of climate literacy into the existing format will need to be carefully

[209] Canadian Apprenticeship Forum. (2019) National Strategy for Supporting Women in the Trades. Ottawa: https://caf-fca.org/wp-content/uploads/2020/09/SWiT-National-Strategy_en-web.pdf
[210] Construction Industry Training Network. (BC). (2016) Construction Industry Training Consultations: Final Engagement Report. January.

woven into future curriculum updates of the existing Red Seal Standards for the construction trades.[211]

Despite its limitations, as noted, the Red Seal system plays a critical role in ensuring that the classroom curricula benefit from the input of a wide range of industry stakeholders. Their inputs mean that its content reflects what they feel apprentices need to know to practice their trade. It also provides a reasonable level of comparability in what is taught in training centres across Canada, facilitating sharing of best practices and cumulative learning. More importantly, from a climate perspective, having a standardized, national curriculum offers a valuable opportunity to introduce elements of climate science into Canada's apprenticeship programs.

Beyond the Red Seal there is a confusing pattern of certificates, endorsements and other qualifications administered by a wide range of public, union, manufacturer, not-for-profit and for-profit training organizations. Many of these make sense in the context of specific niches in the construction industry, such as endorsements for working on a specific manufacturer's technology or mastering specific computer software or apps. Where credentials are being offered to provide specific knowledge, skills, or competencies to a qualified journey worker who already has a thorough grounding in the trade, they can be extremely valuable by adding to a well-developed skill set. Given the rapid advances in technology, courses which enable a trades worker to remain current are necessary for many workers to stay on top of developments in their trade. Some are also valuable for professionals, such as the ECO Canada Environmental Qualification, which confirms that the holder has taken its course and passed the exam.[212]

However, there are many other certifications – often referred to as micro credentials - especially around 'green' qualifications whose value is questionable. The proliferation of micro credentials presents a challenge to the industry, given the lack of regulation and standards. What these certificates actually signify in terms of the qualifications of those holding them is often unclear and sometimes quite misleading.

Some training providers are promoting micro credentials to short-circuit the need to take a full apprenticeship by offering workers the possibility of learning a particular marketable skill, normally to qualify for a specific type of job (or task) for which there may be a demand at the time. While advocated as a way of providing employable skills, some employers see micro credentials as a way to cut labour costs and avoid hiring qualified journey workers.

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[211] See the Ellis Chart for the number of classroom and worksite hours required for each trade. https://www.ellischart.ca/eng/h.4m.2.shtml

[212] ECO Canada (2016) Competencies for Environmental Professionals in Canada: National Occupational Standards. August. www.eco.ca. See the Eco Canada web site for a listing of its environmental certificate programs. https://eco.ca/environmental-professionals/lifelong-learning-for-professionals/higher-education/climate-change-certificate/

They can also be a way to minimize obligations for training the workforce. The proliferation of narrow, task-based micro-credentials, often based on completing a few weeks of training, does not guarantee that the holder is competent to perform the work the certificate may imply, if the person is not already a qualified journey worker.

In the construction context, a major problem with the proliferation of a confusing number of unregulated private micro-credentials is that work on building sites requires much more than acquiring a skill to perform a specific task. Construction workers need to know about health and safety, environmental regulations, building code requirements and a wide range of other matters to work productively and safely. They also need to know something about the workplace culture and the role of the various occupations working on building sites. It is misleading to promote very short courses that claim to provide workers with a particular skill that will enable them to work on construction sites when the skill is being taught in isolation from the more comprehensive knowledge and competencies construction workers need to know.

The fragmentation of the various components of a building trade into a collection of narrow skills, each of which can be taught separately, undermines the goal of workers having a proper trades occupation based on comprehensive training in the trade and with the expectation of a long-term career in the industry. Narrowly focused, task-based skills do not enable the worker to learn the kind of problem solving, communication, teamwork and other occupational components that are essential for high performance construction practice.

Given that they are based on a particular task, they also create employment vulnerability when this task is no longer in demand. Unlike a worker with a full trades apprenticeship, the holder of this kind of micro-credential does not have the flexibility to work on other components of the trade and is therefore less likely to remain employed in the industry, given the cyclical pattern of construction work that is normally reflective of the business cycle.

While it is not the mandate of this project to resolve the challenges of micro-credentials, this is an area which requires governments to address the current lack of standards and regulations. The public policy goal should not be to implement a kind of Taylorist fragmentation of occupations, but rather to upgrade the overall qualifications of the construction workforce by expanding opportunities for workers to take full apprenticeships leading to a lifetime career in the industry.

11.0 The Current State of Climate Literacy Training in Canada's VET Programs

There are numerous pathways for workers to learn about the impact of climate science on construction. Some climate material is delivered in progressive college and union

apprenticeship programs by instructors who have added climate content to their provincial or Red Seal curricula, a development we have discussed elsewhere in this document. However, there are many other sources of climate related pedagogy. In addition to colleges and unions, these include: the K-12 system, training on proprietary 'green' construction standards systems like LEED and Passive House, in-house company programs, training by manufacturers of proprietary technology, equipment & software and training provided by a wide range of other organizations involved in the construction industry.[213]

In addition to formal classroom-based training or on-line programs, as earlier noted much training takes place on job sites by employers, unions and their journey worker members – activity that is spread widely in the industry and is not well regulated or documented. As noted earlier, approximately 80% of VET programs take place on construction sites and is supervised by contractors and their qualified trades mentors. Other forms of training occur through programs offered by a host of different commercial organizations of varying degrees of competency and capacity.

CIRT felt it would be helpful to survey some of the major Canadian organizations that are delivering elements of climate focused training for apprentices, journey workers, trades instructors and others working in the construction industry. The purpose is to get a fuller picture of the extent to which these various organizations are contributing to the development of climate literacy in the workforce. Admittedly, this is a challenging task, given the large number of organizations that deliver various forms of training to construction workers. The following survey identifies some of the major training organizations, describes what they do and discusses the extent to which they are incorporating elements of climate literacy into their curricula.

A starting point is with the two most important sources of trades training: public colleges and union training centres. These organizations introduce workers into the trades and provide the basic skills needed to perform high quality construction work. Their trades training programs are overseen and officially recognized by provincial governments through provincial trades certification programs and by the national Red Seal Standards system.[214]Their training programs are based on formal apprenticeships and, in some cases, upgrade certifications for qualified journey workers.

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[213] For a good overview of all the major organizations involved in construction industry training see the now slightly dated 2009 study by the Construction Sector Council. The study examined 1,226 programs and courses, three fifths of which were offered by public colleges. It carried out national surveys of colleges, unions and employers to document the kinds of training courses they provided. Its list of providers included: governments, educational institutions, workers' compensation boards, construction safety associations, unions, employers and firms supplying construction equipment, technology and services. Unfortunately, it did not focus on climate related training or include the many private organizations involved in low carbon construction training. Construction Sector Council. (now BuildForce Canada). (2009) Skills: Training Capacity in the Canadian Construction Industry. https://www.buildforce.ca/en/terms?fid=217.

[214] Canadian Council of Directors of Apprenticeship. (2021) 2020 Annual Review. Ottawa: July. https://www.red-seal.ca/_conf/assets/custom/docms/ccda-2020-ar.pdf
See the Red Seal web site for more information about its standards and the training requirements to obtain a Red Seal certificate for each trade in the Ellis Chart. https://www.red-seal.ca/eng/w.2lc.4m.2.shtml.

Both public colleges and unions also offer additional training to the trades workforce outside the Red Seal Standards. They offer pre-apprenticeship training to enable prospective apprentices to acquire the educational qualifications and basic skills to be able to enrol in a formal apprenticeship program. Climate change is sometimes part of their curriculum. They provide a variety of elective upgrade courses of varying lengths to qualified trades workers to enable them to learn about new technologies, computer software packages or working practices. Some of these are offered in cooperation with Passive House Canada or the Canada Green Building Council and focus on net zero construction practice. Colleges also offer micro courses on a variety of subjects to their own students and to the wider public who want to learn specific skills but not enrol in a formal apprenticeship.[215]

11.1 College and Institute VET Programs

Canada's public colleges and institutes are the largest providers of the classroom component training for the construction trades. However, their educational mandates extend beyond trades training.[216] As public institutions, they are extensively engaged in climate-focused undergraduate and graduate teaching as well as research.[217] Most college programs are targeted at students taking academic, science or professional degrees, including architecture, engineering, planning, project management, business administration and a range of science subjects. The curriculum for some of these academic programs may include climate change material. Depending on the specific college, their academic programs cover a wide range of climate-related subjects such as: environmental science, planetary ecology, biodiversity, sustainable agriculture, artic impacts, marine studies, wildlife impacts, land conservation, ocean acidification, urban impacts, population health and numerous other environmental, ecological or sustainability issues. Some offer dedicated courses in climate science itself.[218]

[215] The national organization representing colleges, institutions, institutes of technology and other public post-secondary training organizations is Colleges and Institutes Canada (CIC). A large portion of its membership provide construction trades training. A list of its membership can be found at. https://www.collegesinstitutes.ca/colleges-and-institutes-in-your-community/our-members/ The web site lists all the construction trades training courses provided by its member organizations, identifying them by individual trade and the college/institute that offers the course. https://www.collegesinstitutes.ca/colleges-and-institutes-in-your-community/benefit-college-institute-credential/list-degrees/

[216] Skolnik, Michael. (2021) Canada's High Rate of Short Cycle Tertiary Education Attainment: A Reflection of the Role of its Community Colleges in Vocational Education and Training. Journal of Vocational Education and Training. Vol. 73, No. 4.

[217] Moore, Jenny. (2021) Strategies for Energy and Climate Management at the British Columbia Institute of Technology. Journal of Sustainability Perspectives: Special Issue.

[218] For a concise overview of the role of colleges in Canada's post-secondary education system see: Skolnik, Michael. (2021). Canada's High Rate of Short Cycle Tertiary Education Attainment: A Reflection of the Role of its Community Colleges in Vocational Education and Training. Journal of Vocational Education and Training. Vol. 73, No. 4.

Many colleges are also positioning themselves as climate change advocates in their research and public engagement.[219] Some are branding themselves as climate champions and use this label to attract students. Many are engaged in integrating elements of climate science throughout their programs as they see climate change as a major threat to our species and an area which urgently requires public action.[220] They are highlighting the importance of the issue to all their students. Many are also demonstrating their commitment to addressing climate change through commissioning net zero buildings to show their students that this approach to construction is both affordable and desirable.

In an environment where colleges are actively promoting learning about climate change throughout their program offerings, apprentices and journey workers taking trades courses, like other students, are being encouraged to recognize its importance and think about how it will affect themselves, their future occupation, and the wider society. Some colleges, such as BCIT in BC, or George Brown in Toronto have incorporated limited elements of climate awareness into their trades courses.

However, the extent to which colleges have done so varies considerably. What gets taught, or not, is often left up to individual instructors in the different trades or their department heads. There is no standard national climate literacy curriculum template for each trade for the college sector although they must meet provincial standards which, in turn, are based largely on the national Red Seal system. Knibb and Paci note that collecting data on college programs that address climate change is complex because there is no data base that analyses course content (lesson plans) of the tens of thousands of courses being offered and no single agency responsible for collecting this information in Canada (Knibb and Paci 2016).

Colleges and Institutes Canada (CICan) represents Canada's approximately 150 public colleges, technical institutes, and Quebec CEGEPS, most of whom provide trades training at many of their 680 facilities across the country.[221] Its member colleges teach the curriculum mandated by each province/territory; a curriculum based on the national Red Seal Standards which, as discussed elsewhere, does not include climate change. Depending on the extent to which climate change is a priority of the college and its instructors, they may include varying amounts of climate change information within their trades courses. More commonly, they cover skills related to issues such as energy conservation, sustainability, building standards, LEED principles and the rationale for building code energy and GHG requirements, although not normally within a broader climate science or climate literacy framework. Instead, the focus is on learning practical skills associated with implementing these standards or working practices.

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[219] Knibb, Helen and Chris Paci. (2016). The Greening of Canada's College Curriculum: A Pan-Canadian Survey. Trent University and Colleges and Institutes Canada. Vorlage bwpat-Artikel (tvet-online.asia)
[220] Ibid.
[221] Colleges and Institutes Canada and Canada Green Building Council. (2022). Are We Ready: Climate-Focused Curricula, Applied Research, and Campus Infrastructure in the College and Institute Sector. September 20. https://www.cagbc.org/news-resources/cagbc-news/new-report-showcases-key-role-of-colleges-and-institutes-in-canadas-climate-action/

As noted, CICan has not carried out a comprehensive survey of the climate change content in the trades curricula of its member colleges. So there is limited data on what is being taught. However, working with the Canada Green Building Council, it produced a broad environmental scan of environment and sustainability initiatives for approximately 1,000 programs of all types offered by its member institutions in 2022.[222] The purpose was to provide…"a showcase of sustainable design and initiatives, a resource to inspire more leaders in the post-secondary sector to take action and as a means to support collaborative approaches – one of our greatest tools in the fight against climate change." [223] It referenced the United Nations Sustainable Development Goals as its framework for addressing climate change and included a specific focus on indigenous ways of seeing.

The colleges operate quite extensive trades training on-site workshops that are well resourced and often overlap with other programs for architects, engineers and planners. The CICan report found 10% of the approximately 10,000 programs offered by its member institutions had some elements of climate change in their curricula. It found that about 50 construction courses included some climate information. These involved a range of construction areas, including: carpentry, construction management, renewable energy, electrical systems, mechanical contracting, building automation and building science. Unfortunately, the report does not distinguish between elective, pre-apprenticeship, professional, upgrade or regular apprenticeship, so it is difficult to determine what is included in college Red Seal apprentice programs as opposed to construction programs for other students.[224] Discussions with CICan staff indicate that apprenticeship curricula follow the Red Seal Standards quite closely, however, so specific climate literacy material is very limited.

Lack of data on the curriculum content of college programs poses a barrier to more widespread sharing of good examples that integrate climate issues into the training of various trades or the development of generic curriculum modules. Sharing is also impeded by a proprietary approach to curriculum content in some institutions, partly because colleges normally charge tuition to students taking their programs and are reluctant to give away what some see as their investment in the intellectual property of their curriculum.

In addition to the trades curriculum colleges teach as part of their apprenticeship programs, some colleges, such as BCIT and George Brown have developed partnerships with organizations such as Passive House Canada and the Canada Green Building Council to provide elective courses on low carbon, sustainable or net zero construction principles and practices.[225] While not directly part of their apprenticeship programs, these provide an

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[222] Colleges and Institutes Canada and Canada Green Building Council. (2022). Are We Ready: Climate-Focused Curricula, Applied Research, and Campus Infrastructure in the College and Institute Sector. September 20. https://www.cagbc.org/news-resources/cagbc-news/new-report-showcases-key-role-of-colleges-and-institutes-in-canadas-climate-action/

[223] Ibid. p. 4.

[224] Ibid. p. 14.

[225] For example, BCIT lists the following Net Zero Courses in 2022 – 2023:

- Course 1001 Fundamentals of Zero Energy/Emissions and Passive House Buildings
- Course 1120 Air Tightness & Low-TEDI Enclosures of Zero Energy/Emissions and Passive House Buildings

opportunity for interested apprentices, journey workers and other students to acquire knowledge about net zero or Passive House practice. The fact that colleges offer these courses also indicates that they are finding alternative pathways to incorporate climate related instruction for the trades. Some of the content of these elective courses may also be filtering into their core apprenticeship offerings.

In 2020, a group of 14 cegeps, colleges, institutes and polytechnics established a national body, Quick Train Canada, to offer a range of short courses in on-line, hybrid or in-person formats based on what its member institutions either already offered or committed to develop as part of the initiative.[226] According to the web site of Canadian Colleges for a Resilient Recovery (C2R2), it has multiple aims, including: "to quickly develop thousands of training and applied research opportunities to help Canadians access new careers, support the transition to a low carbon economy and foster inclusion, diversity and equity."[227] The initiative involves pooling of curriculum resources from the partner institutions to develop national, standardized training programs across a number of economic sectors. The other subject areas are: agriculture and agri-food, natural resources and environment, transportation, clean tech, industry development and construction. It has a National Industry Advisory Council to provide direction to the initiative which includes representatives from industry, aboriginal organizations, green NGOs and private consulting firms. At this time, it appears that there is no union involvement.

One of its first initiatives is Quick Train Canada, which is intended to help workers upgrade their skills in a variety of subjects, including constructing affordable housing and green buildings. Quick Train Canada is a collaboration among the above noted institutions to develop an internet portal offering on-line, hybrid and in person micro-credential courses in various subject areas, including construction.

The initiative is funded by the Government of Canada and there is no tuition charged to students taking the courses. Access to courses varies, with some institutions having prerequisites to take specific courses, while some have no prerequisites. Students must

- Course 1146 Mechanical and Electrical Essentials for Zero Energy/Emissions and Passive House Buildings
- Course 1120 Airtightness and Low-TEDI Enclosures of Zero Energy/Emissions and Passive House Buildings
- Course 1171 Site Supervision of Zero Energy/Emissions and Passive House Co While no outlines currently exist for this course, below are the course learning outcomes/competencies.
- Course 1173 Applied Project for Site Supervision of Zero Energy/Emissions and Passive House Construction
- Course 1166 Advanced Topics in Whole-Building Life Cycle Assessment XZEB
- Course 1150 Introduction to Solar Photovoltaic & Electrical Systems for Zero Energy & Passive House Homes XZEB 1150
- Course 1166 Whole-Building Life Cycle Assessment Final Project XZEB 1169
  https://www.bcit.ca/outlines/xzeb1120/

[226] The 14 organizations are: Algonquin College, British Columbia Institute of Technology; Cegep Rimouski; Cegep de Shawinigan; Holland College; Mowhawk College; Nova Scotia Community College; Okanagan College; Red River College Polytechnic; Saskatchewan Polytechnic; Seneca College; Southern Alberta Institute of Technology; Yukon University; Humber College.

[227] A more detailed account of its mandate can be found at https://resilientcolleges.ca/about/

register and take courses during the scheduled time slot – normally starting in a specific month – as indicated by the institution offering them.

The participating institutions initially established a group of micro-courses with accompanying credentials. The six courses were: Building Information Modelling, 3D Visualization Modelling and Rendering Tools, Digital Twins – Fundamentals, Techniques & Approaches, GIS and CAD Techniques, Visualizing 3D Data – Virtual Reality and 3D Printing and Data Systems and Visualization for Manufacturing. Quick Train Canada has subsequently expanded its course offerings to a much wider selection of micro-courses noted in the footnote below. [228]

Its courses are of varying lengths, calculated in total study hours. Some courses offer students a certificate of completion from the institution offering them. In-person courses require students to enrol in the institution that provides the course which limits access to those able physically to attend classes. However, on-line courses offered by individual institutions can be taken from anywhere in Canada. While most courses have a specific time frame, some institutions offer courses that students can take at their own pace.

The Quick Train web site is set up to enable potential students to identify the subject they wish to study and then locate the institution and month in which the course will begin. Normally, students must enrol, formally, and make a commitment to taking the entire course through to completion. So, for example, if a BC student wishes to take a construction course, he/she would identify their area of interest, their province, and then see which courses are offered in the upcoming months. Then they would enrol and start in the month the course is offered.

Colleges also partner with provincial governments and municipalities to provide trades upgrade training to accommodate policy changes in the building sector such as the introduction of amendments to their building and energy codes. For example, BCIT's School of Construction and the Environment offers courses designed to help both trades and professionals comply with the City of Vancouver's building step code as well as offering various short micro-credential courses on aspects of high-performance building construction. This is embedded in BCIT's larger climate change program as part of its UN affiliated Centre for Ecocities that promotes a wide range of climate initiatives. BCIT also offers a short free course on the basics of climate change for its faculty and students, but this is not made available to the wider public [229]

[228] The following are examples of some of the micro-credential courses offered through the Quick Train web site: Introduction to Construction Management; Building Envelop Science, Principles and Practice; Business Decision Making and Green Solutions; Applied Circular Economy - Construction Material Flows; Applied Circular Economy - Deconstruction Management; Applied Circular Economy – Design for Disassembly; Electric Vehicle Technology and Service; House Construction Fundamentals; Introduction to Construction Estimating; Introduction Studies in Mass Timber Construction; Building Information Modelling. Construction Estimating, Management and Contracting; Green Construction and Renovation.
[229] British Columbia Institute of Technology (BCIT) Centre for Ecocities (2020) 2020 Year In Review. Burnaby, BC. https://www.bcit.ca/files/centre-for-ecocities/cfe-annual-report-2020-unlocked.pdf

As the preceding discussion indicates, many colleges are expanding their range of micro-courses to include subject matter that corresponds to the work of various trades. Some are targeted at qualified journey workers who wish to acquire new skills in an emerging area of the practice of their trade, or to become competent in using new technologies or building methods. However, others are designed to provide a very limited type of skill, such as installing solar panels. The certificate provided is not part of a recognized trades' occupation and normally has limited value in the construction labour market. This type of micro-credential can create the impression that it is possible to do parts of the work of a trade without undergoing a proper apprenticeship or learning the basics of working on a construction site such as safety practice and working with other trades and occupations.

Colleges are actively promoting the expansion of micro credentials to expand enrolment. The issue is complex because of the wide variety of different types of micro-credentials which are being developed for different education and training objectives. A key issue is whether micro-credentials are being developed to supplement and enhance the education and training of qualified trades journey workers by providing courses in construction methods technologies and systems which construction workers need to know to keep up with an industry characterized by the rapid introduction of new materials, technologies, computer software and working practices. In this context, they can build on the foundation of construction competencies formed through a full apprenticeship and thus offer the opportunity for journey workers to deepen their qualifications.

However, another approach to micro credentials can have the effect of promoting the deskilling of the construction workforce. This approach provides training to enable workers to perform very specific, narrowly focused, tasks required by employers who wish to avoid hiring fully qualified trades workers. They are normally offered through short, highly specialized courses which are not linked to enhancing an existing occupational qualification. In this context, their primary function may be to lower labour costs. While some micro credentials can lead to employment, they do not provide workers with the scope or flexibility associated with a proper trade's certificate and therefore limit the employability of workers obtaining them when there is no longer a demand for the specific tasks they have learned to perform.

The focus on micro-credentials, absent a commitment to provide construction trades with the full scope of practice learned through an apprenticeship, also ignores the broader issue of the need for a climate literate workforce with the kinds of knowledge, skills and competencies which much research shows are required to implement effective net zero construction practice. It also fails to consider the developmental needs of workers themselves by restricting what they learn to narrowly focused skills with no prospect of progressing to a proper career or an occupational identity in a specific trade.

An encouraging development is that the CICan has recently started a major research project to document in much more detail the extent to which instructors are able to teach climate

science in the trades programs of its member colleges and institutes. It has established eight committees bringing together instructors and other staff from a select group of colleges to begin the process of identifying what is currently being taught on climate issues and to identify what could be included in college training programs for instructors in the future. This research is supported by a 5-year grant from the federal government and the McConnell Foundation.[230] To date its focus is only instructors and is limited to four trades specialties. The plan is to expand this to more trades once the curriculum for the initial group is completed and tested in selected institutions. However, it is not looking at the actual curriculum provided to apprentices or to working journeypersons. In the longer term, CICan does plan to expand its capacity to teach climate literacy. It also intends to make the curriculum it develops available to all its member colleges and institutions although it is not clear if this also mean publicly available.

CICan has done more substantial research on the pre-apprenticeship programs its members provide, including a very large survey, in conjunction with the Canadian Apprenticeship Forum, of programs for members of under-represented groups. It has identified three types of programs: introduction to the trades; certificate; and skilled trades diplomas.[231] The former are not recognized by provincial apprenticeship boards, but the certificate and diploma courses are often recognized for level 1 or level 2 credit in the formal apprenticeship system. These programs are supported by a combination of tuition fees, federal government grants and provincial subsidies. CICan has also been lobbying in support of the wider use of micro-credentials and the recognition of this form of training more formally by governments.

CICan has also been an advocate for additional federal funding to address the current limitations of both pre-apprenticeship, regular apprenticeship, and journey worker training programs, particularly for indigenous people, women and other under-represented groups. [232] It has also promoted greater harmonization of trades training across the country, including national standards for apprenticeship curriculum.

To summarize, while climate change is extensively researched and taught in the college sector's academic and professional programs, information covering the basics of climate science is not normally a component of the curriculum of their construction apprenticeship or trades upgrade programs because they follow the Red Seal Standards. Many colleges do provide elective courses designed to give apprentices and working trades the specific skills required to carry out aspects of low carbon construction such as Passive House. These may

[230] Colleges and Institutes Canada Website https://www.collegesinstitutes.ca/programs/impact-climate/
[231] Colleges and Institutes Canada. (2020). Inclusive Pre-Apprenticeship Pathways Environmental Scan of College and Institute Pre-Apprenticeship Programs in Canada. Ottawa: July. External Collaboration - Inclusive Pre-Apprenticeship Pathways Environmental Scan Report.pdf - All Documents (sharepoint.com)
[232] Colleges and Institutes Canada. (2021). Resilience, Recovery and Reconciliation. Submission to the House of Commons Standing Committee on Finance. August. CollegesAndInstitutesCanada-e.pdf (ourcommons.ca); Colleges and Institutes Canada. (2022). Canada's Colleges: Supporting Sustainable Jobs. Submission to Natural Resources Canada. April. External Collaboration - CICan_JustTransitionSubmission_April2022_EN.pdf - All Documents (sharepoint.com)

contain a significant amount of climate information.[233] However, the extent to which climate literacy is integrated into their core apprenticeship programs is up to individual instructors and contingent on their interests and preferences and those of their individual institutions. Although they have identified including climate science – as opposed to learning trade specific green construction skills - into their core curriculum for the construction trades, colleges still are at an early stage in this process.

One final point is called for here. A major gap in the college system is that colleges do not have a direct relationship with the employers who provide 80% of the VET program for apprentices.

11.2 Union VET Programs

The second largest source of formal trades training is found in the programs offered by unions, either unilaterally, or cooperatively with unionized employers through joint apprenticeship and training committees (JATCs). They teach the provincial curriculum in each province which is normally built around preparing apprentices to pass the Red Seal Standards exam. CBTU notes that there are approximately 195 union or joint union-employer training facilities across Canada. The JATC apprenticeship model is normally governed by a joint training trust established and funded as part of collective agreements negotiated between construction unions and unionized employers.[234] This system is well established and has grown significantly in recent years in provinces such as Ontario, as the benefits of this arrangement have become more obvious to industry and government.[235]

Normally a jointly trusteed training centre involves one union from a specific trade and a group of employers who are party to a multi-employer collective agreement. Because the union has half the seats on the governing board and because there are different employers with varying levels of interest in the centres, unions tend to play a central role in how centres are managed. Funding is provided through the negotiated cents per hour allocated to the trust. Because the system is based on collective agreements, unions, understandably, also view the money as something their members are paying as part of the employment package, even if nominally employers are paying half the amount. This does not ignore that employers have a major interest in having a well-trained workforce or properly managed training centres. But it means that unions are strongly motivated to participate in the management of the centres.

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[233] An exception would be the GPRO courses offered by George Brown College in its Continuing Education Program under the sustainable building program. It currently offers these for electrical, plumbing, mechanical and operation & maintenance trades. https://coned.georgebrown.ca/courses-and-programs/subject/sustainable-building

[234] O'Grady, John. (2005) Training Trust Funds: A Review of Their History, Legal Foundations and Implications for Trade Union Training. Ottawa: Canadian Labour Congress. Microsoft Word - TTF Report - Final Draft.doc (ogrady.on.ca)

[235] The exception is Quebec, where the Commission is responsible for organizing trades training.

Not all training centres are governed by joint trusts, as many unions have their own centres funded by their members. Because most construction unions are part of international unions, they also take advantage of the training programs provided by the North America's Building Trades Unions (NABTU), its 14 construction affiliates and their numerous affiliated U.S. locals.[236] NABTU operates 1,900 training centres across the U.S. and states that it trains 70% of U.S. construction apprentices. It also provides an extensive range of pre-apprenticeship and journey worker courses, as well as occupational health and safety programs.[237]

JATCs and union owned training centres deliver a variety of different programs in Canada. The most significant is apprenticeship training for provincial certificates of qualification (COQs) and national Red Seal Standards endorsements. While they may absorb some of the costs of apprenticeship themselves, union centres normally receive funding from provincial governments for each apprentice enrolled in the classroom component of their programs. This is based on provincial governments paying so much per apprenticeship 'seat'. Many centres also qualify for provincial funding for health and safety courses, workers' compensation courses, pre-apprenticeship programs and special elective upgrade courses for working trades. Where provinces provide funding for apprenticeship classroom programs, they may also require unions to accommodate trainees who are not union members.

The federal government also provides funding for some VET and curriculum development through its Union Training and Innovation Program (UTIP) and other funding envelopes. As noted elsewhere in this document, UTIP is currently providing $50 million, annually, to support union-based training, including innovative programs that focus on raising the participation of women, indigenous people, people with disabilities and visible minorities.[238] BC's SkillPlan JATC is an example of union involvement in supporting curriculum development for the construction trades (and for other workers as well).

Because of their success in trades training, the federal government and many provinces also provide capital funding to union training centres. They do so because they believe investment in these centres will increase the supply of qualified workers to meet critical industry skills gaps. A recent example of government support for union training programs is Ontario's Skills Development Fund Capital Stream. It has provided tens of millions of dollars to union or JATC training centres in recent years to enable them to expand their facilities and acquire new equipment and technology. The fact that unions already have significant investments in these centres and a solid track record in training apprentices has meant that governments see them as good candidates for capital investments in VET facilities.[239]

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[236] We should note that NABTU has been very helpful to us in carrying out the research for this project. See: https://nabtu.org/

[237] For an overview of NABTU's courses, see: https://nabtu.org/apprenticeship-and-training/

[238] Employment and Social Development Canada. (2022). Evaluation of the Union Training and Innovation Program. https://www.canada.ca/content/dam/esdc-edsc/documents/corporate/reports/evaluations/union-training-innovation-program/ssbp-ed-utip-final-report.pdf

[239] In March 2023, Ontario added $226 million to its Skills Development Fund as well as $75 million over 3 years to assist with ongoing operations. While unions are among several categories of recipients of the

It is worth mentioning that government financial support for union owned training facilities in Canada is quite different from the practice in other countries. In the U.S., government per seat funding for apprentice training is unusual and capital grants extremely rare. While there are significant differences in the training systems of various European countries, in most cases it is the state that owns the training facilities. European unions have varying degrees of influence over training programs, but the buildings and related VET facilities are not owned by labour. Canada's approach is unique.

JATCs often cooperate with public colleges. For example, in BC the electrician's training facility provides the classroom component of instruction for the first-year apprentices, while BCIT handles the subsequent years.

An important strength of the JATC approach is that the collective agreement provides a vehicle for providing employment to apprentices. Unions take responsibility for the apprentices that they indenture and try to ensure that they receive sufficient work time to complete their apprenticeships. Some agreements have ratios of journey workers to apprentices that employers must follow. Because construction work is project by project based and because of the relatively rapid turnover of projects, the ability of unions to assist their apprentices obtaining work with other signatory contractors when they are laid off provides an important method of ensuring that this happens. The link to employers provided by the collective agreement is a key reason why the success rate of union apprenticeship programs is comparatively high.

It is worth noting that historically, unions maintained a hiring hall system which gave them considerable control over the allocation of apprentices to employers. Under this system, when an apprentice was laid off from one employer, he/she was put on the hiring board that managed the assignment of members to jobs requested by employers. On lay off, a member was placed at the bottom of the board's list. Over time as others were assigned to jobs, the member's place would move up until he/she reached the top of the list. He/she would then be first in line to be sent to the next job requested by an employer. However, the system also permitted unions to assign apprentices to employers to ensure that they were exposed to a variety of different types of work within their trade. This enabled them over their typical 4-year apprenticeship to develop a well-rounded occupational profile. The system was not perfect because it was not always possible for unions to provide the variety of different work assignments needed to achieve competency in all fields of a trade, given the numerous factors influencing the work available to apprentices. But in principle it provided a vehicle for doing so.

Employers strongly resisted the degree of control the hiring hall system gave unions, preferring to hire whomever they wanted. Beginning in the 1970s – in some cases earlier -

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funds, they will obtain a significant share and have indicated their support for the program. https://christinehogarthmpp.ca/2023/03/21/ontario-building-skilled-trades-training-centres/

many union locals witnessed the gradual erosion of the hiring hall system. Consequently, they lost the ability to determine which apprentices were dispatched to employers and thus oversee their development. This change occurred because of concerted efforts by employers to control who they hired and restrict the role of unions. While the situation varies according to trade, geographical location, economic conditions and other factors, most employers can choose which union members, or apprentices, to hire. However, many union locals do have some influence and do encourage employers to consider the development of apprentices in their hiring decisions.

Union responsibility for their apprentices also means that they encourage them to fulfil the required classroom component of their apprenticeships, thus progressing through each year of their program. The reason this is an issue is that apprentices may want to continue working rather than return to school to maximize their earnings. However, this delays completion of their apprenticeships and, in too many cases results in failure to complete them. Employers have an interest in pressuring apprentices to stay at work if they need their labour and wish to avoid the challenge of finding replacements. But this has a negative impact on apprentices as missing the scheduled classroom component of the program often results in dropping out entirely. To the extent that unions encourage apprentices to stick with the schedule of classroom studies they play a positive role in facilitating completions. Obviously, this depends very much on the capacity and willingness of each union local to take responsibility for the progress of its apprentices. But it is a factor in raising completion rates. Moreover, because unions have a relationship with employers through the collective agreement, they are able to exercise some supervisory influence over the progress of their apprenticeships.

The question of who will be responsible for ensuring apprentices have the opportunity to learn the full scope of their trade is an increasingly important one, given the higher performance requirements of net zero construction. The VET system needs to ensure that apprentices receive the variety of work experiences that are essential for them to acquire the full range of knowledge, skills and competencies that are the defining attributes of a qualified journey worker. The reduction in the role of unions in supervising apprentices as a result of the erosion of the hiring hall function has left a gap in the system, given that there is no other organization with responsibility for promoting the advancement of apprentices. Arguably, there is a need to re-assess the consequences of unions no longer having the kind of influence they once had over the progression of apprentices both in terms of the quality of the work made available to them and the actual completion of their apprenticeships.

This is obviously a problem for apprentices because the deeper and more extensive their workplace experience, the more employable they will be. And the development of the knowledge, skills and capacity of apprentices is clearly a desirable objective from a personal and human perspective and is a legitimate – indeed desirable – goal of any educational system.

But it is also a problem for the industry and for government. If apprentices are only exposed to a relatively narrow area of work in their trade, they are not going to have the capacity to

perform effectively when confronted with new or different work challenges. If employers only give apprentices simple, repetitive work that does not enable them to put into practice what they are learning in the classroom, this undermines the value of the classroom experience. Similarly, if apprentices do not complete their programs, they will not have the capacity to perform the work needed by the industry. As noted elsewhere in this document, the attributes needed for high performance, net zero construction necessitate a workforce with a wide range of competencies and the capacity to apply theoretical knowledge to new circumstances. Gaps in the apprenticeship system reduce the industry's capacity to meet the much more demanding requirements of low carbon construction.

From the perspective of the industry and its trades workforce, ensuring that apprentices get the opportunity to learn the full scope of their trade is desirable and something that governments need to consider in developing their policies for supporting apprenticeship, particularly given the need for workers to be able to handle the more complex challenges associated with net zero construction.

11.3 High School (K-12) Trades Programs

The impact of the secondary school system on climate literacy in the trades falls into two categories: first, their role in informing young people about climate science and what it means for their future. And second, their role in providing climate information in the pre-apprenticeship classes they provide to students who wish to embark on a career in the trades.

With respect to the former, many trades trainers that we interviewed indicated that the younger apprentices they taught seemed to be more aware of climate change than older students. This reflects a variety of influences on the attitudes and knowledge of young people, not all of which may result from what is happening in the schools themselves. But a key influence is still what they learn about climate change in secondary school.

All provincial education programs provide some information on climate science as part of their curricula.[240] A Common Framework of Science Learning Outcomes K-12 was originally developed in 1997 by the Council of Ministers of Education. It has subsequently been updated to provide provincial curriculum developers with a template for providing science education in their educational programs. Each province has built on this and developed its own curriculum on climate science. Current students are receiving far more information about the issue than previous generations which may explain, in part, the views of new apprentices.

[240] Wynes, Seth and Kimberly A. Nicholas. (2019). Climate Science Curricula in Canadian Secondary Schools Focus on Human Warming, not Scientific Consensus. PLOS 1 Research Article. Lund University, Sweden. Climate science curricula in Canadian secondary schools focus on human warming, not scientific consensus, impacts or solutions (plos.org)

For example, in British Columbia, the K-12 curriculum incorporates climate science throughout its program. The government outlines this focus as follows:

"British Columbia's redesigned curriculum offers a strong foundation for climate change education. The curriculum is concept-based and competency-driven and provides many opportunities for students and teachers to explore climate change in varying levels of detail, across learning areas and grades. For example, topics related to the environment and climate change are found in the required learning standards throughout the provincial science curriculum from kindergarten to Grade 10. Specialized science courses such as Earth Sciences 11, Environmental Science 11, Science for Citizens 11, and Environmental Science 12 provide opportunities for students to study the environment and climate change in more detail." [241]

The latter courses are electives and not all students take them. But those who do will have learned some of the basics of climate science before embarking on their apprenticeships. K-12 teachers are also permitted to include climate science material in their regular courses if they feel it is appropriate. The Ministry of Education and Child Care jointly with the BC Teachers' federation has developed a leaflet that outlines the numerous resources available to teachers on climate science. Significantly, it includes 86 lesson plans for teachers to consider in developing the climate change components of their courses.[242]

An Ontario survey indicated that information about climate change is …"predominantly taught in science followed by social studies but that over 75% of teachers believe that climate change education is the role of all teachers." (Field, Schwartzberg et. al. 2020)[243]. They believe that it should include discussions of social justice, reflections by students of their own values and beliefs and encourage behavioural change. On average, slightly less than half the teachers surveyed felt they had the knowledge and skills to teach climate science. They also identified lack of time, lack of resources and lack of professional knowledge as significant barriers. (Field, Schwartzberg et. al. 2020).

However, the survey also noted some challenges. An important one was the limited time many Ontario teachers spent on climate issues. Those who included climate change in their courses said that they did not allocate a significant amount of classroom time to climate change material.[244]As Putland et. al. note:

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[241] See Ministry of Education and Child Care web site: https://www2.gov.bc.ca/gov/content/education-training/k-12/administration/program-management/climatechangeeducation

[242] BC Ministry of Education and Child Care. (n.d). Climate Ready BC: Preparing Together for Educators. Victoria. https://www2.gov.bc.ca/gov/content/education-training/k-12/administration/program-management/climatechangeeducation

[243] Field, Ellen, Pamela Schwartzberg et. al. (2020). Climate Change Education in the Canadian Classroom. Feb. 26. Ed Can Network. https://www.edcan.ca/articles/climate-change-education-canada/

[244] Putland, Jennifer, Mai Hoeberechts et. al. (2021) Including the Ocean in Formal K-12 Climate Education: Assessment of a Lesson for Middle and High School Students. Canadian Journal of Environmental Education. Vol. 24., no. 1.

"A recent national survey was conducted to understand levels of knowledge and perceptions of climate change among public, parents, youth, and educators in Canada (Field et al., 2019). The survey found that formal educators are the primary source of climate change education for youth; among those teaching climate change education, each dedicates only 1–10 hours to climate change education per year. A significant portion of the educators do not have a solid understanding of climate change and acknowledge they do not feel prepared to teach the subject. Thus, it is not surprising that 43% of Canadians (general public) surveyed failed a climate change knowledge test." (Putland et. al. 2021, p. 190.)[245]

With respect to students, the authors found that slightly less than half understood that climate change was caused by humans, a worrisome finding.

Acccording to Wynes and Nicholas, there are significant variations among provinces in what they include in their respective K -12 programs.[246] Some have developed specific courses dealing with climate and environmental issues while others have tried to 'mainstream' information about climate science into their core course offerings (SEPN 2021).[247] In their view, the latter tends to dilute the significance of the issue as teachers may see it as peripheral to the core curriculum for each subject.

In terms of the content of climate change information, the authors note some significant concerns. Some textbooks misleadingly indicate that there is still a major controversy around whether humans are responsible for climate change. In their words…"We have seen that in several regards Canadian climate change education is not consistent with scientific understanding. Doubts are cast on scientific consensus in curriculum documents." (Wise and Nicholas p. 17). Other researchers have raised concerns that the curriculum has a "shallow engagement" with climate change with a disproportionate emphasis on issues such as energy efficiency in school buildings but far less on the much larger national and global impacts (Bieler et. al.). [248]

Some curricula suggest there are still controversies within the scientific community about whether humans are responsible for global warming, a view completely at odds with what

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[245] Putland, et. al. op. cit.

[246] "These variations appear to be quite independent of the political orientation of different provincial governments..;" (Wynes and Nicholas)

[247] Sustainability and Education Policy Network. (2021). Responding to Climate Change: A Primer for K-12 Education. University of Saskatchewan, Saskatoon. https://sepn.ca/wp-content/uploads/2021/01/SEPN-CCEd-Primer-January-11-2021.pdf Chopin, N., Hargis, K and McKenzie, M (2018. Building Climate-Ready Schools in Canada: Towards Identifying Good Practices in Climate Change Education. Sustainability and Education Policy Network. University of Saskatchewan, Saskatoon. https://sepn.ca/resources/report-building-climate-ready-schools-canada/ Eaton, Emily and Nick Day. (2019) Petro-pedagogy: fossil fuel interests and the obstruction of climate justice in public education. Environmental Education Research. Vol., 26, No. 4. See also Green Teacher magazine for various articles on environment and climate change teaching, https://greenteacher.com/now-available-green-teacher-133-fall-2022/

[248] Bieler, Andrew, Randolph Haluza-Delay et. al. (2018). A National Overview of Climate Change Education Policy: Policy Coherence between Subnational Climate and Education Polices in Canada (K-12). Journal of Education for Sustainable Development, Vol. 11, No. 2. https://journals.sagepub.com/doi/10.1177/0973408218754625

virtually all scientists now believe. Some suggest the impact will not be that significant. Others promote the idea of a 'balanced' debate between sceptics and advocates, again providing a platform for deniers. Some present the science in a way that ignores the need for citizens to engage in discussion about the policy responses governments should adopt to deal with the issue. There is very little about climate justice.

Consequently, while climate science is being taught in all provinces, there are significant variations in the actual content of the curriculum across Canada as well as among school districts within provinces. Some students are getting mixed messages about the extent of the threat and what needs to be done about it. As Bieler et. al. note:

"Provincial and territorial curriculum guidelines are woefully lacking in preparing an engaged citizenry to help mitigate and adapt to climate change. Aside from a few environmentally focused curriculum guides and subject-specific resources, curricula seem to be largely ignoring the challenge of integrating climate change across the curriculum."[249] (Bieler et. al. p. 79)

In terms of the impact on the assumptions that new apprentices are bringing to their programs, secondary school programs are teaching about climate change, so young workers are aware that this is an issue of some importance. However, their knowledge of the science is variable. Perhaps more importantly, they may not have considered how climate change may be a major factor in shaping the work they will do in their future career in the trades. This suggests that while the school system is providing some important information about climate science, it cannot be taken for granted that it is giving every student a solid grounding in it. It may. But it may not. For this reason, it remains important to include information about climate science in the apprenticeship curriculum.

Turning to the second role of the secondary school system – climate literacy in pre-apprenticeship programs - provinces provide students with the option of taking courses that prepare them for an apprenticeship in the trades. These normally include basic numeracy and literacy and a range of other subjects that apprentices will need as they progress through their programs. Some secondary school programs also have shops that enable students to obtain 'hands on' experience with equipment or technology. These may mimic what they would experience subsequently on job sites and provide them with the opportunity to become familiar with what they will end up doing in practicing their trade.

Depending on the policies of provincial ministries of education, secondary schools may encourage students to consider an occupation in the trades by providing information about the employment and income benefits of taking an apprenticeship. Teachers also play a role in linking students with unions and employers and assist students in obtaining an apprenticeship contract with a company willing to take them on. Thus, they play an important role in

[249] Ibid., p. 79.

recruiting new apprentices and providing them with the basic educational and skills requirements to have a career in the trades.

However, secondary school apprenticeship pathway programs often do not include climate literacy in their curricula. For example, in co-operation with the BC Ministry of Education and Child Care, Skill Trades BC provides K-12 teachers with detailed curricula on various aspects of introductory apprenticeship training for which students may get credit when they start their formal apprenticeship. The material includes a core program guide to introduce students to the trades. It also includes various trade specific modules.[250] The material is quite detailed for each trade, so teachers will have the resources they need for their classroom instruction programs. However, these guides, some of which are almost 150 pages in length for some trades, do not mention climate change at all. Similarly in the Skill Trades BC promotional information for young people considering entering the trades, Youth Explore Trades Sampler, Youth Explore Skill Trades and Youth Train in Trades, the term climate change does not appear once.[251]

In response to a question about how much students in the secondary school pre-apprenticeship program learn about climate literacy, a trades teacher gave the following response:

"Unfortunately, I don't think there is much going on in trades training with direct links to the climate crisis and climate literacy. The curriculum makes mention but it's really only when a particular teacher has interest and sees the magnitude that direct instruction around this might be included. To be honest there are many teachers in my area that I am pretty sure think that climate literacy is the "job" of the socials department to cover..."

Given the time and resource constraints of this project, it is not possible to provide a more detailed account of how every other province handles the curriculum modules they supply to teachers who are providing introductory trades instruction. But it is not likely that BC is an outlier, especially as the province covers climate issues in its main K-12 curriculum and promotes itself as a climate change leader. For these reasons, it cannot be assumed that all recent K-12 graduates will have a solid foundation in climate science from their introduction to the trades programs. This suggests that any new curriculum on climate literacy for the trades must, minimally, cover the basics of climate science to ensure that apprentices have a basic grounding in the issue.

11.4 Canada Green Building Council (CAGBC)

[250] https://mytrainingbc.ca/youthexploreskills/#portfolio
[251] The guides can be found at the following web sites: Youth Explore Trades Skills, Youth Explore Trades Sampler, and Youth Train in Trades

Outside the college, union and K-12 systems, a significant source of training in low carbon construction is offered by not-for-profit organizations such as the Canada Green Building Council (CAGBC) Passive House Canada and the Canadian Standards Association (CSA). These offer a wide range of climate focused training courses to industry professionals, skilled trades and members of the general public.

The most well-known for its extensive 'green' advocacy is the CAGBC. It is a non-profit membership organization that offers a wide range of specialized on-line and in-person training programs. It hosts 'on demand' courses, webinars, instructional videos and training guides. Many of its courses are linked to its role as the Canadian administrator of the international Leadership in Energy and Environmental Design (LEED) program.[252] It offers LEED Green Associate credentials and LEED Advanced Professional credentials in green building practice. These credentials confirm a person's competency to work on green buildings and can assist them in finding employment. It provides other credentials that authorize its graduates to advise government agencies and construction firms on LEED standards.[253] CAGBC also offers certificates to enable professionals to assess and approve buildings using the LEED certification system. And it also provides certificates for those teaching the LEED system.[254] Its affiliation with the U.S. Green Building Council, gives it access to over 180 courses that that organization currently offers.[255]

CAGBC has worked closely with governments and industry in carrying out research on a variety of climate and sustainability issues in recent years. This has resulted in literally dozens of technical and training reports on various aspects of 'green' building work. For example, it has developed a suite of 8 courses to assist the industry in implementing BC's step code for a program sponsored by the Canadian Home Builders Association of BC.[256]

It has established 'Zero Carbon Building Standards' for the industry. It consults with governments on changes to buildings and energy codes. It works with architectural and engineering firms to advance green construction principles in their professional work. It also promotes low carbon construction with developers, building owners and municipal planners. It has partnerships with universities and colleges. And it works with various environmental NGOs, such as the Atmospheric Fund, on green building research.

Part of the organization's research involves economic modelling to assess the amount of investment required to achieve GHG and energy targets in the coming years. This is broken

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[252] For example, it currently offers 53 short courses on LEED and low carbon issues varying from one hour to 8 hours in length. https://portal.cagbc.org/CAGBC/Education/Search/Search.aspx?search=73,7,8&sort=Title

[253] Canada Green Building Council web site. https://www.usgbc.org/credentials/leed-ap

[254] Ibid.

[255] https://www.usgbc.org/education-listing?Program=%5B%22LEED+v4.1%22%5D

[256] The courses are: Module 1: Overview and Requirements; Module 2: Meeting the BC Energy Step Code by Design; Module 3: Building Science for the BC Energy Step Code; Module 4: Building Envelope Options for the BC Energy Step Code; Module 5: Airtightness; Module 6: Mechanical Systems; Module 7: Quality Assurance/Quality Control; Module 8: Project Management. https://cpd.chbabc.org/professional-development/bc-energy-step-code-modules-1-8/

down by province/territory and by sectors of the construction industry. Its modelling also projects the job creation potential of a comprehensive program of retrofitting Canada's building stock.[257]

Another of its functions is advocacy. It does this through research and through lobbying and outreach efforts with governments, educational institutions, employers and unions. The CGBC regularly submits briefs to provincial and federal governments and attempts to have them include specific changes to funding programs and building codes that will advance its net zero agenda. It also partners with labour and environmental organizations in developing pilot projects and examples of best practices. The CAGBC organizes educational conferences bringing together industry stakeholders to discuss the most recent developments in high performance construction and to share its own findings from its well-resourced team of industry researchers.[258]

The CGBC is a founding member of the World Green Building Council (WGBC) which was established 20 years ago and is based in London, UK. The WGBC has member Councils from across the globe, including North America, Europe, Africa, the Middle East and the Asia Pacific region. Through its affiliation, the CAGBC has access to training and research resources that are shared among the WGBC's membership of over 75 national councils and 46,000 industry partners.[259]As a non-profit promoter of green construction, CAGBC fills an important training niche in the Canadian construction system. Many skilled trades workers take courses from it and make use of its certificates, and especially its LEED credentials in advancing their careers.

The CAGBC's construction training courses include its view that the building sector has a major role to play in reducing GHG emissions, curbing energy use and promoting resource conservation. They are premised on incorporating climate science and climate literacy into the curriculum and implementing significant changes in how construction is carried out so that it will facilitate the transition to net zero buildings and infrastructure.

11.5 Passive House Canada

Another well-known organization involved in 'green' construction training is Passive House Canada.[260] A not-for-profit NGO, its focus is to promote a particular approach to planning and constructing net zero energy buildings. Originating in Germany, the Passive House system has expanded across Europe and North America. Like the CAGBC, Passive House Canada is able to utilize the resources of an international network of affiliated passive house

[257] https://www.cagbc.org/news-resources/research-and-reports/canadas-green-building-engine/
[258] See, for example the extensive list of courses offered on its web site. https://www.cagbc.org/learn/take-a-course/
[259]World Green Building Council. (2022). Annual Report. London. https://worldgbc.org/wp-content/uploads/2022/12/WorldGBC-Annual-Report-2022_FINAL-version_LR.pdf
[260] https://www.passivehousecanada.com/course-outlines/

organizations. Audits of the energy performance of passive house buildings consistently show that they are far more energy efficient than new buildings compared with them. This is partly because passive house design standards are very high. But it is also because of the approach to construction itself which encourages understanding the environmental principles that underpin the projects coupled with teamwork and constant quality control.

Passive House Canada offers a wide range of courses for architects, engineers, planners and other industry professionals as well as courses tailored to the skilled trades to provide them with the knowledge and techniques used in passive house construction. Its courses cover a wide range of areas, from providing a basic understanding of the principles of passive house construction to how to design and construct passive house buildings.[261] It offers a designers/consultant certification program that leads to a certificate in passive house construction for builders and industry professionals. It also offers a trades certificate in passive house practice which is based on the international passive house curriculum. Its courses cover various construction issues and processes, including building envelopes, thermal bridges, ventilation and heating systems, control layers, air and vapour barriers, water management and many other topics. Its students also learn about compliance with current building and energy codes.

While passive house construction initially focused on residential buildings, in recent years it has branched out to building larger multi-unit, mid-rise commercial and office buildings. It encourages use of wood and other low carbon materials that minimize GHG emissions. The passive house approach involves a whole building concept and encourages teamwork throughout the construction process with the goal of involving workers at all stages of the building process. It requires very high standards of workmanship as buildings must meet extensive passive house criteria to be approved, including energy and GHG measurements of completed structures.

Passive House Canada also plays a role as an advocate for higher green building standards in Canada and internationally. It lobbies governments to modernize their building codes and implement higher standards of construction across the industry. It is a regular contributor to government commissions and shares its research widely within the industry through its newsletter, its resource library, its conferences and its extensive training programs to advance its goal of making industry practices greener.[262] Its approach has become more mainstream in recent years as the scale of buildings it constructs has risen and as the importance of addressing climate change has become more widely accepted.

Passive House has a major focus on public policy. It is critical of what it sees as the very slow progress in modifying Canada's building and energy codes and related standards because it believes that governments have been too influenced by some of those in the industry who are reluctant to embrace the kinds of changes that it sees as necessary. For example, in its

[261] See the list of courses posted on its web site: https://www.passivehousecanada.com/training/
[262] https://www.passivehousecanada.com/passive-house-resources/

submission to the 2021 National Infrastructure Assessment, Passive House Canada made the following observation:

"Systemic Factors Limiting Canada's Ability to Deliver Better Buildings Policy and regulatory decisions are often based off the decisions of regulatory committees. Many of the individuals who sit on these committees have limited experience designing and delivering high performance buildings and deep energy retrofits. It is common for these individuals to have misconceptions about how to build high performance buildings and the costs associated with this type of building standard. Moreover, many committee participants are representatives of industries that have a stake in maintaining the status quo. This threatens Canada's ability to implement codes, standards, and policies that deliver the outcomes required to achieve our climate targets." (July 29)

It has lobbied the federal government to change its conflict-of-interest guidelines on participation in committees tasked with upgrading Canada's building and energy codes because it feels that vested interests are impeding the development of more climate friendly regulations.

Passive House has consistently demanded much higher standards of building performance than governments have been prepared to implement thus far, arguing that the long-term costs of not being aggressive today will be much higher if work has to be re-done in the future when standards are raised again. Thus, it pushes for deep, rather than mild retrofits, arguing that we should do it right rather than do it half-way and re-do it later. The organization also believes that as high-performance buildings become more widely constructed the costs will diminish as the industry becomes familiar with the new design features, building materials and working methods. Volume will drive down costs making new high-performance buildings no more costly than conventionally built ones.

It has also been a strong advocate for the health benefits of high-performance buildings, arguing that they need to be promoted not only to save energy, but also because they will provide a much healthier, more comfortable and more productive indoor environment for building occupants. Properly designed buildings or appropriate retrofits reduce occupant exposure to airborne pollutants, toxic chemicals, mould and other health hazards providing an important co-benefit. As part of its critique of Canada's policies on net zero construction, it believes that governments need to invest much more in supporting system change if they are to achieve the target of 40% to 45% reduction in emissions by 2030.

In terms of climate literacy training, Passive House is significant because it provides an example of how climate literacy can be introduced into a training program for construction workers. It has to fund its activities through charging for its courses and materials, which limits its ability to promote its approach within the industry. The proprietary nature of its curriculum is also a barrier to wider acceptance and application of its approach to net zero construction. However, its overall approach is gaining ground and many of its ideas are gradually entering the mainstream industry.

11.6 Canadian Standards Association

The Canadian Standards Association (CSA) plays a significant role in training for the construction industry, some of which has environmental elements. It is part of the large CSA Group that is responsible for setting a wide range of standards, globally, through the International Organization for Standards (ISO). The history of ISO standards setting goes back to 1947 and over 23,000 standards of various types have been developed since then. Of particular relevance to this study is ISO 1401which was developed to provide guidance on environmental best practices through the implementation of an environmental management system (EMS). The standard is the basis of certification which companies can use to indicate that they are following CSA approved environmentally sound practices in their operations.

CSA establishes standards for a wide range of construction materials, systems, equipment, technology and measuring tools. Among others, CSA standards apply to: reinforced concrete, laminated timber, electrical equipment, intelligent building systems, workplace ergonomics, geotechnical building designs, gas equipment, building energy data reporting, recycling, asbestos management, modular construction standards, masonry structures design standards, microgrids in buildings, information and communication technology infrastructure in buildings, smart lighting systems, high rise modular construction, metal exposure in the welding trades, building energy modelling, diesel engine emission testing, work environment reporting standard, portable ladders and building power distribution systems.

CSA is consulted when Canada amends its various building, energy, fire and other regulatory codes and plays a significant role in providing research that informs code development. It also provides courses to the industry on implementing the codes.

Turning to construction training, the CSA provides detailed technical training to industry professionals, trades workers and instructors in six major areas: electrical, gas, petroleum & natural gas, health & safety, construction and infrastructure and environment. Depending on the specific course, it may be offered to architects, engineers, modelers, designers, electricians, energy auditors, technicians, mechanics utility mangers, apprentices, and others in the building industry or to the general public. CSA courses cover a wide range of construction issues, but generally focus on understanding how to meet the legal and technical requirements of statutory building, energy, fire, bridge and other codes as well as specific CSA-ISO standards. CSA offers training in person, on-line and in blended formats. CSA also has a set of certifications which successful course participants can add to their resumes.

A number of CSA courses deal directly with climate issues, including measuring greenhouse gases, calculating carbon footprints and assessing environmental impacts, including how to measure and verify GHG emissions based on the ISO14064 standards parts 1, 2 and 3 as well as guidelines on how to reduce environmental impacts. It has a benchmark energy factor training course for SPE-500 and SPE-501 standards. It also provides training on CSA codes that deal with measuring energy performance of buildings.

The CSA also provides guidelines on issues such as equity, diversity, inclusion and accessibility in VET programs adopted by the Canadian Apprenticeship Forum and the

Canadian Council of the Directors of Apprenticeship for the Red Seal Standards. In doing so, it consults widely in the construction community to ensure that it incorporates the views of key stakeholders in developing its training guidelines. It also does the same for advisories on issues such as health and safety training for apprentices.

Although a not-for-profit organization, CSA charges users for its standards guidelines to recover its costs. This information is proprietary, so access is restricted to those willing to pay. The same is true for the large number of technical courses it offers which vary in length from an hour to many weeks. Given the very broad scope of its standards setting and training activities and given its environmental and climate coverage, CSA plays a significant role in advancing knowledge relevant to developing climate literacy.

11.7 Eco Canada

ECO Canada is a diverse environmental human resource organization that provides a combination of career development, employment promotion, 'green' climate certifications, workforce training, labour market research, consulting and advocacy for professionals and others involved in the low carbon workforce. Started in 1988, it defines itself as the "Environmental Careers Organization for Canada." It works closely with industry, consulting firms, colleges and universities in providing human resource advice designed to address climate change. Its mandate is to cover all areas of the economy by supporting environmental employment issues with a particular focus on professionals.[263]

One of its early initiatives was to develop a program to certify environmental professionals. This was to establish third party registration affirming the training and qualifications of individuals claiming to be environmental professionals. It has supported the development of National Occupational Standards for Environmental Employment Services which is used to assess the competency of applicants for its certification. It has certified over 6,000 environmental professionals as part of its efforts to create a properly trained environmental workforce. [264]

Eco Canada carries out research on best practices for environmental professionals largely funded by the federal government and has published over 100 reports. Its economic modelling identifies where new environmental jobs will be needed in Canada, including the type of job and region, or province, where jobs will be located. This also involves identifying critical shortages of environmental professionals as a guide to those seeking current and future employment. It offers a jobs board where professionals can post their resumes in their search for employment and has succeeded in placing over 3,500 applicants.

[263] Eco Canada. (n.d.) The Evolution. https://eco.ca/about-us/eco-evolution/
[264] Ibid.

ECO Canada offers a certification for environmental professionals that is nationally recognized that they can add to their resumes. It provides a variety of environmental courses directly through its Accreditation Program. More recently it has produced numerous on-line courses supplemented by a growing number of topic specific webinars. It also works closely with the Canadian Environmental Certification Approvals Board and the Canadian Environmental Accreditation Commission to certify programs offered by other organizations based on guidelines that it they have developed. It has accredited 20 institutions, primarily colleges and universities to award its certification.

In the area of trades training, it has researched an extensive report, "Assessment of Occupation and Skills Needs for the Energy Efficient Buildings Workforce" that provides an environmental scan of the way the industry is changing to address environmental concerns and the key characteristics of low carbon building practice. It notes that there is a "lack of awareness, understanding and expectations of the 'building-as-a-system' mindset and performance-related expectations that go with it."[265] It also identifies the skills that it believes will be needed in the future, as well as outlining what construction workers will need to know to be able to achieve the standards required of net zero construction practice. [266]

Although promoting climate literacy in the construction trades is not a core activity in the program of ECO Canada, it has attempted to influence the discussion about what needs to be done to create a more climate aware and energy efficient workforce and its research is directly relevant to advancing the issue.

11.8 Canadian Apprenticeship Forum (CAF).

The Canadian Apprenticeship Forum is Canada's major apprenticeship network. It brings together governments, colleges, unions, employers, advocacy groups and apprentices to promote the improvement and expansion of the apprenticeship system and particularly the Red Seal component of it. It plays an advocacy role through its publications and its research. It promotes reconciliation and seeks to expand opportunities for indigenous people to join the skilled trades. It also supports a more diverse trades workforce through encouraging women, people of colour and other disadvantaged groups to seek a career in the trades.

CAF has three main committees: research, outreach and diversity, equity and inclusion. CAF conducts extensive research on a wide variety of issues affecting apprentices and the skilled trades. This includes studies on labour markets, completion rates, employment data and other economic issues affecting apprentices. It also includes identifying barriers to apprenticeship and exploring ways that these can be overcome.

[265] Eco Canada. (2021). Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Workforce. February. Calgary. https://www.caba.org/wp-content/uploads/2021/10/IS-2021-205.pdf
[266] Ibid., table 5, p. 43.

While the CAF is not directly involved in providing classroom or on-the-job VET for apprentices, its extensive research and communication resources have become valuable contributions to those directly engaged as instructors in the classroom or on work sites. It also helps apprentices by holding workshops on preparing for the Red Seal exams. Its annual conference brings together a wide variety of stakeholders to share their experiences and learn about the most promising developments in VET.

In its 2022 biennial conference, CAF included a major block of time in its plenary session for a presentation on climate literacy made by CBTU and its team of researchers, curriculum developers and evaluators. This signalled for the first time that CAF was beginning to expand its approach to including climate literacy information in its promotional activities. There is support for promoting the issue among its stakeholders and in the future CAF may be a major contributor to this issue in the future.

11.9 Boma Canada

Boma represents building owners, managers, real estate agents and property investors. It has established a set of construction standards which incorporate various construction objectives that builders must meet to achieve its BOMA BEST designation. Boma advertises this widely within the industry as a guarantee of quality performance by builders. Its certificate is a major way for developers to promote their buildings as meeting a high standard of construction.[267]

Boma Canada is affiliated to the U.S. Boma organization and benefits from its expertise in developing building standards. Boma maintains that it has a strong public commitment to promoting sustainability in its standards and in the work it does with its corporate members in designing, building and renovating buildings. Boma offers an E-Energy Training program for engineers and building operators on ways to reduce GHGs and energy use in commercial and institutional buildings. It has an affiliated education organization that offers courses in its BOMA BEST rating system through online and in person workshops. The standards it establishes can affect what some apprentices and construction journeypersons do on building sites to meet Boma certification. The standards also can influence what is taught.

Boma has produced an extensive list of publications documenting the work of its members in implementing buildings that meet its standards, including climate resilience and net zero performance goals. These are available on its web site and are part of its effort to publicize its approach to building standards.[268] Given the fact that building operational energy costs are a major concern for its members, Boma's approach emphasizes the numerous ways that buildings can reduce their energy consumption. The publications also promote the benefits of

[267] Boma Canada (2021) National Green Building Report: Building on Sustainability. Toronto: Boma Best. https://bomacanada.ca/aboutbomacanada/; Boma Canada. (2022). Lessons from the Net Zero Challenge. Toronto. September. https://bomacanada.ca/wp-content/uploads/2022/09/Net-Zero-ReportFIN.pdf
[268] https://bomacanada.ca/resources/publications/

net zero building practice which Boma presents as part of its overall commitment to addressing climate change. The organization also acts as an advocate for amending building codes across Canada in line with its standards.

11.10 Community Benefits Agreements

Another source of some green training is found in the expansion of community benefits agreements (CBAs) by provincial governments and municipalities. These use public construction investments to leverage training, local hire, employment equity, diversity and inclusivity in the workforce hired by contractors obtaining contracts funded by its projects.[269] A major goal is to provide employment opportunities to groups traditionally excluded from construction. Projects also bring community representatives into the process of planning and evaluating the impact of these projects on the local economy. Addressing climate change is normally one of the objectives that they pursue.

CBAs have evolved out of the earlier project labour agreements (PLAs) whose history goes back many decades. They were used to build the Saint Lawrence Seaway during the 1950s, a joint Canadian-U.S. project. The PLA was designed to ensure that employers would have sufficient numbers of skilled workers by an agreement covering the entire workforce on the project. It provided union recognition and exclusive jurisdiction to the construction unions as a quid pro quo for no-strike, no-lockout provisions during the term of collective agreements. This model was subsequently used on major provincial hydroelectric projects such as the construction of BC Hydro's large dams in the 1960s and 1970s. It provided the template for the project agreement on the Vancouver Island Highway during the 1990s. However, the model was amended to provide commitments to employment equity, training, local hire and First Nations employment provisions to ensure that the public dollars spent benefitted communities along the route of the new highway.

The most extensive recent application of this approach has been in BC through the establishment of a separate Crown Corporation, the British Columbia Infrastructure Benefits Corporation (BCIB).[270] It is mandated to apply this approach to many new government funded infrastructure projects.[271] In addition to providing training to designated equity

[269] Teelucksingh, Cheryl and Laura Zeglen. (2016) Building Toronto: Achieving Social Inclusion in Toronto's Emerging Green Economy. Toronto: Metcalf Foundation. https://metcalffoundation.com/publication/building-toronto/

[270] BC Minister of Finance Mandate Letter to BC Infrastructure Benefits Corporation (BCIB) 2021. Vancouver: May 19. file:///C:/Users/John/Downloads/bc_infrastructure_benefits%20(1).pdf; Toronto Community Benefits Network. (2016) Foundation Document: On Track to Opportunities – Vision, Commitment and Objectives for Community Benefits Agreements. Toronto. https://www.communitybenefits.ca/foundation_document

[271] For examples, see the inauguration of the BC program at: https://news.gov.bc.ca/releases/2018PREM0057-001406. For a review of CBAs and their impact on indigenous people, see: Berglund, L., and J. Miles. (2022). British Columbia's Community Benefits Agreement: Economic Justice for Indigenous Workers in Relation to Union Politics in Urban Infrastructure Projects. The International Indigenous Policy Journal, 13(2). On CBAs generally see: Nugent, James. (2017) The Right to Build the City: Can Community Benefits Agreements Bring Employment Equity to the Construction Sector. Labour/Le Travail. No. 80., Fall 2017 pp. 81 – 114. An early

groups, First Nations and members of affected local communities, it tracks the training and employment impacts of the projects it oversees to ensure that they are meeting the legislated goals. Contractors winning bids on the project are obligated to meet its training and employment objectives and the construction unions work closely with it, assisting with training and job placements. Its major projects to date are the widening of the Kicking Horse Pass section of Highway 1, the Broadway subway extension in Vancouver and the Pattullo Bridge replacement linking New Westminster to Surrey. BCIB is co-operating with CBTU in piloting the climate literacy curriculum that is being developed as part of this UTIP funded project.

It is perhaps worth noting that PLAs and CBAs are also used in a number of U.S. states and are included in the U.S. federal government's recent package of legislative initiatives such as the Build Back Better Act, American Jobs Plan and the Inflation Reduction Act.[272] The government states that the Act is the most significant climate legislation in U.S. history.[273] It imposes conditions on contracts and on its various subsidy programs that are explicitly intended to raise labour standards, promote training of under-represented groups, establish fair wages and encourage unionization.

According to a White House statement outlines the purpose of the American Jobs Plan is to "create good-quality jobs that pay prevailing wages in safe and healthy workplaces, while ensuring workers have a free and fair choice to organize, join a union and bargain collectively with their employers" (American Jobs Plan Fact Sheet). A number of U.S. states including Oregon, California, have adopted comparable measures.[274] While the core focus of these initiatives is not climate change training, some components of the projects being sponsored emphasize the climate and environmental benefits that will result from the investments.

The Toronto Community Benefits Network is an example of a municipal level approach to using public procurement to advance trades training which may include some elements of climate awareness. It operates a number of pre-apprenticeship programs such as the NexGen Builders mentoring program which is focused on providing a ladder into the construction trades for racialized workers.[275] Toronto construction unions are playing a key role in linking prospective construction workers with their skilled trades members who act as mentors for those enrolled in the program. While climate literacy is not an explicit goal of its training

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and very effective example of this approach was the Vancouver Island Highway Project in BC during the 1990s. See: Calvert, John and Blair Redlin. Achieving Public Policy Objectives Through Collective Agreements: the Project Agreement Model for Public Construction in British Columbia's Transportation Sector. Just Labour. Vol. 2 Spring 2000.

[272] See the U.S. Government Fact Sheet. FACT SHEET: The American Jobs Plan | The White House; Also: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/#:~:text=The%20plan%20targets%2040%20percent,based%20transition%20to%20clean%20energy

[273] See U.S. Environmental Protection Web Site: https://www.epa.gov/green-power-markets/inflation-reduction-act#:~:text=The%20Inflation%20Reduction%20Act%20of,of%20new%20clean%20electricity%20resources.

[274] See the following - California: https://hsr.ca.gov/business-opportunities/general-info/community-benefits-agreement/; https://water.ca.gov/Programs/State-Water-Project/Delta-Conveyance/Community-Benefits-Program;

[275] NexGen Builders web site: https://nexgenbuilders.ca/

programs, the initiative is intended to support the City of Toronto's overall approach to developing a healthy city – an approach which has a significant environmental and climate change component.

11.11 Manufacturers' Training Programs

Another group of training providers are companies that supply construction materials, equipment, and technologies to the industry. Documenting manufacturer's training programs is challenging because it is so diverse and pervasive in all aspects of the industry. It is not something that can be easily summarized in a brief overview, other than to note its importance and widespread application in the industry. Identifying its relevance to advancing climate literacy is even more challenging.

Manufactures' training can be specific to individual trades or applicable to entire building projects such as BIM software programs. Its purpose is normally to enable workers to install, or use, new or upgraded machinery, materials, technology, software or proprietary building systems. Depending on what they supply, manufacturers' training may involve brief familiarization with a material, product, or equipment. Or it may be much more extensive to provide workers with the knowledge and skills to master more complex challenges. Suppliers offer it to trades training facilities to use in their classroom programs, to on-site contractors and their workers, or to firms specializing in its maintenance and repair. Manufacturers often give credentials to individuals who complete their training courses. However, as courses are often supplier specific and proprietary, credentials received may be limited only to working on the company's equipment or system.

There is a lack of comprehensive data that analyses the extent to which climate change is being included in the training programs of manufacturers or suppliers to the building industry. Where this may be happening is in technology and software related to issues such as energy and carbon measurement, building information systems, energy saving equipment, low carbon materials and waste management/recycling programs. For example, the use of thermographic cameras and 3E Plus software to assess the energy being released from components of HVAC systems which measures GHG emissions and energy consumption, issues associated with climate change.

Many firms are now offering Virtual Reality (VR) technology and software. This enables training organizations to give apprentices and journey workers the opportunity to learn how to carry out building functions through virtual simulations. This normally involves apprentices sitting in front of a video monitor and manipulating the VR equipment on screen using the computer's handheld controllers. The simulator can mimic the motion of the equipment, generate noise similar to the real equipment and show the work being performed on screen.

Simulation technology enables workers to practice skills in a controlled environment away from the job site and to familiarize themselves with the equipment or machinery they will be using on site. This has the advantage of reducing the cost training on site as well as enabling workers to learn how to handle the equipment without the risk of making costly or dangerous mistakes.[276]Developers or suppliers of this technology are normally involved in training instructors how to use it and may also do the actual training for apprentices and journey workers. Training centres are increasingly incorporating this technology into their classroom programs. Again, the extent to which this technology is incorporating information about climate change is not well researched, but it does have the potential to include it.

11.12 Other Training Organizations: Private For-Profit Training Agencies

Canada has hundreds of private training colleges, many of which provide various forms of construction training from short courses to full apprenticeships. Provinces regulate many of them under a private training accreditation system which provides authorization to provide training courses and have their students qualify for public financial support. However, other companies simply charge students tuition for the full cost of courses. Often the building training component offered by these companies is part of a larger suite of courses that cover professional certificates, language training, business training, IT services, accounting, health care, career development, job readiness and numerous other subject areas. Some for-profit programs parallel what public colleges offer, while others are much more narrowly focused on the construction industry, generally, or on a particular trade, specifically. And some offer only short online courses of a few hours or days. Private training colleges make extensive use of the internet with some offering no face-to-face experience. But others operate classrooms and often offer a mix of on-site and remote training programs.[277]

There is also some involvement of multinational training organizations in providing courses for the construction sector. These draw upon the resources of their parent organizations and often utilize quite sophisticated advertising to attract prospective students.

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[276] Goulding, Jack, Wafaa Nadim et. al. (2012). Construction Industry Offsite Production: A Virtual Reality Interactive Environment Prototype. Advanced Engineering Informatics Vol. 26, pp. 103 – 116 ; Dunston, Phillip, Robert Procter and Xiangyu Wang. (2014). Challenges in Evaluating Skill Transfer from Construction Equipment Simulators. Theoretical Issues in Ergonomics Science. Vol. 15., No. 4. https://www.tandfonline.com/doi/abs/10.1080/1463922X.2011.624647?role=button&needAccess=true&journalCode=ttie20; Barkokebask, R.. C. Ritter et. al. (2019). Application of Virtual Reality in Task Training in the Construction Manufacturing Industry. 36th International Symposium on Automation and Robotics in Construction. https://www.researchgate.net/profile/Regina-Dias-Barkokebas/publication/336444652_Application_of_Virtual_Reality_in_Task_Training_in_the_Construction_Manufacturing_Industry/links/5da8925e299bf1c1e4c99d2a/Application-of-Virtual-Reality-in-Task-Training-in-the-Construction-Manufacturing-Industry.pdf; Yuan, Fangming. (2019). Real-time Construction of 3D Welding Torch in Virtual Space for Welding Training Simulator. I. J. Engineering and Manufacturing, Vol. 5., pp. 34 – 45. https://www.mecs-press.org/ijem/ijem-v9-n5/IJEM-V9-N5-3.pdf.

[277] Canadian Apprenticeship Forum. (2014). Apprentices Enrolled at Private Training Providers in Canada: A Comparative Analysis with the Experience of Apprentices at Publicly Funded Colleges and Institutes. Ottawa. Unfortunately, this study merges union training centres with private for profit companies, so does not distinguish the success rate of these two categories of training facility.

Given the wide range of different private training organizations, it is challenging to summarize their overall impact on the construction sector and there is no comprehensive analysis of their scope and contribution. Although provinces provide a regulatory framework for the sector, it has been characterized by numerous problems associated with the quality of the programs of some companies, poor value for money charged to students and in some cases costly bankruptcies in which students lost their tuition. As many of these are small businesses, governments are inclined to be supportive of them because they see small business as a key component of their economic development programs. Consequently, they tend to adopt a 'light touch' towards regulating their activities. This is not to deny that many private training organizations do a competent job. Rather, it is to highlight the variability of the outcomes resulting from a weak regulatory system.

11.13 Other Training Organizations: Not-For-Profit, Voluntary and Industry Based

There are many other organizations involved in developing low carbon training. In Ontario, the Toronto Atmospheric Fund (TAF) has supported pilot projects in the Toronto Hamilton area to demonstrate the feasibility of implementing zero carbon approaches to new buildings and renovations. Started in 1991 by the City of Toronto and financed by major endowments from the city, the province and the federal government, the fund supports a wide range of municipal climate initiatives, including support for training in net zero construction directly through the projects it funds and indirectly through industry and municipal government partnerships.[278] The fund also plays an advocacy role pushing for higher building standards in provincial and municipal building codes, energy efficient buildings, water use benchmarking and promoting building occupant health.

Some training is being provided by organizations such as Toronto's Labour Education Centre who offer the TradeLinx program. It is targeted at pre-apprentice candidates and offers a 12-week course to introduce people into the trades with the hope that they will then enrol in a full apprenticeship program. The Golden Mile Program is another of the Labour Education Centre training offering, again seeking to create interest in taking an apprenticeship. [279] It also offers a suite of short courses in climate change and low carbon construction for union members that outlines what the labour movement is doing on the issue as part of its Working Green 2050 initiative.

[278] The Atmospheric Fund (2020) Deep Retrofit Diary: Building a Green Workforce. https://taf.ca/retrofit-diary-building-a-green-workforce/ ; The Atmospheric Fund. (2022) Lessons from a Heat Pump Retrofit at City Housing Hamilton: A Case Study. https://taf.ca/wp-content/uploads/2022/05/TAF_CityHousingHamilton-Retrofit-Case-Study_2022-1.pdf; The Atmospheric Fund (2021) Federal Budget Recommendations. https://taf.ca/wp-content/uploads/2021/02/TAF-fedbudgetsubmission-2021-02-19.pdf; The Atmospheric Fund. (2022) A Guide to Measurement and Verification of Heat Pump Retrofits in Multi-Unit Residential Buildings. Guide. Toronto. October. https://taf.ca/wp-content/uploads/2022/10/TAF-Measurement-and-verification-guide-2022.pdf ;

[279] Toronto Labour Education Centre. https://www.laboureducation.org/

Workforce 2030 is an example of a collaboration between unions, labour councils, educational institutions, government, professional organizations, developers, the CAGBC and construction firms to provide training on low carbon construction. [280] It is a broad-based coalition whose purpose is to promote innovative projects and provide a comprehensive data base of training courses currently available on a range of LEC topics from a variety of different providers.[281]

The Future Skills Centre is another organization that promotes low energy construction training as part of its broad mandate to promote skills development areas across the economy. It is funded by the Government of Canada's Future Skills Program and built around a collaboration between Toronto Metropolitan University, Blueprint Analytics, Design and Evolution and the Conference Board of Canada. An important part of its skills development program involves researching and promoting skills relevant to the construction industry. [282]

It adopts an 'inclusive' approach to skills development that focuses on people who are underserved by Canada's current training system, including youth, women, First Nations, persons with disabilities and others. Its mandate is to address structural factors that limit access to training and career development – factors which unfairly discriminate against various groups within society. In addition, it has a particular focus on emerging skills and changes to the labour market and training system that are driven by technology, artificial intelligence, digitalization and automation. The organization has built partnerships with educational institutions, employers, labour and policy makers to further its mandate.[283]

Many construction industry associations that offer training in green skills, primarily through short courses lasting an hour or two, but sometimes a day, a week or more. These focus the training needs of employers in a particular trade such as how to meet the requirements of changes to building and energy codes or to install new equipment or technology. The associations often exist for other purposes, such as lobbying government for regulatory change or financial support. Some of these trade associations have their own certifications which are usually designed to confirm that the credential holder has demonstrated the capacity to perform a specific activity or task in their sector of the economy.

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[280] Workforce 2030 web site: https://www.cagbc.org/Workforce/home.aspx#:~:text=Workforce%202030%20is%20a%20broad%20cross-sectoral%20coalition%20of,build%20a%20low-carbon%20Ontario%20by%20addressing%3A%20Skills%20Development

[281] Workforce 2030. https://discoveree.ca/learn

[282] Future Skills Canada and Conference Board of Canada. (2022) Green Occupation Pathways: From Vulnerable Jobs to Rapid-Growth Careers. Toronto: February 2. https://fsc-ccf.ca/reports/; Future Skills Canada and Conference Board of Canada. (2022). From Low-Mobility to Rapid-Growth Jobs: The Journey to Clean Economy Careers. Toronto: February 22. https://fsc-ccf.ca/reports/; Future Skills Centre and Conference Board of Canada. (2020) Rising Skills: A Toolbox Talk on Social and Emotional Skills in the Construction Trades. Toronto. December 14. https://fsc-ccf.ca/reports/; Future Skills Centre Canada and the Conference Board of Canada (2022) Social and Digital Infrastructure" Laying the Groundwork for an Inclusive Recovery. March 8. Toronto: https://fsc-ccf.ca/reports/

[283] Future Skills Centre. (2020) Strategic Plan 2020 – 2023. July. https://fsc-ccf.ca/wp-content/uploads/2020/07/Strategic-Plan-2020.pdf

The provincial affiliates of the Canadian Home Builders Association (CHBA) offer training on specific areas of construction practice for their members. The focus of their program is to enable contractors and workers to sell their services successfully in the residential housing market. Enrolees pay for each course and if they have a certification, they must pay an annual renewal fee.[284]

The CHBA also has a separate Net Zero Home Labelling program which offers a group of courses on low carbon construction practice in the residential sector. The focus is on energy efficiency and meeting the Natural Resources Canada (NRCan) Housing Technology Assessment Platform (HTAP) requirements. Participants must pass an exam to be certified in the areas the courses cover. Currently the courses offered are: Net Zero Builder Training; Net Zero Energy Advisor Training; Net Zero Renovator Training; and Net Zero Marketing and Communication Training Module. Courses are delivered through CHBA qualified net zero service organizations.

According to its web site, CHBA has labelled 1,252 homes as of March 13, 2023. Homes that meet its requirements can be called a Net Zero home if their net consumption of energy is zero, or Net Zero Ready if they do not yet generate their own electricity through solar panels. There is also a designation for homes that have been renovated to the net zero standard. NRCan also funds a "bootstrap" program with CHBA to develop home building and renovation best practice. It is partnered with roughly a dozen municipalities across Canada.

Another organization that is beginning to explore, tentatively, what can be done to introduce climate issues into Canada's apprenticeship programs is the Canadian Apprenticeship Forum. It brings together colleges, private training institutions, unions, apprentices and construction journey workers to share information about their experiences with training. It carries out extensive research on the current status of the apprenticeship system, commissioning studies on a wide variety of issues including the demographic profile of Canada's apprentices, completion rates and barriers to completion, women in trades, the impact technology on trades training and so forth for its annual conference. While its mandate is to cover all trades, not just construction, a good deal of its work is focused on the construction sector. Until very recently the issue of climate literacy was not included in its research or publications.

Significantly, at its last national conference in Halifax in May 2022, for the first time it devoted a major part of a plenary session to the issue of climate literacy. The session was organized by CBTU. It presented CBTU's work on climate literacy that as part of the UTIP grant it received in the spring of 2021. The positive response of delegates indicate that this

[284] See, for example, the courses offered by the Canadian Home Builders Association and its provincial affiliates, such as the builder's residential builders' license courses, its continuing professional development courses or its certificate programs.. https://cpd.chbabc.org/?gclid=CjwKCAjwq-WgBhBMEiwAzKSH6EgeDv67qWArxkKgA3VVJ_Iqey8m9bFUHuzi21-aOwTLfWF6lebyXhoCD4YQAvD_BwE

was now an area in which large numbers of trainers and their organizations affiliated to CAF believe needs to be given more attention in the coming years.

BuildForce Canada is another organization that provides construction training in collaboration with other training providers. It is beginning to explore climate change and its impact on the construction industry. Although it does not currently have any courses that specifically address climate issues, several of the courses it offers are designed to give construction workers the fundamental skills which are needed to implement low carbon construction. These include communications, negotiations and conflict resolution, project management and mentorship. It also provides courses designed to promote a more inclusive, respectful, anti-racism and worksite friendly construction culture.[285] Its courses are provided through dozens of local delivery organizations across the country. [286]

In collaboration with SkillPlan, BuildForce Canada provides over 20 courses on essential construction skills specifically for the trades, including: carpentry, document analysis, math formulas, interpreting drawings, measuring and calculating jobs, numeracy, worksite communication skills, writing competency and science for the trades. It also provides trade specific manuals for boilermakers, electricians, heavy equipment operators, ironworkers and the piping trades. [287] Its predecessor, the Construction Sector Council carried out extensive research on Canada's construction training system.[288] Buildforce Canada also maintains a data base that provides high level information on the economics and labour force development of Canada's construction workforce.

The most recent annual issue of BuildForce Canada Magazine (2022) signals that climate issues are now becoming a significant focus of its work. The issue is entitled Towards Net Zero and entirely devoted to addressing climate change in the construction sector. It contains a collection of articles by a wide range of industry stakeholders indicating what they feel they can contribute to transforming the industry to meet the demands of high-performance construction and decarbonizing Canada's building stock. The leading article provides a summary of recent federal government initiatives to decarbonize Canada's building stock and signals that this is the direction the industry is now moving in.[289]

The Canadian Construction Association also plays a role in training. It has a membership base of 20,000 firms, representing commercial and industrial contractors, manufacturers, suppliers and service providers across the country.[290]It offers a gold seal certification for

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[285] BuildForce Canada E-learning program web site. https://elearning.buildforce.ca/. also: https://elearning.buildforce.ca/ContentPage.aspx?PageID=b2d8796f-bc40-a618-0ac8-710017a37870
[286] BuildForce Canada web site. https://elearning.buildforce.ca/management
[287] SkillPlan web site. https://www.skillplan.ca/tools-and-publications/online-order-form/
[288] Construction Sector Council (now BuildForce Canada). (2009) Training Capacity in the Canadian Construction Industry. https://www.buildforce.ca/en/terms?fid=217
[289] BuildForce Canada. (2022). Toward Net Zero: Construction is Instrumental in Canada's Climate Plans and Targets. Ottawa: https://www.buildforce.ca/en/magazine
[290] Canadian Construction Association (2021) Annual Review. Ottawa: https://www.cca-acc.com/wp-content/uploads/2022/03/CCA_Annual_Review_2021.pdf

managers, industry professionals and the skilled trades. [291]It has recently published a policy paper "Strength, Resilience, Sustainability: Canada's Construction Sector Recommendations on Adapting to Climate Change." The paper notes approvingly that the European Union has implemented a range of new climate policies, including the 2019 European Green Deal and the 2021 Renovation Wave program which adopts a multi-stage strategy for transforming the economy of its member states to meet its ambitious climate objectives. While recognizing that there are differences between the EU and Canada's economy and construction industry, it maintains that there is much to be learned from the EU's experience. [292]

In the same issue, the Mechanical Contractors Association of Canada notes that the work of its members has a significant impact on the climate and that its member companies will have to expand their training programs to address this. It cites the fact that 78% of building emissions come from space and water heating presenting an enormous challenge to the industry if it is to meet Canada's target of a 37% reduction in building emissions by 2030. Referencing a recent Canada Green Building study, it notes the key role that heat pumps and energy-recovery ventilators will play in this process. Installation of this and other needed technologies will require a major expansion of Canada's training system for the mechanical trades, including a significant increase in the number of trades trainers to meet the demand. The Mechanical Contractors also recognize that greater collaboration among all those involved in the construction process will be necessary to achieve net zero. A key step to accomplishing this will be a sector wide approach to workforce development.

Skills Canada is a national organization that encourages apprenticeships and other workforce training primarily by sponsoring trades competitions in which young workers demonstrate what they have learned in their pathway to becoming a qualified skilled worker.[293] Its events attract a large number of apprentices and are sponsored by a wide range of college, industry and union organizations. Its well-attended annual conferences are held in different provinces on a rotating basis. Although its mandate includes trades outside construction, many of the competitions are organized for the construction trades. The organization is not directly involved in VET but provides a venue for the promotion of the skilled trades. Winning one of its competitions is something that many young apprentices see as a major way to advance their careers.

As noted at the beginning of this section, Canada has a wide range of different training arrangements for providing its construction workforce with the knowledge, skills and competencies required for low carbon construction. The preceding overview highlights some of the most well-known organizations that deliver programs promoting, supporting - or at

[291] Canadian Construction Association web site. https://www.cca-acc.com/workforce-excellence/gold-seal/
[292] Canadian Construction Association. (2021). Strength, Resilience, Sustainability: Canada's Construction Sector Recommendations on Adapting to Climate Change. Significantly, it does not discuss the work of the EU to modernize its training system. It is also a strong critic of the community benefits agreements approach to public construction. Strength-resilience-sustainability-Full-Report-Final.pdf (cca-acc.com).
[293] Skills Canada's membership and extensive information about its skills competitions can be found on its web site: https://www.skillscompetencescanada.com/en/

least opening the door - to increased climate awareness or green construction practices. Some are focused primarily on climate science, while others provide the basic knowledge and skills needed to work as qualified trades workers on sustainable projects.

The survey also reveals the complexity of the system. The Red Seal Standards provide a key benchmark by establishing guidelines for classroom and on-the-job components of the VET system as set out in the Ellis table. The Standards ensure that there is consistency in the curriculum for each construction trade across Canada and that the granting of a TQ or Red Seal endorsement indicates that the holder has completed a recognized apprenticeship and is qualified to practice the trade. The Red Seal Standards and their provincial equivalents also establish the qualifications provinces use to legislate their compulsory trades while providing the industry and its customers with the assurance that those holding the certifications are qualified.

11.14 Observations and Insights from the Canadian Research

As the preceding discussion indicates, the issue of workforce climate literacy is emerging as a key focus of successful net zero construction practice. This is in response to the growing body of scientific evidence that climate change is now having a profound impact on our economy and society – an impact which is becoming more alarming with every passing year. In response, governments have implemented a wide range of new policies designed to limit increases in global temperatures through mitigation efforts while adapting their economies and societies to the growing number and intensity of damaging weather and climate events.

The results of the research carried out by CIRT members in English Canada, Quebec, the U.S. and Europe indicates that achieving climate objectives requires a well-trained workforce with a high degree of knowledge, skills and competencies, as well as positive attitudes towards performing quality work. In Canada, for example, the existing Red Seal vocational education and training (VET) system in Canada generally provides construction apprentices with a solid grounding in the technical skills required to practice various trades. This is a precondition for successful net zero construction practice.

However, the current curriculum, based largely on the Red Seal Standards, does not explicitly address the impact of climate change on Canada's economy and society or its importance in shaping government policy in the construction sector. It needs to expand its focus to provide a basic understanding of climate science and the way in which rising global temperatures are impacting the construction industry and its workforce. It also needs to highlight the positive role the industry and construction workers can play in addressing the climate crisis including in their own workplaces and in relation to the activities associated with their individual trades.

One of the trades trainers interviewed in the English Canadian research provided what is perhaps the clearest insight into the challenges the current system faces. He noted that we are providing apprentices with the 'how' but not the 'why.' By this he meant that we are equipping them with many of the practical, hands on, technical skills needed to achieve net zero construction. But we are not providing them with an understanding about why achieving net zero is so important, for their own work, for the building industry and for the wider society which benefits from this work. Nor are we providing them with knowledge about the valuable role the industry and their work can play in addressing the climate crisis.

Every construction project is different and presents unique challenges in fulfilling design specifications. A climate literate trades workforce requires the ability to solve problems as they arise at the work site. This involves understanding the basics of building science and the theoretical principles that underlie the performance of the skills of a trade. Acquiring a skill to carry out a particular building procedure is different from understanding the principles underlying the application of the skill. Knowing the principles makes it possible to deal with a variety of different on-site problems and to adopt new technologies and working practices because the theoretical knowledge provides the basis for solving new problems. It also means that workers have the capacity to make independent judgements about the appropriate standards and quality of work - and to act accordingly.

Good net zero construction practice also entails positive attitudes towards work. Part of this involves being 'professional' in the sense that the competent exercise of the work of a construction trade is part of an occupational identity and a source of pride from accomplishing work well done and meeting the standards expected of the trade. Knowing what a good job should look like and being able to achieve it in the context of a wide variety of different on-site circumstances is what it means to be a competent, qualified trades journey worker. High performance construction also requires employers to provide support for doing things the right way and reinforcing practices that advance climate objectives.

In the context of net zero construction, understanding the climate objectives of high-quality work has an additional dimension. It means knowing that the work has a positive impact on the environment and provides important benefits to the wider society. It means knowing how high-performance buildings improve the working and living conditions of building occupants and members of the community who use the resulting buildings and infrastructure. Understanding how and why one's work is valuable is an important source of job satisfaction. It provides meaning to what one does on the job and a sense of accomplishing something worthwhile beyond receiving a pay cheque, important as that is.

This raises a fundamental issue about the stated purpose of government investment in construction apprenticeship and in vocational and education training (VET) systems generally for the building trades. The prevailing narrative, in Canada, for instance, is one of preparing the workforce to be able to achieve government net zero objectives. Obviously, in the context of the climate crisis, this is critically important. However, the impact on workers is also

important. As the United Nations Environmental Program argues, the goal of having a climate informed workforce should be to provide decent work, that is work that is not only safe and healthy, but that also provides opportunities for personal development, agency and job satisfaction. Slotting workers into the perceived needs of the system is very different from promoting policies that consider the occupational interests and participation of workers as an integral part of the shift towards a 'greener' economy. And this is why the human development of the workforce should be an integral part of efforts to promote a climate literate workforce.

One observation from our research both in Canada, and internationally, is that climate literacy is much more easily achieved where there is already a well-functioning VET system in place that emphasizes the broader educational elements of workforce development rather than focusing exclusively on technical skills and prepares apprentices for an occupation, or career, and not just a narrowly defined job. It provides workers with theoretical knowledge as well as practical skills. Knowledge of the building process and the role of one's trade in that process facilitates understanding of how climate objectives can be integrated into construction projects. Ideally, VET also promotes positive attitudes about the value of performing high quality work – quality that is essential for successful net zero construction.

As governments raise building and energy code standards to meet their higher net zero construction objectives, employers will need workers who can meet these more demanding standards. VET programs that enable workers to acquire the knowledge, skills and competencies necessary to deliver high performance construction – that is programs that promote climate literacy - will provide workers with new opportunities to secure, well-paid employment.

International experience indicates that where unions and employers are jointly involved in the VET system as 'social partners', outcomes are better. This is because the interests – and contributions - of workers are represented more effectively than in systems that are employer dominated or run exclusively by the state. As the European research for this project demonstrates, there is a major contrast between the effectiveness of the VET systems of Germany, Belgium and the Scandinavian countries, which incorporate a social partnership model and the employer dominated United Kingdom and U.S. systems that largely exclude labour's input. The social partnership model recognizes the importance of worker and union input which enables more effective delivery of the kind of training required for successful net zero construction as our European report documents.

A strength of the Canadian system is the extensive involvement of the construction unions in providing training. It is not accidental that some of the most innovative climate training, such as the use of GPRO modules, are taking place in union operated or Joint Apprenticeship and Training Committee (JATC) facilities. The latter are normally based on multi-employer collective agreements that fund a joint trades training trust. While currently there is little explicit climate literacy content in the curriculum of Canada's union or joint union-employer trades training centres – due largely to the constraints of the Red Seal Standards - the 195

union or joint union-employer training centres across Canada have the capacity to introduce relevant material on climate and environmental issues into the trades curriculum.

Union and JATC apprenticeship programs are also comparatively more successful in graduating apprentices than other VET programs because unions take responsibility for ensuring that their apprentices succeed in both the classroom and on-the-job components of their programs. Employer signatories to multi-employer collective agreements accept responsibility for supporting apprentices on their worksites. Unions have the right to enforce agreements to ensure that their apprentices obtain employment to meet their qualifying hours requirements and also obtain opportunities to learn the full scope of their trades. These arrangements can overcome the challenge faced by small and medium sized employers who do not have the resources, or mentorship capacity on their own, to provide the learning support apprentices need. By being able to despatch apprentices to different employers during their learning period, the collective resources of a group of employers can be utilized to provide the appropriate support. The positive experience of JATCs also suggests that for Canada higher union density and an expansion of collective bargaining in the industry is an important way for governments to achieve the goal of a construction workforce capable of fully implementing their climate objectives.

One of the major barriers to advancing climate literacy in Canada has been the absence of climate content in the curriculum guidelines of the Red Seal Standards. Our review of the current Standards found almost no references to climate change, global warming, environmental sustainability and similar concepts. This omission is important because the Standards largely determine what provinces require public college and union training centres to include in their curricula. The absence of climate information acts as a major constraint to incorporating the issue within apprenticeship programs. We understand that a consultative process is now underway to revise the Red Seal Standards to include the role of the industry and its workforce in addressing climate change. This is a positive step forward. However, revisions are still at an early stage and the extent to which they will provide apprentices with a solid grounding in climate issues remains unclear.

An important benefit of incorporating information on climate change within the Red Seal Standards is that it would open the door for many instructors who see the issue as relevant to the trade they teach to be able to cover it in their classes. Many instructors are concerned about the climate but feel constrained by the limitations of the current curriculum guidelines. They recognize the legitimate interests of apprentices in focusing their studies on what they anticipate will be covered in the Red Seal exam. Including climate and environmental content in the Red Seal Standards would result in its inclusion on the exam for the Red Seal endorsement, providing a major reason for apprentices to study the issue.

Trades instructors note that the current classroom curriculum is already quite full, creating a potential barrier to adding new material. Finding space in the curriculum for climate change information is, therefore, a challenge. However, we found that some union training centres are already integrating it into their curricula such as by using the U.S. Green Building

Council's GPRO modules or incorporating climate specific material developed in-house by union instructors in several trades. Climate issues can also be incorporated into how specific skills are taught by highlighting ways in which these skills advance sustainability. They can also be included in discussing the reasons the building and energy codes now emphasize reducing GHG emissions and energy use. In addition, the Standards are revised periodically to accommodate changes in technology, building methods, materials and other factors that influence the work of each trade. Adopting a climate lens during these revisions, which should take place more frequently to address industry changes, can provide a method of ensuring that climate related information is incorporated within the revised Standards.

We believe that there are two basic components to incorporating climate literacy into the trades curriculum. One should be designed for all trades. Its purpose should be to provide a basic understanding of the findings of climate scientists and the implications of their findings for the future of our economy and society. It should also document the way in which increasing global temperatures are affecting the construction industry, both in terms of the impact on working conditions and in terms of the adoption by governments of increasingly ambitious targets for GHG and energy reduction – targets which are now having a major impact on building codes and construction standards. This component should also emphasize how important the construction industry will be to addressing the climate challenge in the coming years and, consequently, the valuable role that the trades workforce will play in achieving society's climate goals. The work of the trades is an important part of the 'solution' to the climate crisis.

As the effects of climate change on the industry and its workforce becomes more pronounced in the coming years – as it will – the need to incorporate climate science into the curriculum will become increasingly clear, underscoring the need for making climate literacy an integral part of the apprenticeship curriculum. Knowledge of the basics of climate science answers the 'why' industry transformation is now so urgent.

The other component of the curriculum should focus on what each trade can contribute to meeting Canada's net zero goals in the building industry. Construction projects include contributions from every trade and cannot succeed without each trade doing its part. However, the input from each trade will vary depending on its role in the building process. The unique contribution of each needs to be highlighted. Knowledge of the climate and environmental impacts of each trade's contribution can be incorporated in the way various technical and collaborative skills are taught, as well as its importance in facilitating achievement of overall project targets. This is something that the various trades specialists are best suited to develop and this project is now enlisting their expertise in the process of curriculum development for the trades specific component of the CBTU initiative.

Current government net zero targets will require a dramatic increase in the number of construction workers. This is because of the large number of jobs that will be created both in in new construction and in refurbishing Canada's existing built environment. It represents both an enormous challenge and a major opportunity for the industry, its workforce and its

VET system. Canada currently has approximately 16 million residences and 480,000 industrial, institutional and commercial buildings. To meet the target of 40% to 45% GHG reduction by 2030 and 100% reduction by 2050, most of the existing structures will require deep retrofits, creating literally millions of new construction jobs over the next three decades. These will be in addition to the jobs created in new construction to accommodate population and economic growth. Even more jobs will be created upgrading the resilience of existing buildings and infrastructure to adapt to increasingly adverse climate and weather impacts While there are different ways to project future labour requirements, depending on how quickly Canada meets its very ambitious climate targets, as well as other assumptions about technological and economic developments, there is no question that the industry will need many more workers in the coming years – workers who will need access to good VET programs.

The challenge will not only be to provide a workforce to do this enormous amount of new construction work but, more importantly, to provide a workforce with the knowledge, skills and competencies to deliver the high-performance outputs needed to meet climate requirements. Although federal, provincial and territorial governments are ratcheting up their emission reduction targets, they are not matching their ambitious climate targets with corresponding investments in the VET system needed to deliver the required training for the trades workforce. Absent major new investments in this area, Canada's ability to deliver on its climate promise will be fundamentally compromised. Matching their climate objectives with a corresponding expansion in VET programs is something governments now need to do as a matter of urgency.

There are other barriers to the development of a climate literate workforce which are largely outside the scope of this project but which merit mentioning. The workplace component of most formal apprenticeship training in Canada is managed by large and some mid-size employers. But with a few exceptions, a major part of the industry, such as residential construction and small commercial, does not contribute significantly to training the workforce. It is, of course, challenging for small employers to provide apprenticeships or other training for their workers unless they are part of a multi-employer collective agreement. However, achieving the ambitious climate target that governments have announced will require more on-the-job support by employers. Governments will need to provide them with the resources and the incentives to do so.

Governments will also have to focus much more attention on the workplace component of the VET system. It is vital that the on-the-job experience of apprentices supports the climate curriculum being provided in the classroom. Unfortunately, government regulation of what happens on job sites is very limited. This can result in a wide variety of different outcomes for apprentices. Some employers are diligent about ensuring that their apprentices learn the full scope of their trade. Others are less supportive. Improving the performance of employers is essential to ensuring that the workforce has the capacity to implement high performance construction outcomes. Accordingly, governments need to explore methods for assessing the quality of the workplace experience provided to apprentices by employers and implement

measures for addressing gaps in employer training programs. This means much more extensive monitoring of what apprentices experience on job sites including clear measures to assess progress and mechanisms to address employers who are not providing the appropriate level of support.

Except for Quebec, which has a very different approach to construction VET, which is discussed in Chapter 2 of this report, a major barrier to a climate literate workforce is that a very substantial segment of the industry is simply not supporting Canada's VET system. Too many construction workers are left to figure out how to perform their work on the job with little or no opportunity to learn the knowledge, skills and competencies that are – or should be – an essential part of their trade. This also means that there is no vehicle for delivering climate literacy to the large segment of the construction workforce who are excluded from the formal apprenticeship system.

Of course, many individual workers do choose to take courses to upgrade their knowledge, skills and competencies. But this is not easy for them for reasons of cost, lost income, no guarantee of returning to a job on completion and lack of employer support. As many small employers do not require their workers to have any formal qualifications, unless required by law, the benefits for workers of acquiring such qualifications can appear problematic. In many provinces, the list of compulsory trades is small, meaning that anyone can perform – or claim to be able to perform - the work of a trade. This acts as a disincentive for workers to pursue – and complete - formal apprenticeships.

Considering the much higher performance standards that net zero construction will require in the future, governments need to review their regulatory policies with the view to expanding the list of compulsory trades. To encourage workers to pursue training, it is necessary to make the training relevant to obtaining work. Expanding the number of compulsory trades is one important way to achieve this.

Many large and some medium employers, whether unionized or not, provide targeted training for their core employees – the ones they need to ensure they can manage their projects effectively. They need competent journey workers and are prepared to make investments in training and upgrading these key workers. But beyond their core workforce, they have little incentive to train because the fluctuating nature of project contract work means they do not want to have a large workforce to whom they have significant employer obligations without having guarantees of a continuing stream of contracts to fund their payrolls. Instead, they prefer to sub-contract much of the work. They also have concerns about losing workers that they train during cyclical downturns, or gaps between contracts. And some employers are worried about seeing workers they train poached by other employers.

This speaks to the need for governments at all levels to recognize that implementing their climate objectives in the construction industry will require a much stronger commitment to upgrading the qualifications of the entire construction workforce by providing additional

pathways for workers to undertake apprenticeships and by increasing – and enforcing - the qualification standards required to perform construction work.

As noted, far too many Canadian construction workers do not have an opportunity to acquire formal training. Countries with a higher proportion of skilled workers and, correspondingly, a much smaller proportion of unskilled, such as Germany, Denmark and Belgium are better able to achieve climate objectives because their VET system provides them with a workforce with the knowledge, skills and competencies to undertake the more demanding specifications of net zero construction. This objective is best achieved by policies designed to reduce workforce precarity through labour market policies that support continuing employment and shift part of the burden of market fluctuations to employers and governments. Providing more secure employment and attractive career paths for apprentices can also address labour shortage issues. This means respecting the occupational interests of the trades to a secure, productive, personally rewarding, long term career in the industry.

The most successful Canadian apprenticeship programs are those offered by unions and/or JATCs. They have a higher completion rate for apprentices because unions take responsibility for obtaining work for their members while employers have obligations under the collective agreements to provide apprentices with jobs when they become available. However, outside Quebec – and acknowledging that there are major regional variations - the building trades unions represent approximately one quarter of the construction workforce. So, the JATC option is not available to most construction workers. There is a reluctance on the part of many provincial governments to pass legislation that would facilitate an expansion of unionization, reflecting the vigorous opposition of many employers and their lobbying organizations. However, given the solid track record of union VET programs and the pressing need to address the climate crisis, this is an option that governments need to consider if they are serious about achieving their climate goals.

Another successful approach for improving the workplace component of VET programs is through community benefits agreements (CBAs). These explicitly identify - and include - a variety of training and employment goals that accompany the procurement of construction services by governments. Canada has extensive experience with these agreements. They are a well-established way to provide opportunities for both training and employment for women, First Nations, people with disabilities and members of local communities through local hiring preferences. CBAs have the potential to integrate climate science concerns as an integral part of their approach. They also have the capacity to ensure that the targets established are measured and that modifications implemented where called for, based on ongoing assessments of how well they are doing in meeting their targets.

Much of the impetus for a more representative workforce has reflected concerns by employers and governments about labour shortages in the industry. Attracting members of equity groups thus has an appeal from a narrowly economic perspective. However, from a climate perspective progress towards a more representative workforce links measures to address the inequitable impact of climate change on vulnerable communities with

opportunities for members of those communities to be part of the workforce that contributes to reducing the very same adverse climate impacts. Additionally, community support for climate measures is a key factor in promoting effective implementation. For example, as our U.S. chapter indicates, labour's support for initiatives that combine training and good jobs at union rates for members of marginalized communities has been a key factor in obtaining public funding for environmentally sustainable projects.

A major barrier to expanding climate literacy in the industry is the existence of a large unregulated, underground economy characterized by widespread tax evasion and the exploitation of vulnerable workers. Its workforce has virtually no opportunity to benefit from Canada's VET programs and, correspondingly, little chance to acquire knowledge about climate issues. Implementing tough measures to end these widespread questionable practices in this part of the industry is an important way that governments can contribute significantly to achieving Canada's climate objectives.

There are other barriers to the achievement of climate literacy in construction. A major one is the industry's extensive reliance on low bid contract tendering. Too often this practice undermines building quality and encourages contractors to 'game' the system by cutting corners at every opportunity at the expense of sound construction – and climate – building practice. Poor construction practice is reinforced by the absence of effective auditing of the energy and GHG emission performance of buildings. Canada lags behind the standards that have been established in other jurisdictions, such as the European Union, where building energy performance has been measured for over a decade. Proper performance measurement, such as by legally required building audits, coupled with increasingly tighter energy and GHG targets, is a necessary step to raising industry standards.

Building and energy codes are major policy tools that governments have available for promoting net zero construction. In recent years governments have increasingly recognized the important role of codes in advancing climate objectives. There is no question that codes have improved from a climate perspective in recent years. However, the pace of change is still not rapid enough to meet the ambitious climate goals governments have established. Tougher codes also require higher performance standards from the workforce, raising the importance of improving the capacity of the VET system to prepare the workforce with the needed qualifications.

Enforcement of building and energy codes remains a major issue, given the need for much more extensive monitoring of the energy and GHG performance of buildings. However, short-sighted budget constraints by provincial and municipal governments undermine achieving this objective. There is no point in raising standards if they are not enforced – and enforced throughout the industry. To ensure that climate targets are met, governments will have to allocate more resources to ensuring that building and energy codes are followed properly.

There has been a notable increase in industry efforts to address climate issues in recent years. Many construction firms are now asserting that they are implementing elements of net zero construction practice. Passive House, LEED and a variety of other climate and environmental standards are being adopted by firms who maintain that they are now committed to lowering the climate footprint of their construction operations and building outputs. While there can be concerns about how extensive and comprehensive these changes are, the fact that climate change is now a part of the narrative on the future of the construction industry is a welcome development.

However, much of the industry remains unaware of the seriousness of the climate crisis and does not accept the urgent need to implement the improvements in quality outcomes that net zero construction requires. Consequently, it does not see the need to change its way of operating. Some in the industry also believe that addressing climate change is someone else's problem. But there is no longer room for the view that climate change is somebody else's problem. Governments need to focus much more attention to explaining to the industry the rationale for the higher building and energy standards that are now needed and the role the industry must play in implementing these standards. This also means promoting a workplace culture and environment which supports achieving climate goals and that reinforces what is taught about climate change to apprentices in the classroom component of their programs. Changing these attitudes – and workplace practices - must be a major focus of industry transformation in the coming years.

The progress Canada has made thus far in lowering the climate footprint of the industry and its outputs has been largely attributable to the role of public policy. It is governments, not industry, who are responsible for establishing and implementing new climate and environmental standards. This has been done through a range of policies, including establishing increasingly ambitious energy and GHG reduction targets, more stringent building and energy codes, tax incentives, subsidies, research, public education, pilot projects and numerous other initiatives. Given what the scientists are predicting about the deeply worrisome future trajectory of climate change, we can expect that governments will be expanding the scope of their policy interventions significantly in the coming years to require the industry to meet their increasingly aggressive climate targets.

The underrepresentation of women, indigenous people, visible minorities, and other excluded groups has been an ongoing issue in Canada's construction industry for many decades. The federal and provincial governments have implemented a variety of different policies to address this issue with varying, but largely limited, results. There are strong arguments that promoting a more representative workforce is an important way to advance climate literacy. This is because the adverse impact of climate change falls disproportionately on vulnerable groups within the population – groups who are particularly sensitive to the ways it is adversely affecting them and their communities. Aside from the issue of basic justice, recruitment, and retention of members of equity groups has important implications for shifting the culture of construction towards supporting better environmental and ecological

practices in part because of the positive impacts measures addressing global warming can have on their communities.

Canada also has much to learn from Indigenous communities about our relationship with nature and the importance of conserving the resources that nature has endowed on our planet. Indigenous ways of viewing how we produce and consume provide valuable insights about how to implement a more sustainable, more healthy and more equitable approach to our environment. Indigenous understandings of biodiversity and ecology underscore the value of healthy ecosystems and the importance of respecting and conserving our natural endowments.

Part of the process of developing climate literacy involves a deeper understanding of the relationship between work and nature. Climate literacy involves understanding how our everyday work and actions are part of a wider social and economic system that produces the carbon emissions which are heating our planet. It recognizes that positive changes in society to promote biodiversity, sustainability, and equity in general, together with ecologically focused construction planning and practices can diminish the harmful impacts of climate change and improve everyone' working and living environments.

Advancing workforce climate literacy will be a necessary part of efforts by industry, unions, communities and government to address the climate crisis. As noted, it will require incorporating relevant elements of climate science into the curriculum of Canada's VET programs to provide the workforce with an understanding of 'why' Canada is now implementing new climate policies in construction. Implementing climate literacy will also require a change in workplace culture involving all those engaged in construction projects. This includes developers, planners, architects, engineers, building inspectors, contractors and, critically, the building trades who do much of the work on building sites. What is needed is a culture that supports a commitment to high quality construction work based on an understanding of the importance and value of doing work properly and how this work advances the goals of environmental sustainability, Greater climate literacy is a key attribute the industry will require if it is to fulfil the energy, GHG and environmental goals governments have signalled they want it to achieve in the coming years.