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

Appendix 3:
Examples of Innovative Climate Literacy Material in Trades' Curricula and Programs in North America and Europe

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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. Its members are: Pier-Luc Bilodeau, Linda Clarke, John Calvert, Evelyn Dionne, Melahat Sahin-Dikmen, Vivian Price and Christopher Winch. This analysis was drafted by John Calvert.*

***ABOUT Building It Green**: The Building It Green project 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).*

1. Introduction: Examples of Climate Literacy Material in Trades' Curricula or Programs

In its research, CIRT has sought to find curriculum that provides examples of best practices developed by training organizations to encourage awareness of climate change and its impact on the construction industry. Identifying and reviewing curriculum is valuable because it provides potential models for how to incorporate elements of climate literacy into apprenticeship and journey worker upgrade programs. It is also valuable because it reflects actual teaching material being used in current programs which has been tested by instructors and training institutions. In the following pages we review some of the curriculum now being offered by training organizations in North America and Europe. Some of this analysis was included in the March Interim Report to CBTU. However, what follows fills in some gaps and includes a new section looking at the Irish experience in updating its construction training program to include the basics of climate science.

The following examples are not to be interpreted as representing the full extent to which climate issues are currently being taught to apprentices and working journey persons. Many individual instructors and some training institutions are currently providing elements of climate science in the curriculum of their training programs. They are doing so despite the already crowded content they need to cover in their apprenticeship courses. However, there is no national data base that lists courses on climate literacy in Canada or that offers a detailed analysis of curriculum content dealing with climate issues. Moreover, both training institutions and individual instructors normally view course content and lesson plans as proprietary so obtaining copies is challenging.

Our purpose here is more modest. It is not to provide a comprehensive survey of all programs that include some aspects of climate science. Rather, it is to illustrate what is feasible by highlighting existing examples of course content that illustrate what could be included in future climate related training for the trades' workforce.

We have divided the following curriculum material into two broad sections. The first covers training course material which we have found in use in North American training programs. The second section deals with an example of curriculum being used in Europe. The most well-known climate training curriculum for the construction trades in North America is the GPRO system. Its approach is discussed immediately below. A second example is a training course module from the Ironworkers International which, although focused on the US industry, is directly relevant for Canadian members of that trade. The third is from a union electrical training program in Canada. A fourth is from the well-known organization, Passive House Canada, which provides training for instructors and for practitioners of its approach to net zero construction practice. A fifth is

from the Canada Green Building Council which offers a wide range of courses on energy and climate related issues for industry professionals, qualified building trades and the general public.

Given the very large number of trades' training institutions in North America and given that many see their curriculum as proprietary, we are aware that there are other programs that contain significant climate literacy material that we have not included in this account. We are also aware that individual instructors who are concerned about climate issues are weaving information about the role of the building trades in addressing climate change. However, we also feel that the examples we have identified are sufficient to provide a good overview of what it is reasonable to include in a future curriculum for apprenticeship and qualified trades' workers.

The second section of this review outlines a good example of climate focused trades' training material from one country in Europe. It uses the curriculum of the recently updated Irish construction training program as an illustration of some of the developments in climate and energy literacy in that jurisdiction. It was initiated as part of a major European Union initiative called Build UP Skills which involved 30 countries in Europe and was designed to assist member countries to promote low energy training for their respective workforces. Its suite of training manuals is publicly available on-line and provides a very detailed set of training modules for instructors and trades' workers. (These various examples of curriculum have already been shared with CBTU, SkillPlan and SRDC).

We conclude this discussion with some comments on the lessons that Canada can learn from a detailed review of current curriculum content, including issues associated with the lack of availability of training modules due to the proprietary nature of much of the material and the siloed character of current training programs.

2. North American Examples

a) GPRO Training Modules on 'Green' Low Energy Construction

The most well-known low energy, 'green' training program in North America is one developed by New York's Urban Green organization. Launched in the summer of 2010, it is called GPRO and is composed of a set of modules that provide curriculum material on climate and energy issues as well as related trade specific low energy training. GPRO was developed specifically for construction workers. Its Fundamentals of Building Green is a foundational course targeted at the entire construction workforce. It is also available to others without a trades background. GPRO's other courses have been tailored to provide specific training on low energy construction practice for individual trades. To deliver its program more widely, GPRO has developed a suite of on-line courses which are open both to those with a general interest and those with trade specific interests.

GPRO has partnered with employers, unions, and some community colleges to deliver hands on 'green' training programs in training facilities across the US and Canada. Various locals from the UA, Insulators, SEIU, IBEW and IUOE have all participated in GPRO training as well as some contractor associations. To expand the reach of its program, GPRO has set up a special 'partner portal' that is designed to help organizations organize GPRO courses in their regions. This portal has detailed instructions concerning venue selection, advertising, recruitment of instructors and promoting courses to potential students. This has enabled GPRO to deliver its courses in numerous locations across North America. GPRO has also created a program for certifying GPRO instructors who are then able to deliver its training material to other instructors and union members.

In Canada, GPRO's authorized representative is the Canada Green Building Council. But it also has direct links with some of Canada's building trades unions as they are affiliates of the internationals. In addition to overseeing the delivery of GPRO in Canada, the Council links GPRO courses with other certifications it offers, such as LEED, which it also administers in Canada, so that students can acquire some of these credentials through the GPRO process and add them to their resumes. LEED principles are also covered in the content of some of its courses.

Because it addresses many of the issues of concern to this project, a CIRT team member took one of its on-line courses to get a sense of how it approached teaching climate and energy literacy issues. This was followed up by attending a three-day course offered by the UA in Chicago where it was possible to experience the actual delivery of one of GPRO's courses.

Currently there are 12 GPRO modules. They are:

- Fundamentals of Building Green
- Integrated Systems are Key to High Performance
- Operations & Maintenance Essentials Transforming Buildings for Sustainable Future
- Operations and Maintenance Essentials Operations and Maintenance
- Operations and Maintenance Essentials Indoor Air Quality
- Electrical Systems
- HVAC Heating and Cooling
- Assuring Building Performance
- Mechanical
- Insulation
- Plumbing
- Stormwater[1]

[1] In some of GPRO's promotional material only the most popular 5 trade specific courses and the Fundamentals are listed indicating that not all courses are being offered at the same time.

The first two modules are designed for all construction workers. They provide key elements of what GPRO believes they should know about the impact of climate change with a focus on how it affects the construction industry. The remaining 10 modules are specific to particular trades. The curricula material for the individual trades has been organized in a way that integrates information about climate change into its discussion of the knowledge and skills GPRO believes each trade needs to know.[2]

b) GPRO Foundation Module: Fundamentals of Building Green

The introductory GPRO course is called Fundamentals of Building Green.[3] The curriculum is laid out for the use of instructors in the form of an extended lesson plan with questions and answers on a variety of 'green' issues for those taking the course. GPRO explains what students can expect from the course, including learning about climate change and its impact on the building sector, the key features of high-performance buildings and the contribution the trades can make to constructing them.

The course gives participants an account of the way in which fossil fuels release carbon into the atmosphere and how this is warming the climate. It notes that buildings are the principal source of energy use in the US which explains why such attention is now being paid to reducing their energy use, particularly because most of the energy being used is from burning fossil fuels directly or from electricity generated largely from fossil fuels.

GPRO expects students to learn about the basics of climate science and to realize the impact that fossil fuel produced climate change is already having both on society, generally, and on the construction sector in particular. The section on climate change is fairly detailed, drawing from some of the major scientific organizations that have been researching the issue over the past several decades. It discusses the greenhouse gas effect and how burning fossil fuels results in an increase in carbon in the atmosphere which, in turn, capturing more of the heat from the sun. The module also shows the consequences of climate change in terms of temperature increases, fires, floods, storms and other destabilizing weather events. And it discusses how this is impacting the world's populations, noting the disproportionate burden borne by vulnerable people.

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[2] As this was being written, GPRO announced a new construction management course. https://education.urbangreencouncil.org/events-cal/training/gpro-construction-management-january-20-2022

[3] GPRO. (2021) Fundamentals of building Green: Green Professional Building Skills Training. New York: Urban Green. https://www.gpro.org/

It introduces some key ideas about low energy construction practice, including the concept of high performing buildings, the concept of systems thinking, and the whole building approach. The former involves establishing an appropriate balance between energy and water efficiency, occupant health and environmentally responsible use of resources including minimizing the impact of the construction process on others in the community. It notes that systems thinking provides the basis of bringing together these key components of high performing buildings. And adopting a 'whole building' perspective emphasizes how all aspects of the construction process and its outputs need to be included in the way we construct buildings and infrastructure.

After noting that dealing with climate change is now a huge challenge for humanity, the module clarifies the distinction between mitigation and adaptation and explains the role of each in either curbing further emissions of GHGs (mitigation) or addressing the consequences of global warming (adaptation). It then examines how the building trades can reduce GHG emissions and energy use through improving the quality of the work they perform on low carbon construction projects.

The course then discusses the role of buildings as users of energy and hence contributors to climate change. It notes how high-performance buildings differs from conventional construction practice. They use less water and energy during the construction process, provide better quality working conditions and improved health and occupant satisfaction for those living and working in the resulting buildings. They are also built in a way that respects the environment and minimizes adverse effects on local communities. 'Systems thinking' provides a way to understand how these different issues are related.

The module emphasizes the need for high level coordination among all those involved in the construction value chain from owners through architects and engineers to the trades themselves. It also emphasizes the need for a shared understanding of the purpose of a construction project and the value of effective collaboration and communication.

The GPRO Fundamentals course also provides students with an understanding of the basics of climate science. After distinguishing between weather and climate, it outlines the work scientists have done to trace the history of global warming, referencing recent changes in surface temperature and other climate indicators compared with tens of thousands of years ago and showing how alarmingly temperatures have changed since the advent of the industrial era. It cites the findings of the US Geological Survey, NASA, the Intergovernmental Panel on Climate Change and other widely respected scientific organizations to underscore the validity of the scientific finding that earth's temperatures are rising. It explains how the greenhouse gas effect works and what higher temperatures have meant in terms of the worrisome increase in adverse weather events in recent years, including floods, fires, virulent storms, rising sea levels, heat waves and desertification.

The final sections of the module discuss issues of social justice. They explain the unequal impact of climate change on indigenous people, visible minorities and the poor who face greater exposure to climate triggered illnesses, pollution, hurricanes, floods, forest fires and many other adverse weather events. It notes that vulnerable populations have far fewer resources with which to compensate for the harms they are experiencing from climate change and are less able to adapt to is impacts. The module suggests that efforts to address climate change should include a commitment to environmental and social justice. And it maintains that society's efforts to address climate change must include a strong democratic element that ensures that everyone is able to participate in decisions about how best to addresses climate change. As part of its course material, it provides links to a list of videos that link equity, environmental justice and climate change.

The module concludes by noting that mitigating and adapting to climate change will result in the creation of many new jobs in the construction industry, given how much will need to be done to address the issue. It outlines where many of these jobs will occur, both in new construction and, more importantly, in retrofitting the millions of buildings that will need to be upgraded. It argues that the creation of these new jobs will also provide a way to address issues of historic discrimination as groups traditionally excluded from the construction workforce will be needed and should be welcomed into the trades.

c) GPRO Module: Assuring Building Performance: Commissioning and Whole-Building Coordination

Commissioning is the second general GPRO module that incorporates its climate approach. It begins with a discussion of how the building process gets started, including the original commissioning, planning and financing and proceeds to explain more detailed work needed to translate the original plans into actual construction. It emphasizes how important it is for commissioning to get things right at the beginning to avoid major problems later in the construction process. In New York, Commissioning is handled by a certified person, or firm, who is designated as the Commissioning Authority with responsibility for developing a commissioning plan which will specify the various measurements and tests that must be followed to ensure that the building project meets its design goals

The commissioning module covers a wide range of building systems, including electrical, HVAC, lighting and back-up power. Practitioners have to know how to use the equipment and technology required for testing these different systems to ensure they meet climate objectives. Using New York as an example, it notes that the city also has a process for retro commissioning existing buildings. The module explains this process.

The module emphasizes the importance of inter-trade cooperation and discusses the need to coordinate the interfaces among the work various trades. It gives a number of specific examples where the work of two or more trades intersects in areas such as floors, wiring, HVAC installations and plumbing to illustrate the importance of inter-trade cooperation. It discusses how climate considerations need to be taken into account the selection of construction materials and how 'green' materials are playing an increasing role in this process. It also cautions about unauthorised material substitutions as these may not meet performance specifications. It explains the importance of good waste management practices and proper disposal of materials. And it emphasizes the importance of maintaining a high standard of environmental practice on the site during the work process.

d) GPRO Module: Building on the Fundamentals Module: Providing Courses for Individual Trades

GPRO has developed advanced courses designed for a selected group of construction trades. Students wishing to obtain a GPRO certificate in one of these trades must start by taking the 4-hour Fundamentals of Green course to give them a 'big picture' overview of climate and low energy construction issues. This ensures that they understand the links between climate science and its impact on their specific trade. Assuming they already have a background in the selected trade, they can then proceed to the 6-to-8-hour trade-specific course. After taking the course, students take an exam which covers both the Fundamentals course and the content of the trade specific course, thus integrating the background in climate science with the practical application of it to the work of their trade. Assuming they pass, they then receive a GPRO certificate.

The GPRO approach includes many of the key components that could be included in the training modules for introducing climate literacy in Canada. It outlines the basics of climate science and how climate change is impacting society, including its growing adverse consequences. In addition, it raises important issues about climate and environmental justice and makes the important link between climate change and the disproportionate burden it places on vulnerable communities. The trade specific courses provide students with an understanding of how climate change is impacting their trade and what their trade needs to do to address it.

GPRO has the advantage of having been tested and delivered in Canada and the US over a decade and is reasonably well known among Canadian unions, as noted above. It also has support from the Canada Green Building Council. There are also a number of GPRO certified instructors capable of delivering the program and there is a growing number of trades' workers who have taken its climate modules.

The GPRO curriculum content is proprietary. Its development was not publicly subsidized so the organization has to cover the costs of curriculum development by charging for it. It also has to

charge for the various in person and on-line courses it provides. This is true for many of the other 'green' training curricula that have been developed in North America.

GPRO normally charges for its courses for regular participants as do the organizations through which its courses are delivered. But in the US it has made special arrangements for people who it believes would otherwise be excluded due to lack of financial resources, including indigenous workers, the unemployed, people with disabilities, and members of other groups under-represented in construction. It offers some courses free of charge for people fitting within these categories. This removes a barrier to access to the training material but the majority who take GPRO courses are still required to pay.

e) North American Examples: Construction Electrician Curriculum

Another example of how climate issues have been included into the curriculum of apprenticeship training is found in a training module developed as part of a Manitoba IBEW apprenticeship program that deals with photovoltaics. The curriculum was developed to provide apprentices with the knowledge and skills necessary to pass a CSA exam. But it was also written in a way that would provide them with an understanding of the importance of the work of electricians and how this work could make a better world.

As we would expect, much of the module is designed to provide apprentices with an understanding of electrical theory and, specifically, its application to photovoltaics. It covers types of photovoltaics, installation procedures and related technical issues, including how these systems interact with the electrical grid and the role of battery storage in some solar PV systems. It also covers electrical codes relevant to this kind of installation.

From our perspective what is interesting about the course is that links what they are learning about photovoltaics with the reason this technology is rapidly advancing, namely that it provides a way to generate electricity from non-fossil fuel sources. The module challenges apprentices to recognize the two major issues facing Canada today: climate change and energy supply. It explains the greenhouse effect in detail and shows how the increasing concentration of carbon dioxide in the atmosphere is responsible for raising global temperatures and their related adverse impacts. It notes that some scientists believe that there may be a 'tipping point' beyond which even with best efforts at reducing GHG emissions we will not be able to return to previous temperature levels because of the volume of carbon that will still be in the atmosphere. Consequently, we must take steps to deal with the climate challenge both in how we live as individuals and by attempting to make positive changes in our society to address the issue.

One component of the module includes a discussion of the disparity in fossil fuel emissions between wealthy, developed countries like Canada and many less developed countries who emit

only a fraction of what we do on a per capita basis. Canada like other rich countries is responsible for a disproportionate share of the global temperature increase and is second from the top in terms of per capita GHG emissions. The module notes that many of the people who are experiencing the damaging impacts of climate change are not responsible for creating the problem. Responsibly lies overwhelmingly with the wealthy nations who have benefitted from using fossil fuels in the past. Arguably, they now have some responsibility for dealing with the consequences. The module points to some of the ways 6 other countries have been trying to curb their emissions and provides examples for each.

The module looks at the ways in which Canada produces energy, including from coal, hydro, oil and natural gas, noting the mix in each region of the country. It discusses the reduction in GHG emissions from switching to renewables and exposes some of the misleading myths about the impacts of renewables. It explains that solar PV generates more energy than the inputs used to build solar panels and related equipment and that the energy advantage is increasing as the technology evolves. It notes the dramatic price decline of solar panels and predicts that this decline will continue as the technology improves. Even at costs prevailing when the module was written, the economics of solar still make sense for many applications over the long term and will do so more in the future as costs decline. In short, switching more of our electrical generation to solar is a good for the environment.

The module provides students with the history of photovoltaics as far back as the physicist Becquerel who discovered this effect almost two centuries ago. It notes some of the other inventors and their contributions who laid the theoretical foundation for the development of current advances in solar electricity. It also goes into the development of the electrical theory underpinning contemporary solar technology. The module then goes on to discuss how sunlight can be converted into electrical energy focusing on the physics of this transition.

Much of the remainder of the module addresses technical and theoretical issues associated with semiconductors, conductors and insulators. It also reviews the atomic structure of silicon and explains why it is being used in constructing solar PV modules.

The module provides an illustration of how to combine an understanding of climate science and the urgency of reducing GHG emissions with both theoretical and practical examples of how this is affecting the electrical trade by linking it with the growing role of solar PV in electrical installations. It provides apprentices with an understanding of why solar PV is becoming increasingly popular and how it is part of the solution to climate change. This is because it generates electrical power without most of the negative climate impacts of burning fossil fuels. Solar PV is something that the trade will increasingly be installing and, consequently, will be a growing part of the future of the electrical workforce.

f) North American Examples: Green Construction for Ironworkers

The Curriculum for Ironworkers is divided into 7 modules and forms a complete course. It is accompanied by a DVD with additional material for those taking it. The manual reflects the collaboration of the International Union with the US Green Building Council of which it is a member and active participant at that organization's annual conferences.

The manual discusses the importance of climate change and argues that the construction sector is one that is particularly important in terms of its impact in contributing to rising global temperatures. It emphasizes that construction workers have a responsibility to tackle the problem seriously, both individually and in their work. The following quotations from the manual provide a good illustration of how it approaches the issue of climate literacy.

"Global climate change is an enormous challenge facing the citizens of the world. Even as we try to find ways to deal with the current situations and residual effects of rising global temperatures, we must also think about how we, as individuals, can do things differently that will have a positive impact on the environment or at least a less damaging impact than they have in the past. The easiest thing, and maybe the most natural thing for our culture in North America, seems to be to either ignore the problem as if it doesn't exist or be of the mindset that the problem is too large for an individual to make any substantial difference. While this resonates as a good sound bite, it is simply not true."

"As global temperatures rise and threaten rising sea levels (figure 1.4), worldwide crop reductions, (figure 1.5) , and an increase in severe weather systems (Figure 1.6) , we should take the stand that since everyone is affected by climate change, everyone should do something to try and make positive changes. One contribution an ironworker can make is to become experienced in how to construct green buildings. Green buildings are buildings that have not only been built according to new green construction standards, but also have been designed according to new green construction specifications. They are buildings that have been designed to use less energy, waste fewer resources, and require less maintenance.

"One of the changes green construction brings to the job site is that the project specifications shift to focal points like sustainability, biomimicry, rapidly renewable materials, and passive survivability; these shifts have a ripple effect. Some of the things that are affected are the bidding processes, procurement procedures, as well as record keeping and documentation practices… While most of these things do not directly affect every ironworker on a project, there are many Ironworkers in supervisory positions, like foremen, general foremen, or superintendents whom these things will directly affect. This, eventually, in one fashion or another filters down to the Ironworker in the shop or in the field, the one who is actually sorting through the construction waste to help separate it for appropriate recycling the apprentice who is placing the proper caulk in the right location for the curtain wall the Ironworker who needs to understand the reason

behind the sedimentation fence and why it must remain in place even though it forces the delay of steel delivery to the site and compresses the work schedule ”

“Ironworkers completing this training course should have a greater sense of their responsibilities and a heightened sense of the things that they could expect to encounter on a green project. Some ironworkers after completing this course may even have a personal awakening. Some may decide that there are things they can do differently to have less of an impact on the environment, not only on the job where they may be required to do them, but also in their daily lives away from the job. If an ironworker takes away a greater understanding that begins to lessen his or her personal environmental impact, then this training has rewards beyond those associated with the project.”

The passages above highlight the curriculum manual’s strong focus on climate change and underscores the role that a union and its members can – and should – play in being part of the solution to the climate challenge

g) North American Examples: Passive House Canada

Another example of an organization that carries out climate focused construction training is Passive House Canada. It is well known in the industry as a proponent of net zero construction practice, particularly in the residential and small ICI sector. The philosophical rationale of Passive House is integrally connected to addressing climate change. The Passive House system originated in Germany and has been utilized as a framework for constructing buildings for several decades now. Passive House has a world-wide network of affiliates and Passive House Canada was founded as a not-for-profit corporation in 2013.

The Passive House design philosophy is integrally connected to mitigating and adapting to climate change, as well as promoting resource conservation and a sustainable ecological footprint.[4] There are extensive studies in the scientific, engineering and academic literature about the features of this high-performance approach to constructing low or net zero energy buildings. Passive House Canada also carries out research, lobbying, education and is a strong public advocate for net zero building practice, including lobbying for tougher building codes. It also regulates Passive House construction standards by certifying buildings that meet its very detailed performance requirements.

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[4] Yarbrough, David, mark Bomberg and Anna Romanska-Zapala. (2021) On the Next Generation of Low Energy Buildings. Advances in Building Energy Research. Vol. 15, No. 2., pp 223 – 230. Ionescu, Constantin, Tudor Baracu et. al. (2015) The Historical Evolution of the Energy Efficient Buildings. Renewable and Sustainable Energy Reviews. Vol. 49. pp. 243 – 253. Bastian, Zeno, Jurgen Schnieders et. al (2022) Retrofit With Passive House Components. Energy Efficiency. Vol. 15, No. 10.

Passive House Canada offers an extensive program of in-house training courses staffed by instructors qualified in Passive House building systems. It provides a range of certifications for those taking its courses. While some of its training is targeted at the building trades, it also provides courses for industry professionals such as architects, engineers, and individuals interested in constructing their own passive house residence.

Passive House courses are delivered in various ways. One is through the Passive House School which provides direct instruction to those interested in learning its system. It also partners with other training organizations such as public colleges to have them deliver its training content. In terms of curriculum, it benefits from the knowledge base and experience of the global network of national Passive House organizations to which it is affiliated. This provides access to their extensive resources and expertise. It also benefits from their knowledge about recent construction innovations and examples from other countries that may be relevant to Canada.

The organization offers a number of courses. These include: Introductory Course in Passive House (Passive House 101); Passive House Design and Construction; Pathways to Passive House Designer/Consultant Certification; Passive House Construction Training for Trades (Theoretical and Practical); Master Class in Building Enclosures; Control Layers for Passive House Wall Assemblies; and lessons Learned from Passive House Projects in Canada.

As a result of the challenges of Covid-19 it also offers a number of its courses on-line. In terms of trades' training, it offers a 3-day course for journey workers in the principles and methods of passive house construction. Courses offered through public training institutions include, for example, BCIT's 5-day special program for current trades' workers in passive house construction. This has been developed to provide the knowledge and skills needed to deliver the City of Vancouver's new building code regulations.[5]

Passive House is widely recognized as a major advocate for measures to address climate change. Its former Canadian CEO Rob Burkart is widely known for his strong advocacy of much higher building standards, not only with respect to Passive House but also for the entire building industry. He has intervened in numerous consultations around improvements to building and energy codes in Canada and provincially.

While conserving energy (and cost) as well as promoting environmentally sustainable practices are part of its basic philosophy, climate change is a key reason for its extensive advocacy of lowering the energy use and carbon footprint of the building sector. Passive house is active at Federal, provincial/territorial and municipal level in advocating for public policies that will

[5] Details on BCIT web site. https://www.bcit.ca/construction-environment/study/partnership-learning/passive-house-construction/

encourage high performance buildings, both new build and retrofitted. It regularly submits briefs to government commissions and task forces outlining a range of changes it believes are necessary to push Canada towards a more sustainable future.

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 submission to the 2021 [1]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 recommended that the Federal Government change its conflict-of-interest guidelines to recognize that vested interests were impeding the development of more climate friendly regulations and that this needed to stop.

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. Properly designed buildings or appropriate retrofits will reduce exposure of occupants to airborne pollutants, toxic chemicals, mould and other health hazards providing an important co-benefit.

It is also critical of the funding being provided by governments, arguing that to achieve the target of 40% to 45% reduction in emissions by 2030 will require far more funding than the Federal Government has committed, particularly if Canada is to retrofit on a massive scale to meet the targets.

Although still a niche training program which focuses on construction workers, contractors and industry professionals who wish to build Passive House structures, the significance of the program is that it provides another example of how climate literacy can be introduced into a training program for construction workers. The main limitations are the proprietary nature of the curriculum and the still limited – although growing - application of its approach to construction.

h) North American Examples: Canada Green Building Council

Another organization that plays a significant role in low energy education is the Canada Green Building Council. As noted in the GPRO discussion earlier, the Council acts as a Canadian representative of GPRO and delivers its training initiatives. It is also affiliated with the US and international Green Building Councils and draws upon their experience and expertise. Addressing climate change is a core principle which shapes much of the Council's activities. In addition to GPRO, the Council, which is a not-for-profit organization, carries out a wide range of other research and educational activities associated with lowering the energy use and climate footprint of buildings and infrastructure. Based in Ottawa but with staff in a number of other Canadian cities, the Council provides custom tailored training programs for construction employers who are supportive of the Council's focus on high performance buildings.

Among its various educational activities, the Council sponsors a Zero Education Project. This is composed of a suite of training modules to provide construction industry professionals and trades workers with a background in specific low energy or low carbon construction issues. A list of the courses includes: Introduction to the Zero Carbon Building Standard, The Zero Carbon Building Standard Workshop, Understanding the Zero Carbon Building Standard, Making the case for Building to Zero Carbon, Core Concepts: Introduction to Thermal Energy Demand Intensity, Core Concepts: Renewable Energy and Zero Carbon Buildings, Core Concepts: Embodied Carbon: an Introduction, Wood and Embodied Carbon for Zero-Carbon Buildings, Low Embedded Carbon Designs, Intermediate Strategies for Reducing Thermal Energy Demand Intensity and several others.

The Canada Green Building Council is also a strong advocate for low energy construction and is a frequent contributor to government commissions and enquiries on building and climate issues. It has produced a large volume of research studies that address a range of economic, policy and technical issues associated with high performance building.

The Canada Green Building Council administers the LEED building certification program in Canada and provides training on this standard to those in the building industry involved with overseeing the application of this standard, including awarding LEED certifications. While many of these recipients are industry professionals engaged in advanced technical building modelling, CGABC as noted provides courses and certifications for the skilled trades as well.

3. European Examples: Climate Change Curriculum in Ireland

The reason for including Irish climate training in this survey is that it has been developed explicitly to include climate science into the country's trades' training program for its working trades. The course outlines are extremely detailed and include material providing an overview of

how climate change is impacting its construction industry and what that impact means for the actual work of the trades. In this respect it parallels the way GPRO has been developed, using its Fundamentals course and requiring completion of it as a condition to moving on to trades specific modules. The Irish training manuals also provide an excellent account of the linkages between climate change, European and Irish climate legislation and the climate's impact on the work of the trades themselves.[6]

Ireland is a member of the European Union and consequently is covered by its extensive legislation and policies designed to enable Europe's construction workforce to meet the EU's ambitious climate change targets. To achieve its training agenda, the EU established the Build UP Skills initiative in 2010. Its purpose was to assess the capacity of member countries construction industries to achieve its long-term climate targets. This was followed by determining the changes needed to their training systems to prepare their workforces to achieve this and accordingly implement appropriate changes. [7] (More extensive details of the Irish training system are provided in the report of the European CIRT team.)

Ireland has enacted domestic legislation that implements EU climate policies. Its 2021 Climate Action Plan includes an energy retrofit program, a public sector energy efficiency initiative and an Action Plan for Apprentices.[8] The goal is to reduce emissions by between 44% and 56% by 2030 through strengthening building standards, promoting more efficient heating (through heat pumps and district heating), reducing carbon content in construction materials and improve the energy efficiency of existing and new buildings. Ireland has three new Net Zero Energy Building training centres. [9]And it is funding an International Centre of Excellence in High Performing Buildings as part of the United Nations Economic Commission for Europe program.

The Irish initiatives reflect the government's view that Ireland needed to catch up with best practices in the leading EU members, as its trades' training system, historically, had not focused on low carbon construction practice. Like other EU members participating in the Build Up Skills and follow up initiatives, Ireland used the EU's resources to embark on a major review of its

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[6] Copies of these training manuals have been shared with CBTU

[7] In a review of the Irish Qualibuild program, a group of scholars from the Institute of Technology, Blanchardstown, Dublin summarize the key pedagogical lessons from the development of the training program and its related instructor aids. Keys, Mark, Shaun Ferns et. al. (2016) Qualibuild Train the Trainer Lessons Learned from the Development of a Program for Training Trainers of Construction Workers in Ireland. Paper Presented at the Higher Education in Transformation Symposium, Oshawa, Canada. Nov. 2 – 6, 2016. https://arrow.tudublin.ie/cgi/viewcontent.cgi?article=1000&context=heit167; Irish Green Building Council. (2021). Net Zero Whole Life Carbon Roadmap for the Built Environment in Ireland. November. https://www.igbc.ie/wp-content/uploads/2021/11/IGBC-PRELIMINARY-RECOMMENDATIONS-REPORT-11-11-2021.pdf

[8] Irish Climate Action Plan 2021. https://www.gov.ie/en/campaigns/2f87c-climate-action-plan-2021/. This is vehicle for implementing the targets established by the Climate Action and Low Carbon Development (Amendment) Act 2021.

[9] 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

overall trades' training system with the view to prepare its construction industry to meet the ambitious EU climate targets. And, like other EU members, it produced both a status quo report and a national roadmap on which it then based its approach to modernizing its training system.[10]

Ireland is a small unitary state, so the national government was well positioned to oversee the country's training system without having to deal with the complex jurisdictional, geographic and linguistic issues that confront Canada. Ireland's program brought together a group of industry stakeholders, including its key training colleges (Limerick Institute of Technology and Dublin Institute of Technology), the Irish Green Building Council, the Construction Industry Federation and a steering committee involving 14 stakeholders from the education sector and construction industry.

Building on an initial pilot program, the Watford and Wexford Education and Training Board has developed a package of training programs targeted initially at instructors in the country's trades' training system, but with the objective of using the modules as the basis for upgrade programs for its working journeypersons and incorporating the material into its apprenticeship programs. Starting with an initial Foundation Energy Skills course, it has now expanded this to provide climate and energy specific courses for electricians, plumbers, carpenters, bricklayers, plasterers, general construction workers, and supervisors as well as specific courses for upgrading ventilation systems and implementing building retrofits.[11] This has been supported by the government's introduction of new regulations that require higher qualification standards for various construction trades. This is to provide a rationale for workers to upgrade their skills and competencies and encourage employers to require these as a condition of employment.

The preceding provides the background to the next part of this report which provides a detailed account of several of the key training documents developed by Ireland. An examination of these illustrates how Ireland has translated the EU's broad climate agenda policies and legislation into modifications to its specific trades' training system, including the development of detailed training modules for instructors, working trades and apprentices.

To provide context to this account, it is helpful to know that one of the major findings incorporated into Ireland's EU Build Up Skills Roadmap was that the challenge in implementing low carbon construction was not workers' lack of specific skills but, rather, lack of knowledge and understanding of building science and the relationship among key components of the building process, an observation that resonates with Canada and other countries concerned about

[10] Build Up Skills Ireland. (2012). Analysis of the National Status Quo. Energy Europe Program and Qualibuild August; Build UP Skills. (2013). Ireland. National Roadmap for Energy Training in Construction. BuildUpSkillsRoadmaplowresUpdate_0.pdf (igbc.ie)

[11] Clarke and Winch, op. cit.

preparing their workforces for low carbon construction. As an illustration of this conclusion, it is worth citing at length one of the instructor training manuals:

"Generally in the (Irish) building sector, the gap that was identified is one of knowledge rather than skills. However, this knowledge is fundamental for the successful implementation of low energy buildings. It is important to understand the mind set of workers who, based on their years of experience, believe that they already ***know*** *the 'right way' to do their job. The Build Up Skills Initiative research also found that the majority of trainers of construction related crafts lacked the experience and knowledge on the implementation of low energy building. In order to support the efforts to achieve energy saving targets for buildings, the existing workforce employed in the building sector in Ireland will require up-skilling. A foundation level of training is needed across all disciplines engaged in the construction sector and progressing to more advanced levels as appropriate to each workers' role. The science that underpins energy efficient building needs to be presented and demonstrated in a format which clearly illustrates for the construction worker how practices onsite are affected. This is key to fostering a change in attitude and an acceptance of the necessity for a new approach to their work."* [12]

The new program for trainers is organized in detailed modules, supplemented by other learning aids and hands on experience in workshops or on site.[13] Module 1, Building for Energy Performance provides a certificate for training in low energy buildings for trades instructors. Module 2 deals with building fabric issues.[14] Module 3 covers building services such as HVAC systems. The final module examines pedagogical approaches to trades' instruction. There is also a supplemental manual which is basically a set of lesson plans to help instructors teach the course. The package is delivered through a 'flipped classroom' approach, supplemented by workshop demonstrations or on-site activities for each module.

Of particular interest for Canadians is that this training material is 'open source' meaning that it is freely available via the internet to anyone interested in it. It thus overcomes one of the problems facing training systems in Canada and the US where much of the actual curriculum is proprietary and hence not shared widely. In the following pages we shall discuss the various manuals in greater deatail.

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[12] Build UP Skills Ireland (n.d.) Module 1 Building for Energy Performance. Intelligent Energy Europe Program and QualiBuild. P. 8

[13] The Program has a set of modules for trainers plus a learner's manual for apprentices. The trainer modules are: Module 1: Certificate in Training in Low Energy Buildings - Building for Energy Performance; Module 2: the Building Fabric; Module 3: Building Services and Module 4: Pedagogical Approaches. There is also a Trainers' Manual which is basically a set of lesson plans to help instructors deliver the program. The module for apprentices is entitled: Certificate in Introduction to Low Energy Building Construction: What Does Near Zero Energy Mean to Me? https://www.dropbox.com/sh/xljgighzhil67ja/AAAnTgVl7Wk9DlzoClCvozmWa?dl=0

[14] This also points to the failure of governments to recognize that if they wish to achieve their climate goals in the construction industry, they should consider providing training material to all those who may wish to use it without any financial or copyright barriers to its widespread adoption. Absence of government support, understandably private training organizations have sought to fill the gap.

Module 1 provides instructors with a detailed overview of the EU and Irish Government's policy framework on climate change and how it impacts the building sector. It covers the international treaty commitments adopted over the previous 25 years on climate change and how these have been reflected in corresponding legislation in the EU and Ireland. It links the increasing focus on reducing energy use to climate change caused by burning fossil fuels. It notes that "energy related CO2 emissions account for the majority of greenhouse gases in our atmosphere." [15] And it includes a description of the greenhouse effect with images of how it warms the earth.

The manual provides trainers with a history of the establishment of the Intergovernmental Panel on Climate Change (IPCC) by the UN and the World Meteorological Organization in 1988 and the subsequent international meetings to address the issue, including the 1992 Earth Summit and the ratification of the Kyoto Protocol in 1997. It then outlines the IPCC's role in advising member governments on the science about climate change. It summarizes the fifth IPCC report of 2014 in the following way:

"The report indicates an increase in certainty that humans are responsible for global warming from 90% - "very likely" in the 2007 report to 95% - "extremely likely" now. The IPCC have concluded that global warming is happening and that the emission of man-made greenhouse gasses, particularly carbon dioxide, methane and nitrous oxide are directly contributing to the problem. Their assessment reports also note the serious adverse consequences of climate change on the environment, particularly a likely increase in the number of extreme weather events"[16]

The manual provides an account of the various EU Directives that deal with climate change starting with the Energy Performance of Buildings Directive in 2010 and the subsequent 2012 Energy Directive, including their more recent enhancements. It expects trainers to be familiar with these EU Directives and understand how they have shaped the policies that affect the building industry so they can explain this to their students. A key learning outcome is for trainers to be able to "discuss the implications of EU and national energy policies on building construction and renovation activity in Ireland."

The module covers Irish climate policy in considerable detail, including National Climate Change Strategy 2007 – 2012, the National Renewable Energy Action Plan, the National Energy Efficiency Action Plan and the various codes, standards and regulations that have been legislated to conform with EU policy.[17] One aspect of this is the introduction of a mandatory energy rating certification system accompanied by Energy Performance Certificates which building owners are now required to have, a policy which the EU mandated. This provides data on the actual energy

[15] Ibid. p. 17.
[16] Ibid. p. 18.
[17] Ibid. p. 23, 27.

use of buildings, providing the rationale for taking measures to lower their energy use, particularly for those with high energy consumption profiles. The manual also provides considerable information on the various agencies and other statutory bodies responsible for regulating energy and buildings in Ireland and describes their roles in the building sector.

The manual shows how the building regulations are part of a wider government climate policy agenda that encompasses the entire Irish economy, including finance, manufacturing industry and the public sector. This is to provide instructors with the 'big picture' of how changes to the building sector fit in with a larger pattern of policies to address climate change. It provides further information on types of energy, where it is being used and ways in which it can be saved. The section of the manual dealing with climate and energy is followed by a short bibliography of further reading for instructors to enable them to follow up on some of the information it provides.[18]

Another major section of the instructor manual deals with the evolution of the Irish building regulations over the previous twenty years. It links the increasing focus on reducing energy use with the government's ambitious climate agenda. What is significant is the explicit connection the manual makes between the new regulations and climate mitigation. It explains that the purpose is not only to save energy and money, but also to contribute to Ireland's effort to address global warming. The manual also provides a dictionary of concepts relevant to understanding the energy use in buildings which instructors are expected to be able to explain in detail, such as thermal bridging, U values, thermal conductivity, near zero and so forth.[19]

In providing advice on various technical issues associated with low carbon construction, the manual emphasizes the much higher standards of quality control that low carbon buildings require. It notes the "growing realization of the importance of attention to details and specifications on site in the achievement of more ambitious performance targets."[20] It also reiterates the importance of workers understanding the reasons why low carbon construction must be carried out so precisely and to such a high standard.

"Construction workers are far more likely to follow specifications and details for energy performance if they know what the specifications are and where their work fits in the overall scheme of things. Just as important, they need to be aware of the implications of their work on the overall functioning of the building."[21]

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[18] Ferns, Shaun, Robert Hickey et. al. (2015). QualiBuild Train the Trainer: An approach to training trainers of construction workers using flipped learning and peer assessment. School of Informatics and Engineering, ITB, Dublin.
[19] Irish Training Manual Module 1, op. cit. p. 59.
[20] Ibid p. 74.
[21] Ibid p. 86.

The manual links this observation with advice about the value of each trade learning about the work of the other trades on building sites. In the prepared questions instructors can use with their students, it asks the students to describe areas of construction work that impact on their craft and conversely, to describe areas where their work impacts other trades' workers on building sites. In its words: "production of low energy buildings requires diligent attention to detail and cooperation between all involved in the construction/renovation processes.[22]

Much of the remaining content of the manual deals with specific issues related to the Irish construction industry, including building code provisions, the demographics of the industry, a profile of the building stock and so forth. However, it does discuss the fundamentals of building science, and how knowledge of these fundamentals is needed for effective low carbon construction. It presents extensive examples dealing with typical problems faced by plumbers, insulators, roofers, steel workers, electricians and so forth. (These are basically the same kinds of issues that the Canadian apprenticeship system already covers.)

In its concluding section, the manual notes the limitations of simply providing workers with knowledge of specific technologies or installation methods rather than giving them a proper grounding in building science which they can then apply to many different construction problems. It argues that: "The array of newly introduced programmes related to energy efficiency and renewable energy deployment are generally technology specific. As such, many of the programmes do not provide learners with an understanding of the fundamental principles of low energy buildings and system efficiency."[23]

Module 2: The Building Fabric manual is designed to provide instructors with a detailed understanding of the way in which the design and implementation of the building envelope affects energy performance and the demand for heating and air conditioning in buildings. It reflects the approach common in Europe to divide buildings into two specific categories: building fabric (envelope) and building services, that is HVAC and related systems, the latter being addressed in the third manual discussed below.

The Building Fabric is more technical than the first manual, for example, providing considerable detail about issues such the 4 laws of thermodynamics and how they impact the way heat and cold is transferred both within buildings and outside. The emphasis is on understanding the basic physics of energy. The module also defines many of the terms customarily used to discuss energy and heat in the construction industry. It discusses the various forms of energy that can be transformed into heat, including that generated by fossil fuels and renewable sources. And it underscores the importance of controlling temperature and air circulation while minimizing energy use in buildings so that they are comfortable and healthy places to work and live.

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[22] Ibid. P. 87.
[23] Ibid. p. 163.

The module also discusses concepts such as air permeability, fabric heat losses, thermal bridging and the way in which the interface among building envelope components impacts the resulting energy integrity of the structure. It maintains that all building workers should be aware of the way in which their work can impact air permeability of buildings and the adverse consequences of not sealing the fabric properly. It includes specific examples of various building challenges associated with securing the air tightness of the building envelope, supporting this information by extensive photos and diagrams about how these should be addressed. Significantly, it emphasizes the responsibility of all workers on a building site for ensuring the air tightness of buildings. In its words:

"Any worker who has a role at any stage in the development of the building fabric, i.e., bricklayers, carpenters, plasterers, plumbers, electricians, glaziers, painter and decorators, floor and carpet layers, and all other variants of crafts workers listed here including operatives have a reasonability to ensure air tightness is not compromised." (p. 42)

The module also examines some of the health consequences associated with poor construction quality, such as the impact of black mould on asthma sufferers. A major part of the module explains the government's Dwelling Energy Assessment Procedure (DEAP) which is a package of software that is used to determine the performance of the building fabric, including air infiltration and provides guidance on how to use it. The last major section of the manual discusses insulation principles and provides illustrations of various types of insulation and the proper way to install them. Of note is that each section of the manual contains a series of questions instructors can pose to students concerning what they have learned about the material covered.

Module 3: Building Services looks at heating, ventilation, air conditioning and electrical systems in buildings. It discusses the factors that affect energy use in buildings and how they impact total energy consumption. It reviews the different types of air and water-based space heating systems and the fuels they use, including their climate impacts. Like module 3, it contains a great deal of technical information about different types of heating systems and the issues that need to be considered in their proper installation and calibration. It emphasizes the importance of understanding hydraulic balancing to maximize the efficiency of wet central heating systems. It also discusses heating controls and thermostats, outlining how they should be set up to avoid energy losses.

The central part of the module discusses electrical systems for lighting, heating and powering a wide range of equipment and appliances. It compares incandescent (phased out by the EU in 2009), fluorescent and LED lighting options and outlines where each of the latter should be used. It provides examples of electrically controlled pumps and fans, again giving specific information

on technical issues associated with pump selection, operation and maintenance and explaining why some types of pumps are more efficient than others.

The final section of the module examines renewable energy systems. It introduces the issue by providing definitions of the different terms used in the industry. It then distinguishes between solar thermal heating and hot water systems and solar electric systems. There is an extensive discussion of heat pump principles and the different types of air and ground source heat pumps currently being used in Ireland. The last part of the manual looks at the principles of Solar PV and wind energy systems and explains how energy is generated by solar panels or wind turbines, converted to regular voltage through DC to Ac inverters and then stored for use or sold to the Irish electrical grid. Again, the module includes detailed questions for students about the information contained in each of its sections.

Module 4: Pedagogical Approaches, is very different from the other three in that it focuses on theories of learning. It is explicitly intended to change the way in which construction training has traditionally been delivered in Ireland which it sees as "inconsistent" with the approach now needed to teach low energy construction principles and practices. Its starting point is the EU's climate policies and the importance of translating these policies into what is taught in the country's trades' training programs. It repeats the conclusion of the Build-Up Skills analysis that the problem in implementing low carbon construction is that of acquiring knowledge of climate science, not technical skills. Its purpose is to enable workers to expand their 'knowledge of principles and practices applied to the construction/retrofitting of low energy/ near zero energy buildings." In its words:

"For the FES (Foundation Energy Skills) program, the challenge is to address both technical knowledge gaps and attitudinal change. This will require a shift from traditional models of construction training towards a more learner-centred approach, emphasizing learning outcomes beyond the acquisition of technical skills and competencies and into shared knowledge and experiences in communities of practice." (p. 7)

The module emphasizes attitudinal change and a change in the culture of the teaching/learning process - and the wider industry - in which systems thinking and quality of workmanship are prioritized. It is also explicitly learner centred.

Targeted at instructors, the module starts with a survey of different approaches to learning based on various academic and vocational education theories. The module notes that there are numerous theories of learning and that there is no universal consensus on which is most appropriate. The theories examined in this module include behaviourism, cognitivism and constructivism. Each approach is explained briefly and its strengths and weaknesses outlined. A key point is for instructors to be aware that they normally do have a theory underlying the way in

which they teach, even if it is not explicitly recognized, and they need to be aware of it and self-reflect on how it affects their approach to teaching. They also need to be aware of how the approach they use contrasts with other theories of learning and hence how they might wish to modify what they do.

While the module generally favours a constructivist theoretical approach, it maintains that the methodological choice by instructors must reflect the purpose and context in which the learning takes place so elements of behaviourism or cognitivism can be appropriately utilized in certain situations. Nevertheless, it argues that issues such as communication, teamwork, problem solving, time management, and communities of practice need to be integrated into the learning process. Learner centred and learner sensitive approaches need to be emphasized in training programs.

A significant part of the module discusses models of the learning process. It presents Bloom's Taxonomy with its pyramid approach starting with knowledge and proceeding through comprehension, application, analysis, synthesis and evaluation. It also reviews the approach of Gagne based on a complexity hierarchy which identifies pedagogical approaches for each step in the hierarchy. A key point is that different approaches to instruction are required to achieve different learning outcomes.

One central goal of the learning process is the development of "Communities of Practice" both among workers on job sites and as collaborative networks among trades and professionals within firms. This is to promote social learning in which individuals are encouraged to share their knowledge and understandings with their colleagues in a process through which everyone in the community participates and learns. Joint problem solving is a key element of this process and this can be encouraged by using group learning techniques.

The preceding summary provides only a snapshot of a conceptually dense, theoretically focused 143-page module designed to provide instructors with a deeper understanding of the factors shaping the learning process experienced by apprentices. Its theoretical approach is unusual compared with most standard training manuals for vocational training for instructors and underscores the extent to which the Build Up Skills initiative is focused on developing new approaches to learning that will facilitate the cultural change needed to transform working practices for low carbon construction.

In addition to the four manuals discussed above, there is also a separate Build Up Skills manual for Irish trades' trainers which provides detailed lesson plans designed to assist instructors deliver the content of the core instructor manuals discussed above.[24] Of interest is that the 74-

[24] Build Up Skills (2016) Certificate in Introduction to Low Energy Building Construction: What Does Near Zero Energy Mean to Me? Trainer's Manual. Intelligent Energy Europe Program and Qualibuild.

page manual expands on material in the other manuals by providing an entire section on systems thinking. This is found in Section 6, the final part of the training guideline. It outlines the purpose of the systems component of the lesson plan as follows:

"This unit is designed to reinforce 'Systems Thinking' for the students and encourage communication between all trades. As this is the last Unit all the topics discussed in each of the previous sections should be brought together in the context of the need for communication and collaboration onsite. It is hoped that a common understanding and approach will emerge. It is important for students to understand the following:

- *how one trade's work impacts on another trade's work,*
- *the importance of working in a set sequence, paying attention to detail*
- *communicating effectively amongst themselves in order to achieve Low Energy Quality buildings"*[25]

In framing one of the lesson plans, the manual explains the purpose as follows:

"This presentation identifies important steps during the construction of the building and although the individual construction worker may not be involved in all the steps, it is useful for him, or her, to understand the process of work so that they appreciate their role in it. It should be pointed out that all people on site have some role to play in achieving ***quality of workmanship, competency and compliance.*** (emphasis in original)***"***[26]

As the quote indicates, system thinking also involves ensuring that all trades, regardless of what they do, specifically, on a building site, should be recognized for their contribution to the success of the overall project. This is to avoid creating a hierarchy where one trade comes to believe that it is the key contributor to a building's success in meeting energy targets, while other trades have a back seat. It recognizes that an hierarchical approach is divisive and also ignores the basic fact that every trade has something to contribute. A project cannot be successfully completed without each trade doing its part.

The final part of our exploration of the Irish Build Up Skills training program involves a brief look at the 163-page Learner's Handbook [27] It contains 6 units that cover the same material provided in the various instructor manuals, but in a manner targeted at working trades' level and in a less detailed manner. It contains the same basic information about climate change – which it also explicitly refers to it as global warming. It includes an overview of the EU and Irish climate policy framework that informs the government's increasingly stringent building codes,

[25] Ibid. p. 61.
[26] Ibid. P. 65.
[27] Build Up Skills (2016) Certificate in Introduction to Low Energy Building Construction: Learner's Handbook. Intelligent Energy Europe Program and Qualibuild.

regulations and standards. It also explains the 'greenhouse effect' and discusses why the building sector is so important as a contributor to it. [28]And it explains why it is so important to reduce energy in buildings if the industry is going to meet Ireland's climate objectives.

The last unit of the Learner's Handbook again discusses the importance of system thinking both in terms of the need for collaboration and communication among all those working on a building site and in terms of viewing a building project as a unit, rather than a collection of separate tasks. It reinforces the point that the key barrier to more effective low carbon construction is lack of knowledge rather than lack of skills. Apprentices – and everyone else in the building process - need to understand the fundamental principles of low energy buildings. It notes that for many this will be a new way of thinking, but it is essential to delivering high performance buildings.[29] As with the trainer's manual, it emphasizes the need to respect the contribution of all the trades in achieving successful low carbon projects. The trades must see themselves as a team who should be working together in a cooperative way.

The preceding discussion of Ireland's training manuals shows that they provide a comprehensive approach to introducing climate change material into the country's trades training programs. The overall approach shows what a government committed to addressing the issue can do to provide the needed training material to facilitate the development of a more climate literate workforce and thus contribute to meeting the country's ambitious climate agenda.

4. Conclusion

The preceding survey of programs incorporating climate literacy illustrates ways in which different training providers have included climate science into their curriculums for apprentices and working trades. These, and other, training providers have recognized the importance of developing a more climate literate workforce and have developed curriculum material which they now incorporate in various ways into the courses they offer. What they have included provides valuable examples of the kind of course content that can - and should - be made more widely available to the trades. While the details of these courses and programs differ, they share the common theme that an understanding of climate change and its impacts now needs to be part of mainstream trades curricula. The way GPRO has linked its Foundation course with the trades specific courses that follow provides an example of how providing a basic understanding of climate issues and their impact on construction can be effectively integrated into the content of trades specific courses.

However, our analysis of Canada's Red Seal Standards indicates that the basic science of climate change, its impact on the construction industry and the consequences -and opportunities – for the

[28] Ibid. p. 36
[29] Ibid. p. 142.

trades' workforce is not currently part of its curriculum guidelines. Given the already very full course content trades instructors are expected to teach, most have little opportunity for including information about climate issues in their lesson plans. And while some certainly do try to incorporate elements of climate science, their ability to do so is constrained by the lack of scope and direction to do so in the current Red Seal program.

Currently apprentices and journey workers who recognize that climate change is impacting their industry and their jobs and want to learn more have to find ways to do so on their own time and at their own expense. Knowledge of climate's impact on construction is not currently part of what trades are expected to know to perform their jobs. This undermines the incentive to learn more. With the urgency of the climate crisis becoming more apparent with each passing year and with the extent to which it is now impacting the trades' workforce, this gap needs to be addressed by Canadian policy makers.

As the material described in the preceding survey of North American and Irish courses illustrates, knowledge of climate's impacts on buildings and infrastructure reinforces the rationale for moving towards high performance, net zero construction practices. This approach to construction requires a strong commitment to quality work, to working as a collaborative team on building sites and to viewing projects as an integrated whole in which every component must be properly built for them to meet their design – and climate – objectives.

If programs incorporating climate literacy are to be more widely adopted, employers will also have to require that their workers have a background in climate issues. Industry demand for a workforce with the climate informed knowledge, competencies and skills is key to providing an incentive both to apprentices and working trades to pursue climate literacy. Those who commission buildings and infrastructure will also need to ask that workers on their projects have this training. Including climate science and related environmental sustainability content into the apprenticeship curriculum will ensure that the upcoming generation of trades will be knowledgeable about these issues.

While the pick-up of green credentials to add to a working trades' resume is still limited, the policy direction of Canadian governments at all levels is not. Canada's ambitious climate targets, if they are to be achieved, mean that the entire industry will have to focus on developing the capacity to deliver low energy or net-zero construction as a matter of regular practice, rather than a 'boutique' construction service. The demand for workers with an understanding of the basic principles underlying low carbon construction will have to increase and, given government targets, will have to do so in the near future as building codes ratchet up the requirements for

new and refurbished buildings and those commissioning construction increasingly come to see the benefits if not the necessity of demanding high performance buildings.[30]

[30] This highlights a larger policy issue the Canadian and provincial governments may want to address in the future. For unlike the Red Seal Standards, there is no comparable curricula on climate change in construction that is widely – and freely - available. To the extent that the Canadian government is serious about promoting climate literacy in the construction industry, it may want to review how it could make such content more accessible – perhaps through modifying the Red Seal Standards to remove a barrier to access for the construction workforce.