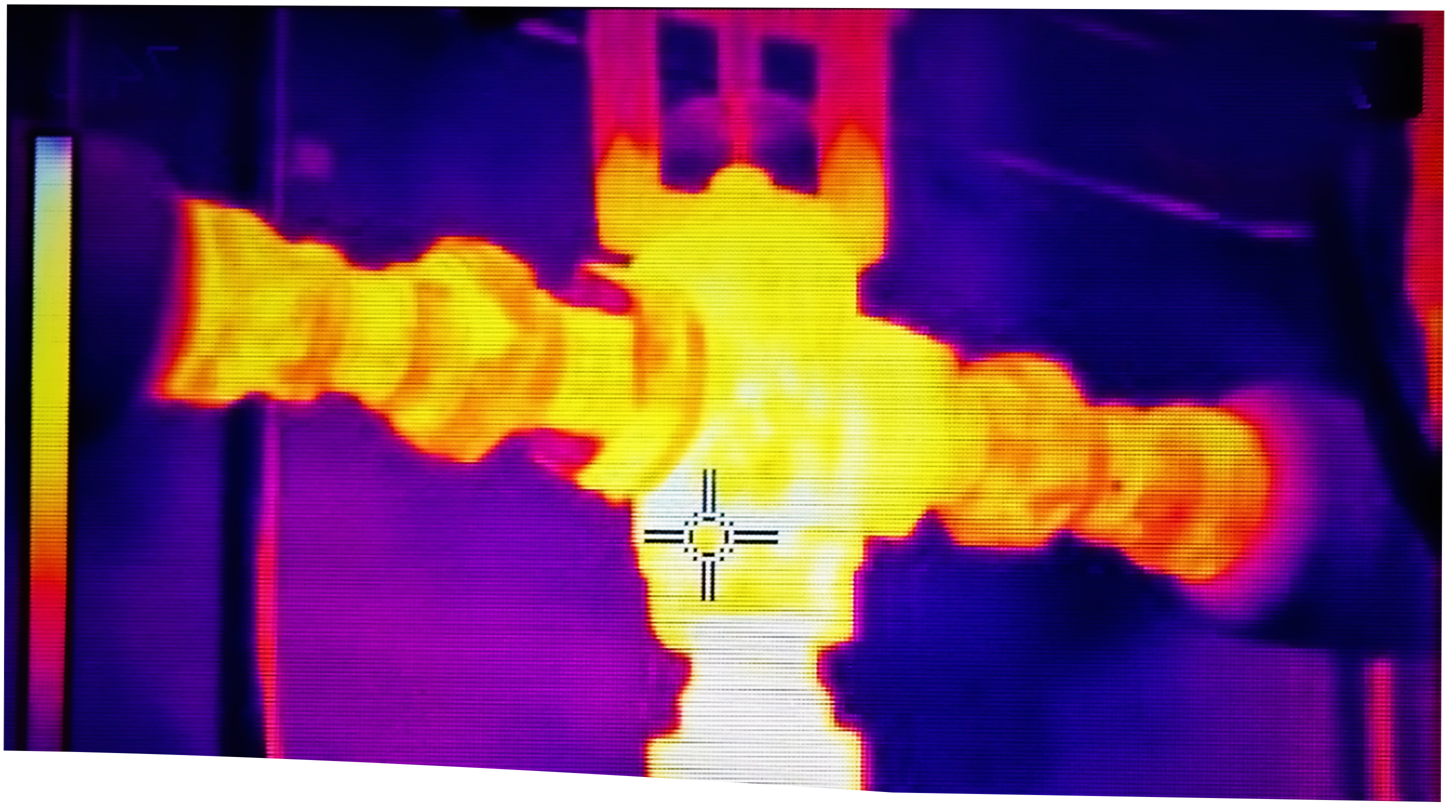
# THE BC INSULATOR UNION'S CAMPAIGN TO PROMOTE CLIMATE LITERACY IN CONSTRUCTION:



# DOCUMENTING ITS EFFORTS TO "GREEN" THE INDUSTRY'S CULTURE

ACW | Adapting Canadian Work and Workplaces to Respond to Climate Change

# THE BC INSULATOR UNION'S CAMPAIGN TO PROMOTE CLIMATE LITERACY IN CONSTRUCTION:

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# Introduction

The role of the labour movement in contributing to Canada's efforts to reduce greenhouse gas (GHG) emissions and energy use has not been the subject of scholarly attention in much of the climate change literature in recent years. Unions have largely been ignored as the academic literature and popular media have focused on the role of climate scientists, environmental NGOs, governments, industry, and professionals in addressing Canada's climate challenges. To the extent that union actions have been acknowledged, too often it has been in the context of construction unions supporting further fossil fuel developments or forestry unions clashing with the environmental movement – narratives that fit well with the neoliberal attack on the legitimacy and rights of the labour movement. However, there are good examples of unions exercising significant climate leadership in the industries employing their members. These merit much more attention than they have so far received and point to the potential of the labour movement to exercise leadership on this vital issue.

The focus of this research paper is to document the efforts of a small British Columbia (BC) based union, the BC Insulators, to reduce energy use and GHG emissions in the work performed by its members while attempting to foster climate literacy in the broader construction industry. The union's campaign has targeted its own members and apprentices, other construction trades, contractors, engineers, architects and industry professionals, developers, environmental NGOs, building owners and various levels of government. It has systematically expanded the focus of its campaign over the past decade, identifying new ways to promote its climate agenda and new target audiences, both in its home province of BC, nationally, and in the US insulation industry. The current paper builds on two previous studies, produced as part of the 'Adapting Canadian Work and Workplaces to Respond to Climate Change' research program funded by the Social Science and Humanities Council of Canada. (Calvert and Tallon 2016; Tallon and Calvert 2017).

# The Background and Context for the BC Insulator's Climate Literacy Campaign

The alarming nature of the global climate crisis is now widely accepted in the scientific literature and by a majority of the world's governments, as signalled in the 2015 Paris Accord which set out specific goals that signatory countries committed to achieve overall. These included keeping global temperature increases below 2 degrees Celsius, compared to pre-industrial levels, and making best efforts to keep the increase below 1.5 degree (UNFCC 2016). The COP 21 Paris agreement, the subsequent COP 24 Katowice conference and the related Kigali Amendment to the Montreal Protocol on HFCs are the most recent steps in a process that started with the Kyoto Accord in the early 1990s. This, in turn, built on the pioneering work of climate scientists such as NASA's James Hansen the previous decade. (Hansen 1988; UNEC 2016). It reflects the deepening scientific knowledge about the accelerating pace of climate change and the urgent need for significant measures to address it (IPCC 2018).

The Intergovernmental Panel on Climate Change (IPCC), created in1988 by the United Nations and the World Metrological Organization, has been in the forefront in documenting the alarming increase in GHG emissions and the deeply worrisome consequences if the world is not able to reduce these emissions in the coming decades. Many other scientific organizations have added to the consensus that global warming is increasing rapidly. This science is now well-established, and it is not necessary to review it in more detail in this paper. However, as is also widely acknowledged, actions to reduce the growth of GHG emissions have failed to date to curb the increase in GHG emissions, despite commitments by governments around the globe to achieve this objective (IPCC 2018).

In assessing the major factors influencing GHG emissions, energy use in buildings is widely recognized as one of the most important contributors (Berardi 2015; CGBC 2016; IEA 2016c; IEA 2019b; Qian 2019). According to the 5th IPPC report (Chapter 9), buildings contributed 32% of global energy use and were responsible for 19% of energy related GHG emissions in 2010 (IPCC 2014b).The International Energy Institute (IEA) notes that "The buildings and buildings construction sectors combined are responsible for 36% of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions." (IEA 2019). It also notes that by 2040 energy use in space heating could be reduced by 25%, in water heating by 43% and in air conditioning by 50% if appropriate policies were adopted.

According to the US Energy Information Administration, commercial and residential buildings will account for a total of 27% of energy use in the US between 2018 and 2050. It estimates that building energy consumption will increase by an average of .2% per year, a deeply worrying projection considering the climate crisis facing the globe and the need for dramatic reductions in energy use to meet climate targets. Commercial buildings, where HVAC systems are widely used, will increase their use of energy by 0.5% per year, offsetting a very small decline in residential consumption during the period (EIA 2019).

Despite its small population, Canada ranked ninth in the list of most significant emitting countries in 2015 according to the International Energy Agency. Its 15.32 Mt per capita of carbon emissions was only slightly lower than Saudi Arabia, Australia and the US. Buildings directly accounted for 12% of Canada's GHG emissions, and 17% if the contribution of emissions from producing electricity used in buildings is included. (NRC Fact Book p. 26). In British Columbia 23% of all GHG emissions can be attributed to buildings. According to the Pan Canadian Framework on Clean Growth and Climate Change, Canada's energy use in buildings is projected to increase "modestly" until 2030, indicating that efforts to curb GHG emission growth are unlikely to be successful in fulfilling Canada's Paris commitments (Pan-Canadian Framework on Clean Growth and Climate Change 2018, p. 15).

The reason the share of energy use in buildings in Canada is considerably lower than in other developed countries is that Canada is a major producer and exporter of fossil fuels. Absent this factor, the share of energy use in buildings would, arguably, be broadly similar to that of other developed countries, that is in the range of 30% to 40% (likely on the higher end, given the heating demands of Canada's relatively cold climate).[1]

## WHO ARE THE BC INSULATORS?

The importance of reducing energy use and GHG emissions in buildings provides the context for the efforts of the BC Insulators campaign to promote climate literacy in its own trade and in the broader construction industry in BC. However, before examining the Union's climate activism, it is necessary to provide a brief profile of the BC Insulators.[2] It is a small building trades' union of just over 500 members, including apprentices, that represents insulators working in BC. Qualified mechanical insulators are Red Seal certified tradespeople who install mechanical insulation (MI) on heating, ventilation and air conditioning systems (HVAC). (MI is not to be confused with the kind of insulation installed under roofs, in walls or in other parts of the building envelope.)

The Red Seal certification requires members of the trade to complete a 4-year apprenticeship totaling 540 hours in class technical training at the British Columbia Institute of Technology and another 6,600 hours on work sites to become accredited in the trade (Industry Training Authority 2018). Red Seal is a national standard which ensures that insulators have been fully trained and understand both the theory and proper application of MI. It signifies that workers are competent in installing the most advanced insulation technologies and energy saving materials in both new buildings and retrofits.

HVAC systems provide heating, or cooling, within buildings to maintain specified temperatures by circulating air or water within the structure. They may also control humidity and manage particulate concentration in the circulating air. Heating is the major role of HVAC systems in Canada, although in some facilities refrigeration is also a major source of energy use. Fossil fuels, primarily natural gas, remain the dominant source of energy.

1 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.

2 The BC Insulators were formerly called Local 118 of the Heat and Frost Insulators and Asbestos Workers. It is a union local of the International Association of Heat and Frost Insulators and Allied Workers.

However, many systems are also significant consumers of electricity, which powers air conditioners and refrigeration units for hospitals, supermarkets, shopping malls and a wide range of industrial, commercial and residential applications. HVAC systems also use electricity to provide energy to motors, fans and other system components that circulate air, or water, in buildings. Depending on the source of electricity (coal, gas, nuclear, hydro or renewable) the energy used by air conditioners can also contribute, indirectly, to increasing GHG emissions from power plants.

Mechanical Insulation is the thermal insulation wrapped around pipes, boilers, ductwork and related equipment in HVAC systems. Properly installed insulation significantly reduces thermal losses. This is its primary function and the reason it plays such a significant role in energy use and GHG emissions.

But MI also has other benefits, such as reducing the risk of fires, limiting noise, preventing the accumulation of moisture and condensation, enhancing HVAC system longevity, preventing corrosion, arresting the growth of mould, and filtering out airborne contaminants that adversely affect building occupant's health (TIAC 2019). It also protects occupants from burns from exposure to hot pipes and other components of HVAC systems. (H.C. Lanarc 2012; NMIC 2017) Keeping HVAC systems operating efficiently also facilitates their role in maintaining good indoor air quality and protecting occupants from hazards such as 'sick building syndrome' which can adversely affect the health of those living or working in buildings. (TIAC 2019)

Although it may seem simple to put insulation on the pipes, ductwork and other components of HVAC systems, this is not the case. Systems are different. They are produced by a wide range of manufacturers, using varying materials and technologies. (Daşdemir et. al. 2017). Pipes can be made of copper, stainless steel, or a variety of plastics and composites. The type of insulation to be used varies accordingly. Similarly, the appropriate insulation for ductwork depends on the type of ductwork installed, its location in a building system, whether it handles hot air or refrigerated air and a range of other factors. (TIAC 2019)

HVAC installations vary according to manufacturer, size, age, location, effectiveness of past maintenance and numerous other factors. Commercial buildings differ from industrial plants and from apartments and condominiums. In addition, there are a wide variety of different types of MI and they are continuously being improved. Installers need to know what is appropriate for the specific HVAC system they are working on, especially when doing upgrades to existing systems. This means knowing the type of insulation required, the appropriate thickness, the amount needed and the right way to install it. There is a reason why the training of insulators requires a four-year apprenticeship.

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To meet climate change goals, governments have taken a number of steps to raise the energy performance standards in buildings, including in HVAC systems. Much of this effort has focused on changes to building codes requiring new buildings to meet tougher energy efficiency standards, including specifying higher performance targets in new HVAC installations. A number of well known private initiatives have also focused on implementing such standards, for example the ASHRAE system in the US, the International Code Council used globally, and the LEED certification program widely used in Canada (ASHRAE; CGBC 2016; CGBC 2018; ICC 2018).

However, the contributions of MI in in improving HVAC energy performance have tended to be taken for granted. According to the Whole Building Design Guide (WBDG) posted on the website of the US National Institute of Building Sciences in July 2019:

"Mechanical insulation, although important to facility operations and manufacturing processes is often overlooked and undervalued. National standards, universal energy policies or generally accepted recommendations as to what should be insulated, what insulation systems are acceptable for a specific use and application best practices do not currently exist. As a result, the value of mechanical insulation is not being realized to its potential in reducing our dependency on foreign energy sources, improving our environment, improving our global competitiveness and providing a safer work environment". (NIBS -WBDG 2016 http://www.wbdg.org/guides-specifications/mechanical-insulation-design-guide/introduction)

For well over a decade the BC insulators have been aware of the evidence of the major impact that HVAC systems have in energy use in buildings and hence, the importance of making these systems more efficient (NIBC 2012; NIBC 2016). While the energy use profile of HVAC systems varies according to a variety of factors, including the type of building, the nature of its heating system, technology, age, building size, location, materials used and so forth, overall, these systems are responsible for up to half of the energy used in buildings. Improving the quality of their insulation thus has enormous climate change benefits (King 2009; Lanark 2010; NAIMA 2010; King 2013; EU 2016; NIBC 2017; Perez et. al. 2018).

However, the union's efforts to raise standards of MI installation confronted the assumption in much of the industry that installing MI does not require much skill and that most of it can be done by almost any construction worker. Hence the way MI is (or is not) installed does not receive a great deal of attention even in buildings that are promoted as low, or zero, energy.

Decisions about the qualifications of installers are largely within the responsibility of the contractors who perform this work. In a low-bid, competitive construction industry such as Canada's, it is often much cheaper for contractors to hire, or sub-contract, the work to building workers who have not undergone an apprenticeship in the insulating trade and whose level of training may be wholly inadequate for the job they are assigned to perform (Lanark 2010). Insulators are not a 'compulsory designated trade' in BC. Unlike skilled trades in many other provinces, such as electricians, sheet metal workers or elevator installers, there is no requirement in BC that a worker installing MI must have a trades' qualification (TQ) , nor is there any requirement that the worker sign off on the completed work to verify that it has been finished to the appropriate standard.[3]

3 Details of the provincial requirements for apprenticeship and trades qualifications can be found in the Ellis Chart in the national red seal web site for Canada at http://www.ellischart.ca/h.4m.2-eng.html.

Engineers and prime contractors normally pay little attention to the details of the type, quality, thickness and other properties of MI in the plans they provide to contractors and installers, an issue that is compounded by the fact that the technology of insulation materials is continuously changing. Instead, they provide a general description of what they want along with a few basic details and then rely on those installing the MI to make the right choices. Even where HVAC manufacturers and building engineers specify in more detail the standards they require, too often they are not in a position to ensure that their specifications are followed on building sites, a problem compounded by other trades not leaving sufficient clearance for MI to be properly installed and by contractors failing to provide adequate time for MI work to be done properly. This results in a significant 'performance gap' between what is specified and what gets implemented (Gleeson 2015).

Recent literature on the effectiveness of energy conservation initiatives in buildings has highlighted this 'performance gap' (Zero Carbon Hub 2014; Gleeson 2015; Itard 2016; Bartoluzzi et. al. 2017). This is the difference between the designed energy use of high-performance buildings and the actual energy use once buildings are finished or renovated. Numerous factors influence the performance gap, such as the basic design of the building, materials used, windows, roof and cavity insulation, air tightness and many others. The energy efficiency of the HVAC system is a critical factor as well. Furthermore, this performance is contingent on all elements of the system being properly insulated so that energy consumption meets design standards such as ASHRAE 90.1 (Hart 2014).

There is considerable evidence that many HVAC systems perform far below their design potential due to inadequate or poorly installed mechanical insulation, thus contributing significantly to the performance gap (Lanarc 2010; King 2014; Gleeson2017). This can be due to the inadequate training and poor qualifications of the workers who install the systems, an observation extensively documented in the EU's Build Up Skills Initiative which examined ways to improve the training of the European construction workforce (Build Up Skills 2012; Clarke et al. 2016). Its 2018 report summarized the key findings of a multi-year, very extensive research project involving all EU countries. The report recommended that member states implement stringent training and qualification requirements for all workers engaged in energy retrofits (Build Up Skills 2018).

In addition, over time, MI installations deteriorate. Insulation needs to be replaced to restore its effectiveness. Effectiveness can also be compromised by building owners or contractors removing it when they perform HVAC maintenance or repairs, or other building renovations if they are not aware of the importance of MI in reducing energy consumption.

Despite its importance from an energy perspective, MI is a small component of construction costs, normally representing less than 1% of the total cost of a new building. The union has used this figure to promote its campaign that MI is the 'one percent solution' to reducing energy use in buildings. Retrofitting MI in an existing building is also not normally a major cost item. As documented later in this study, the return on MI investment in existing buildings is normally quite rapid, with costs being recovered in some cases within a year or two, producing ongoing savings for years, or decades, into the future.

# DOCUMENTING THE CLIMATE BENEFITS OF PROPERLY INSTALLED MECHANICAL INSULATION

One of the problems the union noted was the absence of good research documenting the contribution that MI makes to reducing energy consumption in buildings. To address this issue in 2010 it commissioned independent research from two of BC's most well respected engineering consulting firms, H C Lanarc, and Besant and Associates Engineering, to assess the energy saving potential of properly installed MI. This resulted in a detailed peer reviewed study "Pipes Need Jackets, Too" that has provided the BC construction industry with research documenting the energy losses resulting from the poor installation practices in the industry. Through the use of a number of case studies, the consultants confirmed how significant these losses were. The union has shared this research study with an extensive list of industry professionals as well as government regulators to support its argument that MI plays a key role in making HVAC systems meet their design specifications. (HC Lanarc 2010; BC Insulators 2011; Lang et. al. 2012).

It also funded a comprehensive manual on proper techniques for applying MI (Besant et. al. 2012). This guide was prepared to fill a significant gap in the existing literature on best practices in the application of MI. The manual was prepared not only for insulators and other skilled trades, but also for architects, engineers, planners and government regulators so that they would be aware of proper installation practices. The union provides these documents at no charge to download from a dedicated web site on climate issues in the building sector to ensure that there is no financial barrier to industry practitioners accessing the information. (http://www.energyconservationspecialists.org/)

The BC Insulator's efforts to document the benefits of MI are supported by the research of a number of international organizations. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has recognized the importance of MI and established guidelines for its proper installation (90.1 Energy Standard for Buildings Except Low-rise Residential Buildings). These are regularly upgraded as new insulating materials come on the market and energy performance standards raised. (Hart 2014). ASHRAE 90.1 is one of the key building standards followed by the building industry in North America. Its standards for HVAC systems are based on an assessment of the energy efficiency that a properly designed system should achieve. This is, in part, contingent on these systems having properly installed MI. The ASHRAE standards are paralleled internationally by those of the International Code Council, which largely replicate US guidelines (ICC 2018).

The US Department of Energy's Industrial Technologies Save Energy Now Program (SEN) funded a major research project to identify how manufacturing firms can improve the energy efficiency of their buildings (Crall and King2011). This program has published an extensive list of studies documenting the energy savings from improving MI. According to a summary by Ronald King:

"Of the SEN assessment studies published to date, 53 percent have identified replacing, repairing, and upgrading the MI as an opportunity of which 84 percent have estimated a simple return on investment in less than a year. Annual dollar savings in some studies were approaching $1,000,000, and many exhibited returns in less than four months.

These third party—impartial assessments confirm the 10 to 30 percent missing/damage estimates and the return on investment opportunity." (King 2009)

In 2010 the National Insulation Association launched the MI Assessment Pilot Project as part of its MI Education and Awareness Campaign (MIC) in cooperation with the US Department of Energy. The goal of this project was to assess the state of MI among 25 facilities owned by the State of Montana in the Helena region, and quantify the potential energy and monetary savings that could be achieved through its repair or replacement. A major reason for the research was that there was a perceived gap in the literature on the extent to which installing state of the art MI could lower energy use in existing buildings.

The project involved inspecting the selected buildings, identifying where insulation standards were not being met and recommending remedial actions. Based on the assessment, the National Insulation Association (NIA) identified the work that was needed to meet industry standards. It also estimated the potential annual energy and financial savings that could be achieved if the recommended improvements were made.

A total of 25 buildings were selected, including museums, dormitories, office spaces, maintenance facilities among others. As part of the audit, the researchers created an inventory of the missing and damaged items in the mechanical rooms of the buildings and recommended the type, thickness and other characteristics of the insulation required to establish the desired level of energy efficiency.

The researchers identified over 3500 places in the 25 facilities that required attention. This included completely missing insulation, improperly installed insulation or installations that were below – often far below – appropriate standards. They estimated that implementation of their recommendations would result in annual energy savings of 6 billion BTUs (6330.34 GJ), saving an estimated 300 metric tonnes of CO2 emissions. The return on the required investment would only be 4.1 years, on average, for the buildings. (King 2010). These and other studies have underscored the significant benefits of properly installed MI in reducing energy consumption and limiting GHG emissions

## PROMOTING CLIMATE AWARENESS IN THE CONSTRUCTION INDUSTRY

However, the BC Insulators noted that the lack of concern for the climate impacts of MI was wider than its own occupation and reflected a bigger problem in BC's building industry. The union came to believe that the province's construction industry was simply not taking the issue of climate change seriously. While certain segments of the industry were promoting their climate friendly projects, in reality too much of this was simply self-serving advertising. What was happening on job sites belied the claims. The industry's lack of commitment to low carbon construction also adversely impacted the union's campaign on MI as the actions of other industry actors were not supportive of its climate agenda. Given its deepening knowledge of the importance of buildings in mitigating climate change, it felt that it had a responsibility to deal with this situation. In developing its approach, the union has relied on the International Trade Union Confederation's statement on climate change as a guiding principle:

"Environmental deterioration and rising social inequality are twin perils of the 21st century. Many countries are living through the biggest crisis of unemployment in 100 years, and the gap between the rich and working people is growing… There is no choice but to transition to a greener economy." (ITUC 2012)

The union believed that a key factor inhibiting the implementation of climate objectives was the building industry's lack of awareness of the extent to which building energy use contributed to climate change. It realized that a multi-pronged approach was needed to change the underlying culture of the industry. This meant focusing on its own trade by persuading its members that higher standards of MI were an essential component of low carbon construction. It meant expanding this understanding to the contractors employing its members, to the professional engineers and architects responsible for designing buildings and to the developers and building owners responsible for commissioning buildings. It also meant persuading governments at all levels that tougher regulatory standards and better enforcement of these standards was necessary to achieve the energy saving potential of MI.

As part of its efforts to promote climate literacy within its own membership, in 2015 it introduced a climate change module into the training of BC Insulator apprentices. It was able to do this because, uniquely among skilled trades in BC, it directly controlled the delivery of the curriculum provided to insulation apprentices under a contractual arrangement with BC's major trades training institution, the British Columbia Institute of Technology. Over the past 5 years it has modified this module by incorporating climate change narratives throughout the way it teaches the various skill sets apprentices need to know to practice the trade.

This was the first climate change module that consciously linked global warming with apprenticeship training to be introduced in any building trades curriculum in Canada. A 2019 review of the national Red Seal curricula for each of the 37 building trades' apprentices found that none incorporated a classroom component that explicitly explained the impact of buildings on climate change. (Calvert forthcoming) The BC Insulators believes its climate module should become a model for promoting climate literacy in the apprenticeship programs of the other building trades both in BC and across Canada. (Tallon and Calvert 2017)

The BC Insulators have spent a significant amount of its own money – close to $2 million over the past decade – in developing its campaign for change in the wider industry. This has involved presenting its climate agenda at numerous major construction industry conferences in its home province of BC. But it has also tried to influence the industry by presenting its material to conferences, nationally, in Canada, and in a number of US states. It uses a portable display booth which it sets up at these conferences, staffed by members of the local. The message it highlights in its leaflets and other promotional material is: "saving energy and saving the planet." This is intended to underscore the link between improving the energy efficiency of buildings and achieving Canada's climate change objectives.

Union representatives target participants at these conferences – planners, architects, engineers, and contractors - with leaflets and related promotional material that highlights how improving MI can make a significant difference in the energy used by HVAC systems, particularly in commercial and industrial facilities. They also encourage them to visit the web site the union has created:

'Energy Conservation Specialists' ( http://www.energyconservationspecialists.org/) where industry professionals can find further research material documenting the benefits of properly installed MI and its importance in addressing climate change.

The union has promoted the positive climate impact of MI through a series of presentations at city councils across BC. It normally requests the opportunity to appear before a regular council meeting after having met with council staff responsible for building standards and inspections to explain the energy and climate benefits of MI, and outline why the municipal government should give it a higher priority in the building and renovation approvals process (BC Insulators 2017). These presentations have also been part of its effort to build political support for changes in the building and energy codes. Its efforts at the municipal level have been augmented by lobbying the BC provincial government to establish a new certification requirement that MI should only be installed by qualified trades insulators who have completed a 4-year apprenticeship.

It has also pursued its campaign through building alliances with environmental NGOs. It was a founding member of Green Jobs BC. It co-founded this organization in 2011 to develop a set of policies that environmental organizations and labour unions could jointly campaign to achieve. As part of this initiative, it has contributed financially in support of a number of joint climate change conferences in BC (Green Jobs BC 2015; Calvert and Tallon 2016) . It has also worked with organizations such as BC's Columbia Institute to fund research outlining specific measures that the building industry can implement to reduce Canada's climate footprint (Bridge et. al. 2017).

Another component of its initiative has been to encourage insulator locals in other parts of Canada to join its campaign, by providing them with advice, materials and staff support, and encouraging them to build bridges with local environmental organizations. The union's recently retired business agent, Lee Loftus, has been a longstanding member- and more recently, director - of the SSHRC-funded research project Adapting Canadian Work and Workplaces to Respond to Climate Change (ACW). This organization has brought together academics, unions, environment NGOs and community representatives to focus on strengthening labour's commitment to promoting sustainable climate policies.

Since the election of a more labour friendly NDP government in BC in 2017, the union has participated in consultations with it to encourage it to provide a range of innovative programs that focus on improving energy conservation in the province's building industry. During 2018, the government announced a package of new policy measures that focused on this objective – the CleanBC campaign (https://cleanbc.gov.bc.ca/) - and the union has actively promoted construction industry participation in it. It has also given a strong endorsement to the government's Net-Zero building initiative, as well as climate initiatives by a number of municipal governments such as the cities of Burnaby, Vancouver and numerous others. It supports government investment in the rapid expansion of district energy projects as another key way to reduce GHG emissions.

The union's presentations to the BC government have explicitly focused on the need to address climate change and decarbonize the economy to meet Canada's Paris commitments. It has also emphasized the multiple benefits of better MI standards: health (indoor air quality), environment, energy conservation and community benefits. In the latter case, the union has argued that its campaign will create a large number of new green jobs providing opportunities for young people to enter the trades. It notes that 20% of its own members are under 30 and that it has a much higher proportion of women, First Nations and visible minorities than the rest of BC's construction industry.

During the spring and summer of 2019, the union met individually with key BC Cabinet Ministers, including Environment Minister Heyman, to advocate a package of materials highlighting how installing MI can contribute to meeting the government's climate objectives. It encouraged the government to support a number of pilot and demonstration projects in publicly owned buildings that would provide further evidence of the key role that MI can play in the government's efforts to cut BC's GHG emissions. (BC Insulator's Slide Presentation 2019)

The union believes that the public sector should play a leading role in this effort, given the government's extensive ownership of buildings and its role as a funding agency for the broader public sector. It recommended the government carry out energy audits in 200 hospitals, 1500 public schools, 11 universities and over 1,000 other public buildings. In doing so it would provide a positive example to the private sector as well (BC Insulator's Slide Presentation 2019).

It also urged the Minister of Environment to fast track amendments to the province's Building and Energy Codes to accelerate the implementation of higher energy standards. The codes establish a minimum standard. But the union believes it should be higher. It therefore wanted the Provincial Government to allow municipal governments the statutory right to impose additional requirements in development permits - requirements above those established by the provincial codes. This would make the provincial codes a floor, not a ceiling, and give municipal governments with a commitment to climate change the scope to innovate.

## ALERTING BUILDING OWNERS TO THE POTENTIAL ENERGY AND CLIMATE BENEFITS OF STATE OF THE ART MECHANICAL INSULATION

However, there is another major part of its multi-pronged campaign that has not been properly documented to date. It is the BC Insulators' efforts to convince building owners in both the public and private sectors that installing state-of-the-art MI in new buildings and refurbishing MI in existing structures can realize very significant energy savings – savings which are both financially beneficial and, more importantly, savings that significantly reduce the GHG emissions produced by the built environment. This remainder of this paper is intended to fill this gap in the literature by outlining the details of this campaign and assessing its potential to reduce the climate footprint of buildings.

The union's awareness that large numbers of commercial, institutional and industrial buildings were failing to achieve appropriate energy efficiency standards led it to consider what it could do to alert building owners that they needed to review their existing HVAC systems to determine if significant energy savings were feasible. To do this, it was necessary to demonstrate to them the extent of energy losses and the modest cost of the investment needed to reduce these losses through retrofitting MI in existing buildings.

The BC Insulators also noted that there was a major gap in the energy auditing services available to building owners, both in British Columbia and across Canada. While some engineering firms will carry out audits if requested by their clients, and some large commercial property owners may have internal MI auditing programs, this is not that common. From its knowledge of the industry, the union concluded that there were few commercial firms specifically dedicated to providing owners with MI energy audits. But without such audits, building owners were in the dark. They lacked the data to make informed decisions about whether it made sense to invest in refurbishing their MI.

Most building owners are only vaguely aware of the significance of MI in ensuring the energy efficiency of HVAC systems. The same is true of purchasers of new buildings. Consequently, they tend to ignore the importance of ensuring that it meets the best energy conservation standards in existing or new buildings. While federal, provincial and municipal building and energy codes now require somewhat better insulation standards, they only focus on new buildings. However, new construction represents only about 2% of the overall building stock. Existing building owners are not normally required to make code upgrades unless they require permits for major renovations. And while owners of existing buildings can request an engineering firm to do a complete energy audit, this is not done very often in practice.

Building owners who want to conserve energy or reduce the GHG footprint of their structures normally focus their attention on other seemingly more obvious sources of energy losses, such as lowering indoor temperatures in the winter months, setting higher temperatures for air conditioning in the summer. They may also focus on the building envelope by improving ceiling and wall insulation, retrofitting windows with double glazing and other building modifications. While all these changes can – and in most cases should – be adopted to varying degrees, building owners too often overlook what is often the most significant source of energy loss – poorly insulated HVAC systems.

But it is not simply that building owners are unaware of the value of MI. The way the building industry operates compounds this problem. A common way for contractors and developers of new buildings to cut costs is by minimizing expenditures on MI. In a highly competitive, low-bid construction market, their motivation is to offer the lowest price to get a contract, rather than considering the long-term operational costs, maintenance expenditures or longevity of the HVAC systems they install. Sub-contractors bidding on work will also cut corners to increase their likelihood of obtaining contracts. It is the purchaser, unaware of these compromises, who ends up paying the additional energy costs over the long term. This is a classic principal-agent conflict.

The quality of MI is not something that most purchasers consider in their decision to acquire a new, or existing, building. Even if the owner does carry out a visual inspection, it may not be possible to confirm that the right type, thickness and quality of insulation has been installed. Much of the piping and duct work in HVAC systems is also concealed behind walls or located in places that are awkward to view. Unless an owner is in the construction business, he/she simply may not know whether a particular type of insulation is appropriate for the specific requirements of the HVAC system (NAIMA Facts 82 2010).

However, there are other reasons why building owners may not be alerted to problems with their MI installations. In British Columbia, for example, the MI standards in the provincial building code do not have sufficient detail to ensure that the right type, thickness, and quality of insulation is installed.

As a result, installers are left to their own judgement (and ethics) concerning the standards of materials and workmanship to adopt. There is no licensure requirement for insulators in BC that specifies that only installers with a trades certificate in MI can do the work. Consequently, no one has to 'sign off' that the MI installation has been performed properly and to the appropriate standards.

This contrasts with some other designated trades, such as electricians or elevator operators, where work can only be approved if a qualified trades person has signed it off. Basically, anyone on a building site is permitted to install MI, regardless of their training or knowledge of insulation standards. As a result, unqualified workers are commonly employed to install insulation. While engineers are required to confirm that standards set out in their plans have been met, in reality they receive very little classroom training in MI. In the experience of the BC Insulators, few are conversant with the details of the latest MI standards.

While building owners may assume that MI standards are being monitored by building inspectors, this is also not the case. In the union's experience, inspectors do not normally receive any training in MI standards. Inspecting MI is not part of their regular function. Rather, they are expected to focus on matters such as structural integrity, fire safety and compliance with the building or development plan approved by their municipality. One of the union's other initiatives has been to establish a new training program for MI inspectors in cooperation with the BC Institute of Technology and BC's insulation contractors. (Krippendorf 2013).

# Establishing The Salamander Inspections Program

The previous discussion of the industry's lack of attention to MI provides the background to the BC Insulators decision in 2015 to set up a third-party MI auditing organization called Salamander Inspections. It is formally constituted as a BC registered non-profit corporation. The union felt that by producing well-researched technical reports on the condition of MI in buildings and demonstrating the corresponding potential energy and monetary savings of upgrading, it could encourage building owners to evaluate their MI and make improvements where appropriate. To ensure the credibility of the audits, it arranged for an independent engineer to review each audit and sign off that it has been properly conducted.

One of the major decisions the union faced in setting up the program was whether it would charge building owners for the service. It decided to offer the audits free of charge because charging a fee would be a significant barrier to owners deciding to do an audit. It also wanted to demonstrate that the audits were worth doing. It believed the practice would catch on in the industry, leading to a broader understanding of the importance of carrying out MI audits. But it felt that it had to show that audits made sense first.

To avoid the criticism that the union was only doing the audits to provide work for its own members, the BC Insulators chose not to impose a condition that owners would be obligated to use unionized contractors or its own members if they proceeded to implement audit recommendations. However, the union does assume that once owners decide to proceed, they would be inclined to choose contractors employing qualified installers and these would normally be union members. Moreover, to the extent that the industry became more aware of the costs of poorly installed MI, the union believed that the overall demand for this work would increase.

In addition to persuading individual building owners to take advantage of the energy saving potential of installing state of the art MI, the union's broader goal was to provide additional evidence of how widespread the energy loss problem was within the industry and hence the large climate change benefits of upgrading MI in buildings. Such upgrades would be a key method of contributing to BC and Canada's climate change targets.

Salamander Inspections employs union members qualified in the trade to do the audits. In addition to their qualifications as insulators, the inspectors have undergone additional training to acquire expertise in the use of the FLIR imaging technology used to audit energy emissions in HVAC systems. The union's initial focus has been to conduct energy audits on MI installations in the commercial and industrial sector where it believes the most significant gains can be made.

The process of quantifying energy loss in a building normally begins in the boiler or mechanical room. It involves identifying the type of HVAC system, its manufacturer, its condition, its optimal temperatures and other factors associated with its operation. The inspector first makes a visual assessment of the state of the existing MI to identify obvious problem areas in the covering of the boiler equipment, pipes and ductwork. This may find improperly installed or missing insulation on elbow fittings, tight corners and difficult to access areas. It also may identify condensation, mold, rust and other contaminants. In some cases, it may identify asbestos which needs to be removed by specialized technicians. The inspector will normally examine other rooms that house part of the HVAC system, such as fan rooms or storage areas, depending on the facility, as well as the state of the duct work throughout the system to the extent it is readily accessible.

This preliminary inspection is followed by using a FLIR digital thermal imaging camera to record a thermographic image of the energy profile of the various components (FLIR Systems AB 2011). The images created by the camera make it easy, to identify, visually, the key parts of the system experiencing excessive energy losses. Thermography is a well-established and cost-effective way to measure heat loss from pipes and ductwork and is widely used in the industry for other kinds of energy audits such as identifying thermal bridges in walls and ceilings. Thermal imaging cameras detect temperature differences between surfaces and thus provide an image showing where heat is being lost through walls, pipes, and other fixtures. Variations in the amount of heat released are shown on a color gradient with areas having the highest heat loss normally shown in white or sometimes bright red, while those with little loss in a darker color such as blue or black, depending on the specific device being used (FLIR 2011; Fox et.al. 2014; Fox et al. 2016; Lucci 2018).

The next step in the process is to calculate the energy losses. This is done using industry standard 3E Plus software (proprietary NAIMA software). It can determine the difference between the amount of heat being released and the amount expected in a properly insulated system. Consequently, the software can estimate the potential energy saving associated with retrofitting an HVAC system with state of the art insulation. The last step is to translate the potential energy saving into financial savings. This is done using the current cost of the fossil fuel or electricity powering the system (Fox Coley et al. 2014; Kylili et al 2014; Plowright 2016).

After carrying out a detailed assessment of a building owner's HVAC system using the appropriate software, Salamander inspectors provide owners with a detailed energy audit report. The report includes colour photos of the various components of the system where problems have been identified, along with thermal pictures of the same components, showing visually the extent of the heat loss. The audit calculates the energy losses from the various components of the system, based on a comparison with a benchmark properly-insulated HVAC system.

To show whether retrofitting the insulation makes financial sense, each report also provides an estimate of the total cost of labour and materials for performing the upgrade based on the guidelines of the Thermal Insulation Association of Canada (TIAC 2019). Using this data, the report provides an estimate of the number of years it will take for an investment to pay for itself - the effective return on investment (ROI). The Salamander report thus provides the evidence that building owners need to determine if they will retrofit their MI.

## IMPLEMENTING THE SALAMANDER AUDIT PROGRAM

Salamander Inspections conducted the first of its audits in Alberta, Canada in 2015. The provincial government was receptive to the union's request because one of the newly elected New Democratic Party (NDP)'s election platforms was to address Alberta's public infrastructure deficit and improve its energy management systems. The government's 2016 - 18 Fiscal Capital Plan included a significant amount of new money – $6.2 Billion over 5 years _ for 'capital maintenance and renewal', that is, investments in upgrading a wide range of public facilities including improving energy efficiency in buildings. It also included additional funds for specific sectors such as schools and universities (Alberta 2016 pp. 48, 39).

Additionally, the newly elected government had made a strong commitment to address climate change by reducing GHG emissions in the public institutions it financed. Salamander Inspections' focus on upgrading MI to make public buildings more energy efficient fitted well with the government's ambitious environmental objectives. Recognizing the interest of the government in reducing energy use and GHG emissions, Salamander Inspections offered to audit a sample of government buildings to provide the government with estimates of the potential energy savings of proper retrofitting.

The government agreed to have Salamander inspect seven public buildings of varying ages, conditions, functions and sizes. The union documented the results of its inspections in detailed reports for each facility it audited. The reports calculated the potential annual energy savings as well as the reductions in CO2 and NOx emissions. Salamander Inspections also estimated the potential annual financial savings, the costs of materials and labour for the upgrades and the return on investment (ROI).

The table below provides a sample calculation from the Audit of the OS Longman Laboratory Building in Edmonton.

| | Heating/Steam systems<br>8700 hours operation | Boiler room and two other mechanical spaces |
|---|---|---|
| Heat Loss per hour | 650,478 btu | - |
| @24 hrs | 15,611,472 btu | - |
| @29 days | 452,732,688 btu | - |
| **Total** | **477.65 GJ @ 1 month** | **1 month = 477 GJ** |
| - | - | - |
| Heat Loss per hour | 650,478 btu | - |
| @24hrs | 15,611,472 btu | - |
| @30 days | 468,344,160 btu | - |
| **Total** | **494.12 GJ @ 1 month** | **4 months = 1,976 GJ** |
| - | - | - |
| Heat Loss per hour | 650,478 btu | - |
| @24hrs | 15,611,472 btu | - |
| @31 days | 483,955,632 btu | - |
| **Total** | **510.23 GJ @ 1 month** | **7 months = 3,571 GJ** |
| - | - | - |
| - | **Total** | **6,025 GJ** |
| - | **Cost of fuel** | **$4.00 GJ** |
| **Savings per year** | | **$24,102** |

A review of the actual inspection documents indicates that they provided a detailed profile of the status of the MI in the buildings and the impact on energy use. The reports included photos of the various components of heating and ventilation systems that failed to meet current best practice standards.

The following quote, from Salamander Inspections, is typical of the detail included in the audits. In this case, it documents the state of MI in the chiller room of a major Alberta government building:

"We have inspected the chiller room on the parking garage level. The insulation applied to the chilled systems in fair condition, but there are many instances where insulation has been removed for maintenance and the upgrade of chillers and many other areas where there are bare knuckles on the Victaulic fittings. There are many areas where what appears to be black mold around these knuckles and other areas where the vapor barrier is compromised from poor insulation practices. We noticed that many elbows (PVC) were cracked or broken showing us that the insulation underneath was bare fiberglass with no integral vapor barrier. The contractor was intending that the PVC elbow would provide the vapor barrier, however, PVC is one component of an effective vapor barrier system and not a "stand alone" vapor barrier, especially as soon as there is damage to the PVC covering the vapor barrier is compromised. We did a physical count of just the exposed knuckles and noted that the count was eighty (80). Looking at pipe where there was no insulation corrosion was built up on the elbows and piping, insulation contractors must ensure a 100% vapor barrier to prevent the buildup of corrosion." (Salamander Inspections, Alberta Infrastructure Building 6950 – 113 Street Edmonton, Alberta. p. 8.)

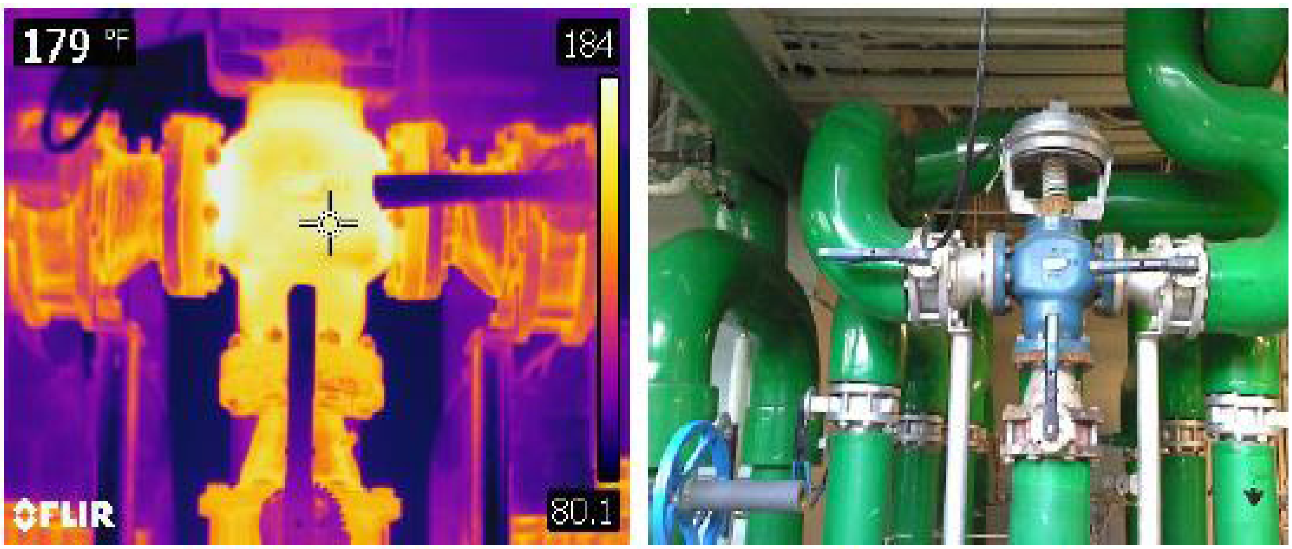
Inspections in other rooms of the building noted other instances of the growth of black mold where insulation had been removed (or never installed). This is both a source of heat loss and a contributor to premature aging of the pipes or ductwork. It is also a significant hazard to indoor air quality if spores are circulated in the building's duct work. In the boiler room there were occupational safety issues due to exposed pipes containing high temperature steam which could burn maintenance or repair personnel trying to work in the confined spaces near these components.

The union's objective was to provide the government with clear evidence on the extent of energy loss and the corresponding cost savings that would accrue from carrying out the retrofits. Each report documented these issues in detail. The following table, compiled from the seven reports, summarizes the findings of the Alberta audits.

## Table 1: Summary of the Audits of Alberta Public Institutions (2016)

| Building ID | Type and number of rooms inspected | Total annual energy savings | Annual CO2 saving | Annual NOx savings | Annual cost savings ($) | Material and labour costs ($) | ROI (years) |
|---|---|---|---|---|---|---|---|
| Brownlee Building, Edmonton | -Boiler room heating system -Penthouse Mechanical rooms -Parking garage piping and mechanical spaces | 0.0158 Mt | 934 GJ | 46.4 Mt | $3736.00 | $5,208.00 | 1.3 years |
| Food Processing Development Center, Leduc | -Boiler Room Mechanical room -2nd floor Mechanical space rooftop ventilation units | 0.032 Mt | 2,527 GJ | 125 Mt | $10, 100.00 | $7,530.00 | 0.58 years |
| Government Building, Edmonton | - Boiler room heating and domestic hot water -3 mechanical rooms (Chillers and piping) | 8.Mt | 17 GJ | 0.0192 Mt | $1,366.56 | $2,725.00 | 1.9 years |
| OS Longman Laboratory Building, Edmonton | Boiler room -2nd floor mechanical room -9th floor mechanical space | 0.072 Mt | 6,026 GJ | 300 Mt | $24, 102.00 | $12, 472.00 | 0.5 years |
| Red Deer Provincial Building, Red Deer | -Boiler room heating system -2 Mechanical rooms Parking garage piping | 0.0193 Mt | 1,221 GJ | 60.6 Mt | $4,885.80 | $5,412.55 | 1.08 years |
| Reynolds Museum, Wetaskiwin | -3 level boiler room -Mechanical fan room | 0.021 Mt | 1,325 GJ | 65.8 Mt | $5,300 .00 | $7,381.00 | 1.3 years |
| Royal Tyrell Museum, Drumheller | -Boiler room heating system -2 Mechanical fan rooms | 7.054 Mt | 759 GJ | 37.7 Mt | $3039.52 | $7,104.46 | 2.33 years |

The buildings inspected ranged in size and function. Consequently, as the table shows, some had greater potential annual savings than others. The projected savings ranged from a modest annual $3039.52 in the Drumheller museum to $24,102.00 in a government laboratory building. The average estimated ROI was 1.2 years, ranging from the briefest, 0.5 years (Longman Laboratory) to 2.33 years (Drumheller Museum). Below is a photo of a heating valve taken from the FLIR camera set beside a normal photo of the same heating valve. It illustrates how the energy and heat loss is not obvious from simply looking at the installation even though it appears to be well insulated. Rather it is necessary to use the infrared technology to get a sense, visually, of how much energy is being wasted.




Bare heating valves in the boiler room of the Reynolds Museum

The projected energy savings and ROI results from Alberta (and the results noted in BC, Saskatchewan and Ontario further in this study) are quite consistent with the findings of the US National Institute of Building Sciences' 2016 review of its Save Energy Now Program. It estimated that in the best-case industrial studies the ROI was only 4 months, and many cases had ROIs of between one and three years. (http://www.wbdg.org/guides-specifications/mechanical-insulation-design-guide/case-studies)

Significantly, the report indicated that substantial annual energy savings could be achieved in all the buildings, from the minimum CO2 reductions of 759 GJ (Drumheller Museum) up to 6026 GJ (Longman Laboratory). NOx reductions ranged from negligible (Oceanside Healthcare) to 300Mt (OS Longman Laboratory). The findings from the Alberta inspections confirmed the benefits of the Salamander initiative in informing the government and its building managers of how retrofitting MI could significantly improving building energy efficiency, lower GHG emissions and provide long term financial savings for the public.

After the concluding the Alberta reports, Salamander Inspections began a series of audits in British Columbia. It approached the Vancouver Island Health Authority which agreed to have it conduct an initial audit on one health care facility. Hospitals are a major user of energy. In addition to basic space heating needs, they require large volumes of hot water and steam for sterilization of equipment, cleaning and maintaining hygiene. Their HVAC systems are complex and far more extensive than many other buildings of a similar size due to the specific requirements of their health care functions.

Based on the results of the first audit, the Health Authority invited Salamander Inspections back to conduct an additional seven audits of other hospital and health care buildings. The eight buildings were of varying size and purpose, including: five hospitals, two care homes and one primary health center. Table 2 summarizes the audit findings.

**Sample Thermographic Image from Audit of Eagle Park Care Home on Vancouver Island**


**Figure 33** Thermographic image of bare motorized heating pump P-1.

**Figure 34** Conventional image of the same motorized heating pump.

**Table 2: Summary of the Audits of 8 Vancouver Island Health Facilities (2016)**

| Building ID | Type and rooms inspected | Total annual energy savings | Annual CO2 savings | Annual NOx savings | Annual cost savings ($) | Material and labour costs ($) | ROI (years) |
|---|---|---|---|---|---|---|---|
| Eagle Park Care Home | Mechanical Room Fan Rooms | 78.00 GJ | 3.9t | 0.0t | $1,150.00 | $3,492.56 | 3 |
| Nanaimo General Hospital | Boiler room | 1430.00 GJ | 71t | 0.4t | $19, 333.00 | $37, 323.59 | 1.93 |
| Oceanside Health Center | Boiler room | 78.11 GJ | 3.9t | 0.0t | $1,255.00 | $466.02 | 0.37 |
| Saanich Peninsula Hospital | Boiler room 3 Fan rooms | 236.00 GJ | 11.7t | 0.1t | $2,336.40 | $10, 765.47 | 4 |
| Tofino General Hospital | Boiler room | 32.40 GJ | 1.6t | 0.0t | $873.50 | $2,428.95 | 2.7 |
| Trillium Lodge Care home | Boiler rooms, Fan rooms | 89.60 GJ | 6.2t | 0.0t | $1,359.56 | $8,128.96 | 5.8 |
| Victoria General Hospital | Boiler room Fan rooms | 1043.00 GJ | 51.8t | 0.3t | $9,240.00 | $31, 860.70 | 3.44 |
| West Coast General Hospita | Boiler Room | 540.00 GJ | 27t | 0.1t | $7,308.9 | $17, 537.23 | 2.39 |

As with the Alberta audits, Salamander Inspections measured the energy losses in the HVAC systems, calculated the potential reduction in energy use, estimated the energy and financial savings and provided the cost of carrying out the retrofits, including the ROI.

The potential energy and monetary savings were greatest at Nanaimo General Hospital: 1430.00 GJ and $19,333.00 respectively. It had the greatest potential reduction in CO2 and NOx emissions of the facilities inspected at 71t and 0.4t per year. The Tofino General Hospital had the lowest potential savings at 32.4 GJ and smallest reduction in C02 at 1.6t. As with Alberta, NOx reductions were modest, with no reductions among Eagle Park Care Home, Oceanside Health Center, Tofino General Hospital or Trillium Lodge Care home. The average estimated return of investment for the 8 facilities was under 3 years. Oceanside Health Center had the shortest ROI, with just over three months to recoup the investment. Trillium Lodge had the longest ROI at 5.8 years. (Salamander Inspections, Vancouver Island Audits, 2017)

## Sample Audit Photos from Tofino General Hospital on Vancouver Island

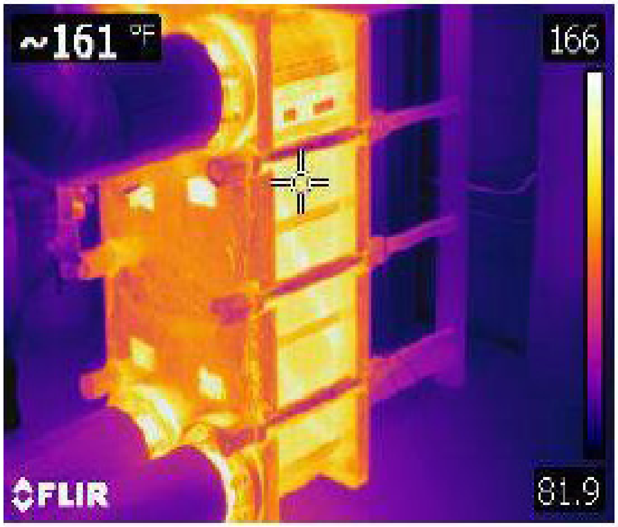



**Figure 1** This is an infrared photo of the heat exchanger showing the areas with where large temperature differences create high rates of heat transfer.

**Figure 2** This photo shows the same plate heat exchanger.

In addition to the Alberta and Vancouver Island Health Authority audits, Salamander Inspections has audited other facilities in BC's lower mainland, including a major building at the University of the Fraser Valley in Abbotsford, BC, and the very large Lougheed Mall in Burnaby, BC. (In the latter case, the owner decided to carry out a wholesale renovation and expansion of the complex, in the process replacing much of the HVAC equipment making the recommendations no longer applicable.)

As part of its effort to encourage local governments to carry out audits, the union has entered into discussions with the municipality of Saanich on Vancouver Island and Burnaby in the lower mainland of BC. (At the time of writing, the outcome of its discussions are not available.)

The BC Insulators believe that its Salamander Inspections program should be a model for the rest of Canada. Even though the BC local has no members in other provinces, it has been willing to expand the program beyond BC and Alberta, starting with Saskatchewan. Working with local 119 of the Insulator's Union, Salamander has carried out six audits in the province. The most ambitious was the Wascana Powerhouse and Legislative building complex. The facility provides heat to the legislative building, the Walter Scott Building, the T.C. Douglas Building and the Wascana Rehabilitation Facility through a series of tunnels.

As it expected, the audit found a number of areas where improving the insulation could significantly reduce energy use. It noted that the "condition of the mechanical insulation systems is moderate to poor, there are many deficiencies if we compare the systems to the standards established in Best Practices Guidelines developed by TIAC." (Wascana Powerhouse Energy Audit, 2018). The calculated savings were in the powerhouse (6141 GHGs), and in the tunnels transferring heat (1077 GHGs). Refurbishing the MI could reduce CO2 emissions by 358 tonnes and NOx by 1.9 tonnes. Annual cost savings would be $15,518.70 and the ROI would be 1.93 years, not counting long term savings on maintenance and the elimination of health and safety hazards.

**Photos of Valves in the Furnace Room of Wascana Power House**

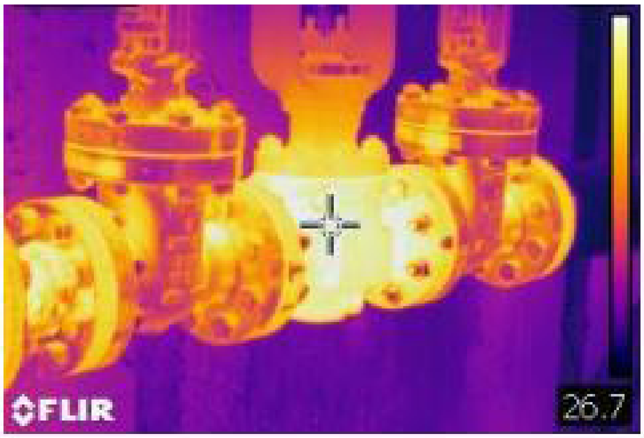



**Figure 41** Thermographic image of bare valves at a temperature of 106° C or 223° F.

**Figure 42** Conventional image of the same valve.

Significantly, the audit also revealed that the buildings contained asbestos in a number of areas. While the existence of asbestos had been identified in some areas of the facilities, Salamander Inspectors found that there was other asbestos that had not been identified. Some of it appeared to be nested in debris lying on the floor of the tunnels. While searching for asbestos is not one of the principal objectives of the Salamander project, its inspectors are well aware of what asbestos looks like and they are also aware of the hazard to occupants' health that loose and unsecured asbestos presents.

The BC Insulators have also provided Ontario Local 95 with training and equipment so that it can begin to promote energy audits in that province. Local 95, based in Richmond Hill north of Toronto, has established a parallel organization, MI Inspections to replicate the Salamander program. The first major initiative has been an audit of the Bur Oak District Energy Facility in Markham Ontario. The union views it as a pilot project that could provide a model for expanding the program to other Ontario facilities. The Bur Oak installation provides heating and cooling to the Cornell Community Centre, the local library and the Stouffville Hospital. In some respects, it was more ambitious than the other BC and Alberta inspections because it was now dealing with a district heating plant that utilized a CAT diesel engine system for heat recovery.

Overall, the audit found that most components of the MI were properly installed and in good condition, so that the need for major retrofits was more limited than might have been the case in a less well built facility. Nevertheless, the audit found a number of opportunities for reducing the energy losses in the facility's mechanical insulation systems. In the words of the report:

"In the powerhouse boiler room, we found that in general, insulation was applied, correctly, and the majority of the insulation is in good condition. However, insulation is missing on piping, valves, strainers, and heat exchangers. We noted that the insulation is a combination of thicknesses from 1 inch thick (25mm), 1½ inches thick (40mm), 2 inches thick (50mm) and 3 inches thick (75mm). (Current best practices and ASHRAE 90.1 (2010) require that the insulation applied to heating systems be 1½ inch thick (40mm) or greater.) There are areas where new insulation that has been applied on upgraded mechanical heating systems that follows ASHRAE 90.1, but the installers did not completely insulate the systems. Completing the insulation would provide small opportunities to save energy and lower GHG output.

During the inspection of the powerhouse upper level we counted at least 63 valve bonnets, 11 flanges, 6 pipe unions, 5 strainers, and 7 vessel manway and access ports that should be insulated. [92 total]" (Salamander Bur Oak Audit p. 3.)

The audit provided a detailed list of all the components that it recommended should be replaced, including the estimated cost of each piece of specialized insulation as well as the labour costs in installing it. The investment required amounted to a one time expenditure $20,272 using the recommended industry standard. If fully implemented, the audit recommendations would result in modest cost saving of $8025 annually. The ROI was 2.5 years for the recommended retrofits. The estimated the potential energy savings of this investment would be 3.086 GJ and a 154 tonne reduction of GHG emissions.

The audit also provided estimates of using thicker insulation beyond the recommended industry standard. This would provide further reductions in energy use, GHG emissions and energy costs, all of which were calculated in the study. The audit was signed off by Besant and Associates Engineers Ltd., providing third party approval of its calculations. In addition, the audit suggested modifications to reduce burn hazards to maintenance and repair workers due to temperatures as high as 150 degrees Celsius in some exposed pipes (Salamander Bur Oak Audit).

The expansion to Ontario is part of the union's vision that it can provide similar auditing services across Canada in coordination with other locals in the different provinces. To accommodate the growing number of projects being audited and other demands on the time of the auditors, Local 118 now has a designated Salamander co-ordinator and has increased the number of qualified auditors to five, all of whom have taken the special auditing course at BCIT.

Another component of the Salamander program has been to provide training for MI auditors in other provinces starting in Alberta and Ontario, thus eliminating the need for BC staff to travel to Alberta by enabling local insulators to use the Salamander program to audit buildings in that province. (Local 118 Newsletter).

# Conclusion

This study has documented the efforts of a small building trades union in British Columbia to link the work of its members with a broader commitment to addressing climate change. The union has chosen this approach because it recognized that its members' jobs can have a major impact in reducing the GHG emissions of buildings and thus contribute to achieving Canada's climate targets.
It has sought to alert other trades, industry professionals, contractors, developers, building owners and government, to the significant energy saving impact of properly installed MI and the corresponding economic benefits. But, more importantly, its goal has been to encourage the building industry and its workforce to develop climate literacy by explicitly incorporating the climate change goals of GHG reductions and energy conservation into its way of doing business.

As the preceding discussion documents, the union has initiated a number of complementary activities to achieve this end. These include efforts to educate industry professionals – engineers, architects, developers and planners – to recognize that a small investment in properly installed MI can have very significant climate benefits. They include efforts to generate awareness of climate issues within its membership and particularly its apprentices by incorporating climate change modules into its training programs. They include lobbying governments at all levels to raise standards in their building and energy codes while pushing them to require that MI installations be carried out by qualified trades workers with the authority to sign off when work has been properly completed.

More recently, the BC Insulators have made a major effort to alert building owners of the need to audit the energy efficiency of their HVAC systems. The Salamander Inspection program has broken new ground by providing a free service that documents both the energy losses from badly installed or missing MI, and the financial consequences of failing to address this issue. But, as noted, the BC Insulators have framed their presentation to building owners not simply in economic terms but also in terms of the GHG savings. These include the tonnes of CO2 saved and the reduction in NOx emissions, explicitly making the link to climate change benefits. Every one of their audit reports has emphasized the climate benefits.

The Salamander Inspection program underscores the determined effort of the BC Insulator's to build on its previous initiatives enabling it to continue to play a leadership role on climate change in the industry. The union has "put its money where its mouth is" through the major expenditures it has made in support of its climate initiatives. In the process, arguably, it has shown that trade unions have the capacity to exercise leadership on the most pressing challenge our civilization faces.

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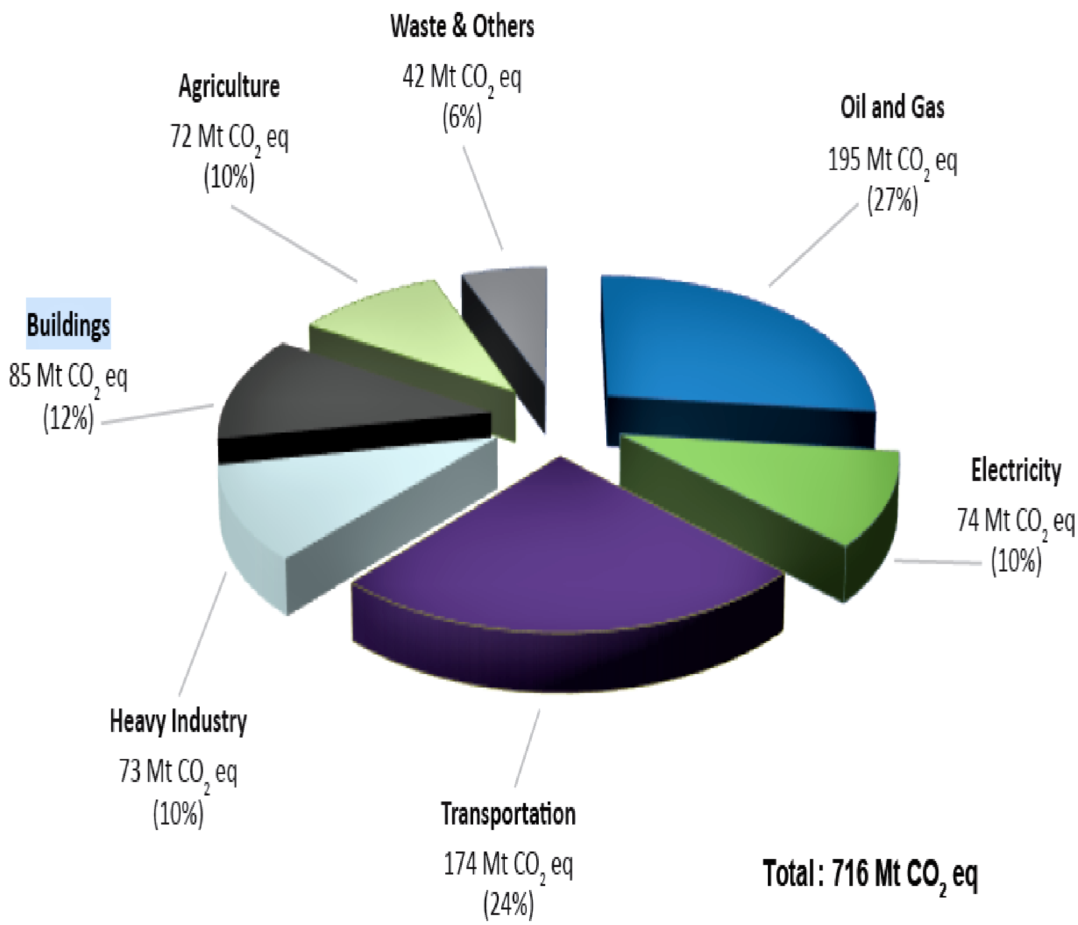
# APPENDIX I

Figure ES-7 **Breakdown of Canada's Emissions by Economic Sector (2017)**




Note: Totals may not add up due to rounding.

Source: Environment and Climate Change Canada. 2019 National Inventory Report 1990 – 2017: Greenhouse Gas Sources and Sinks in Canada. Canada's Report to United Nations Climate Change. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2019.html#figure-es-7

# APPENDIX II

Sample Case Studies of Energy Savings from Installing Mechanical Insulation

in Industrial Facilities

US Department of Energy National Mechanical Insulation Committee (NMIC) (11-18-2016)

http://www.wbdg.org/guides-specifications/mechanical-insulation-design-guide/case-studies

"Bayer (2 Steam Plants), Institute, WV By improving and replacing missing insulation on the steam and condensate lines - Potential savings $926,000 per year

Boise Cascade (Paper Mill), Jackson, AL By replacing missing pipe insulation - Estimated savings $80,000 per year, cost to complete the work $25,000 = 3.8 month payback

Dow Chemical (Chemical Plant), Hahnville, LA By replacing, repairing and improving insulation on steam system - Potential annual savings of $811,000

General Motors (Power Plant), Pontiac, MI By replacing missing insulation and repairing other areas - Estimated annual savings of $298,000

Goodyear, Union City, TN A significant number of process units are partially insulated. Potential savings, $402,000 per year. Estimated payback 2.5 to 6 months depending upon cost of completing the work. "This same opportunity can be applied to other company facilities."

National Starch (Power Plant), Indianapolis, IN By replacing and repairing insulation - Estimated annual savings of $125,000

Sterling Chemical (Chemical Plant), Texas City, TX Improvements in the insulation - Potential annual savings of $123,000

Mead Westvaco, Silsbee, TX Commissioned an "Insulation Strike Team" to go through the plant to repair areas of poor, damaged or missing insulation. They determined that reducing insulation heat loss by 10% would yield savings of over $486,000 per year

United States Steel, Gary, IN Estimated that by using proper type, size and thickness of insulation and improving maintenance of the insulation systems could result in annual savings in excess of $1,500,000 per year

Mittal Steel, Weirton, WV By insulating hot water washing tanks, 140 F operating temperature, located throughout the facility, 50,000 SF of surface area, with an inexpensive - simple insulation system the annual savings would be $371,000 + per year

Eastman Chemical, Kingport, TN "The thermal insulation system throughout the site is observed to be in good condition…several pipes observed to be missing insulation. The approach taken in investigating and illuminating insulation issues is excellent and considered to be a Best Practice approach"

One heat tracing system is not completely evaluated yet - identified savings $1,000,000 with re-insulation cost of $300,000 = 4 month ROI"