British Columbia's Building Electrification Road Map

Photo courtesy of Skyline Living

March 2021

Photo courtesy of City Green Solutions

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The BC Building Electrification Road Map was created through the contributions and collaboration of multiple stakeholders across the British Columbia building industry. It serves as an important starting point in a dialog between stakeholders on how to achieve GHG reduction goals.

While many organizations contributed their time and expertise to the development of the Road Map, staff from the following organizations and institutions were fundamental to its creation:

Funding partners and Steering Committee members:

Additional Steering Committee members:

Lead consultant:

Supporting consultants:

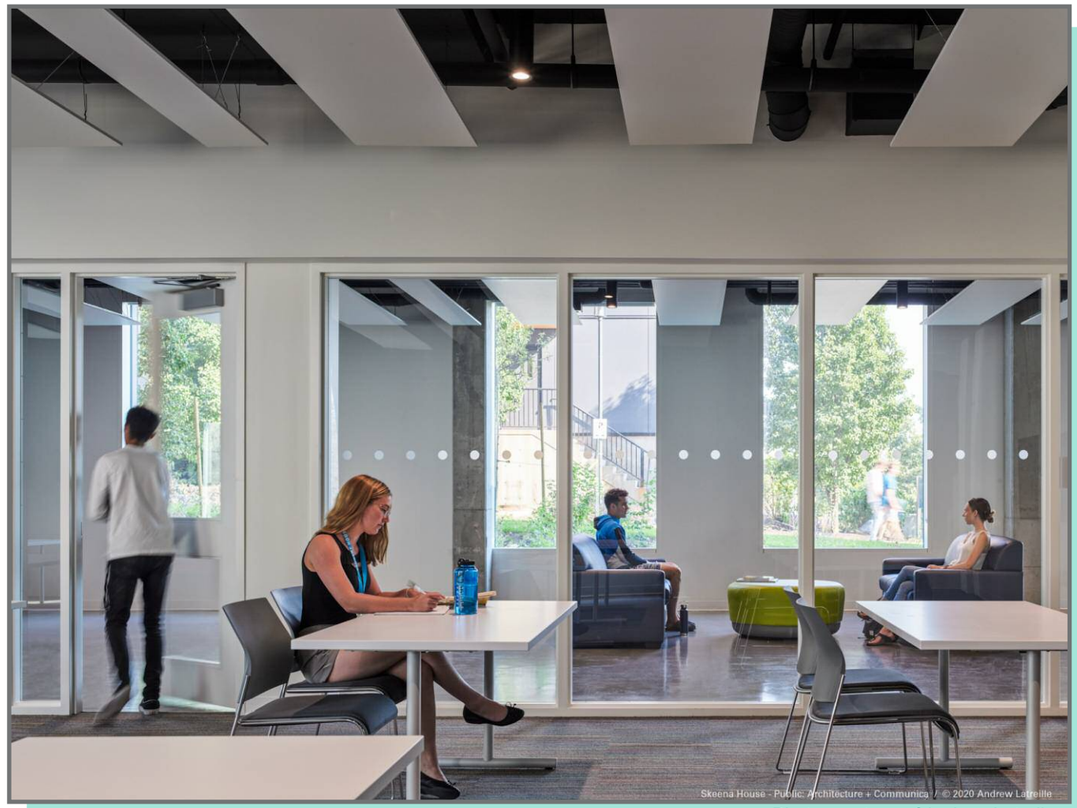

Photo courtesy of Andrew Latrelle

This report was prepared by Integral Group with input from a wide range of building sector stakeholders and the Road Map's Steering Committee which included representatives from BC Hydro, BC Ministry of Energy, Mines, and Low Carbon Innovation (Energy Efficiency Branch), BC Attorney General and Minister responsible for Housing (Building Safety and Standards Branch), City of Vancouver, City of Richmond, and Metro Vancouver.

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A Building Electrification Road Map for British Columbia

Buildings account for

11% of total emissions in British Columbia

30 to 60% of total emissions for many British Columbia municipalities

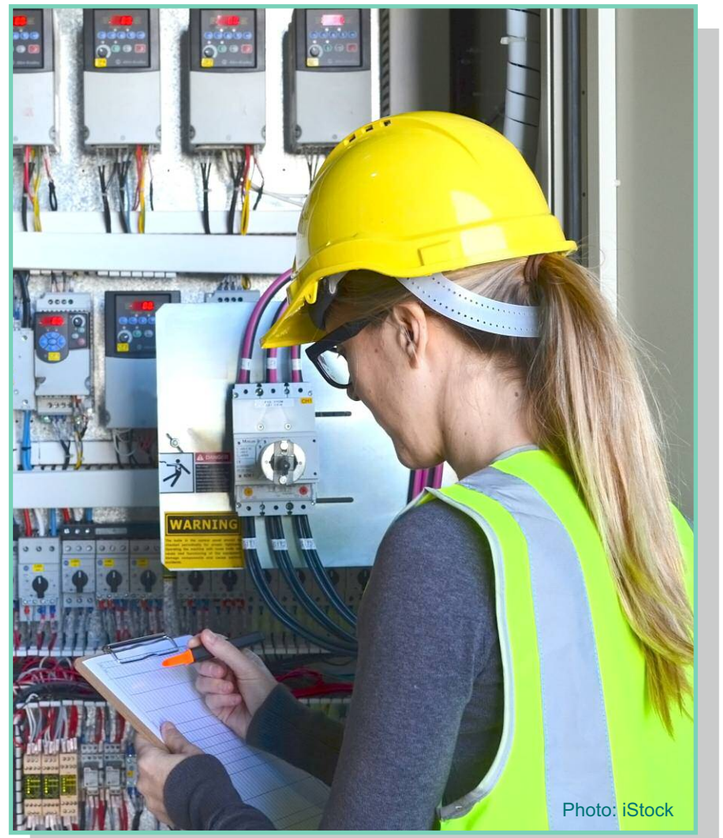
This is why many jurisdictions, including the Province of BC, have outlined plans and programs to help support a gradual decarbonization of the building sector.

Building electrification refers to the replacement of fossil fuel-based building operating systems, (such as space heating, domestic hot water, and cooking) with low-carbon electric powered systems.

Electrification is recognized by all levels of government as a critical strategy for decarbonizing BC's building sector.

The abundant supply of clean, renewable electricity in BC and the mature state of high-efficiency, electric technologies for most building space and water heating applications, means electrification is recognized by all levels of government as a critical component of strategies for decarbonizing the province's building sector.

While there are multiple pathways towards decarbonization of the building sector, the scale of the energy shift needed to achieve the Province's climate targets suggests that it is not a question of whether clean electricity, or some other source of clean energy will be used in this energy transition, but rather that all and every viable low-carbon energy option will need to play a role.



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A Building Electrification Road Map for British Columbia

The Building Electrification Road Map is a tool through which the necessary set of tactical actions has been developed, including the right sequence and steps to ensure that BC's building sector reaps the benefits of a clear and coordinated market transformation for both the existing building and new construction sectors.


Photo courtesy of City Green

In addition to its climate benefits, **there are significant short- and long-term economic benefits expected** to result from the kinds of retrofits that will accompany building electrification over the coming years.

An economic impact study conducted for the City of Vancouver and the Province of British Columbia estimated that the future BC Retrofit Building Code would lead to the creation of more than 4,400 direct jobs and nearly 6,000 indirect jobs between 2019 and 2039 (net impact, full-time equivalent jobs) and contribute more than $8.3 billion to the province's direct GDP.

Similarly, a recent study on the jobs impact of market-wide building electrification in the State of California concluded that it will result in an average of 64,200-104,000 jobs annually by 2045, after accounting for losses in the gas sector.

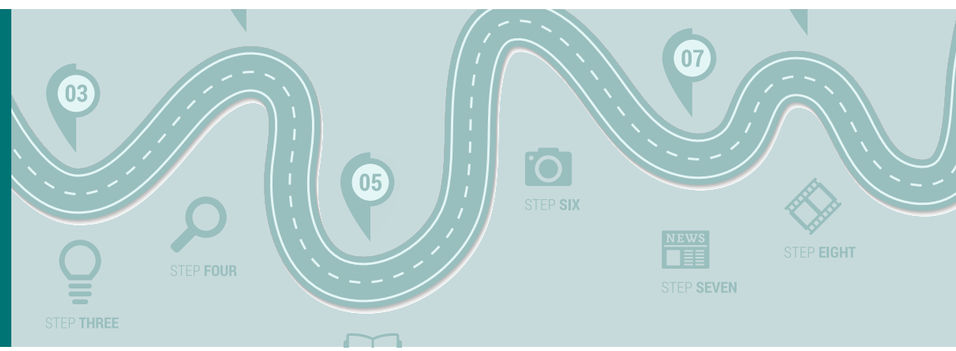
For new construction, a study commissioned by the Vancouver Economic Commission estimates that Vancouver and BC's zero emissions and net-zero energy ready building policies are stimulating a $3.3 billion market for high-performance buildings products and technologies in Metro Vancouver alone.

The report specifically highlights the economic potential of mechanical equipment such as heat pumps and heat recovery ventilators. It estimates that the installation of this equipment will support 770 jobs on average each year from 2019-2032 throughout Metro Vancouver. It also points out that the manufacturing of this equipment holds considerable future potential for job growth.

While provincial and local governments in BC are already exploring means of electrifying the building sector as a central part of their broader building decarbonization goals, there is still a need for a clear pathway that shows the roles, responsibilities and steps that building industry members can and need to play in effecting a shift towards large-scale building electrification.

The overarching goal of this Road Map is to significantly reduce the greenhouse gas (GHG) emissions attributable to BC's building sector and to achieve the following vision:

By 2030, nearly all new and most replacement space heating and domestic hot water systems in BC's homes and buildings will be high-efficiency electric, in pursuit of a province-wide shift to low-carbon buildings.



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The Road Map's purpose is to provide recommendations to the Province and other key building sector stakeholders in BC to identify the necessary steps to achieve a smooth market transformation that will ultimately result in the realization of the Province's climate goals for 2030 and 2050.

The process of developing the Road Map is an important start to building the coalition of support needed to realize its implementation in the short, medium and long term.

Addressing Barriers

The Road Map's actions identify several barriers that need to be addressed in order to decarbonize BC's building sector.


Photo courtesy of Andrew Latrelle

Some of the primary barriers facing BC's building sector include:

1. **A low level of awareness by consumers and industry alike of the benefits and opportunities of building electrification in BC.**
2. **The low cost of natural gas compared to BC's low-carbon electricity.**
3. **The relatively high capital cost of substituting high-efficiency electric space and domestic hot water systems for natural gas systems.**
4. **The perception among tradespeople and building professionals that installing high-efficiency electric systems brings higher risk and lower return than conventional gas-powered systems.**
5. **The need for whole building energy efficiency upgrades in older buildings to allow for the cost-effective deployment of high-efficiency electric space heating equipment.**

Fortunately, a wide range of technologies already exist to make the transition from natural gas to electricity, especially in the new construction sector.

However, as the readiness of different markets varies across the province, the Road Map's success will lie in identifying and supporting those market segments that are ready for a faster transition, while simultaneously working to alleviate barriers in those facing a longer electrification timeline.

The Road Map's Core Strategies

Effectively addressing the barriers to market transformation and a widespread adoption of building electrification will require a concerted effort on the part of multiple stakeholders across the province.


Photo courtesy of Skyline Living

It will also require careful coordination to ensure a wise use of resources, reduce the potential for increased burden or costs to home and building owners and tenants, and ensure the benefits of electrification are reaped equally across BC's communities.

The Road Map outlines five core strategies needed to meet the vision (see the table on following page). Each of these strategies are insufficient on their own. It is recommended that they be implemented as an integrated package with each one reinforcing the others.

For example, to get the attention of consumers and industry and to ensure that the desired GHG reductions are ultimately achieved, it is recommended that government signal its intention to regulate early-on, provide a schedule of those future regulations and adopt them over time accordingly. In the shorter-term, incentives and other supporting measures are needed to build initial consumer interest.

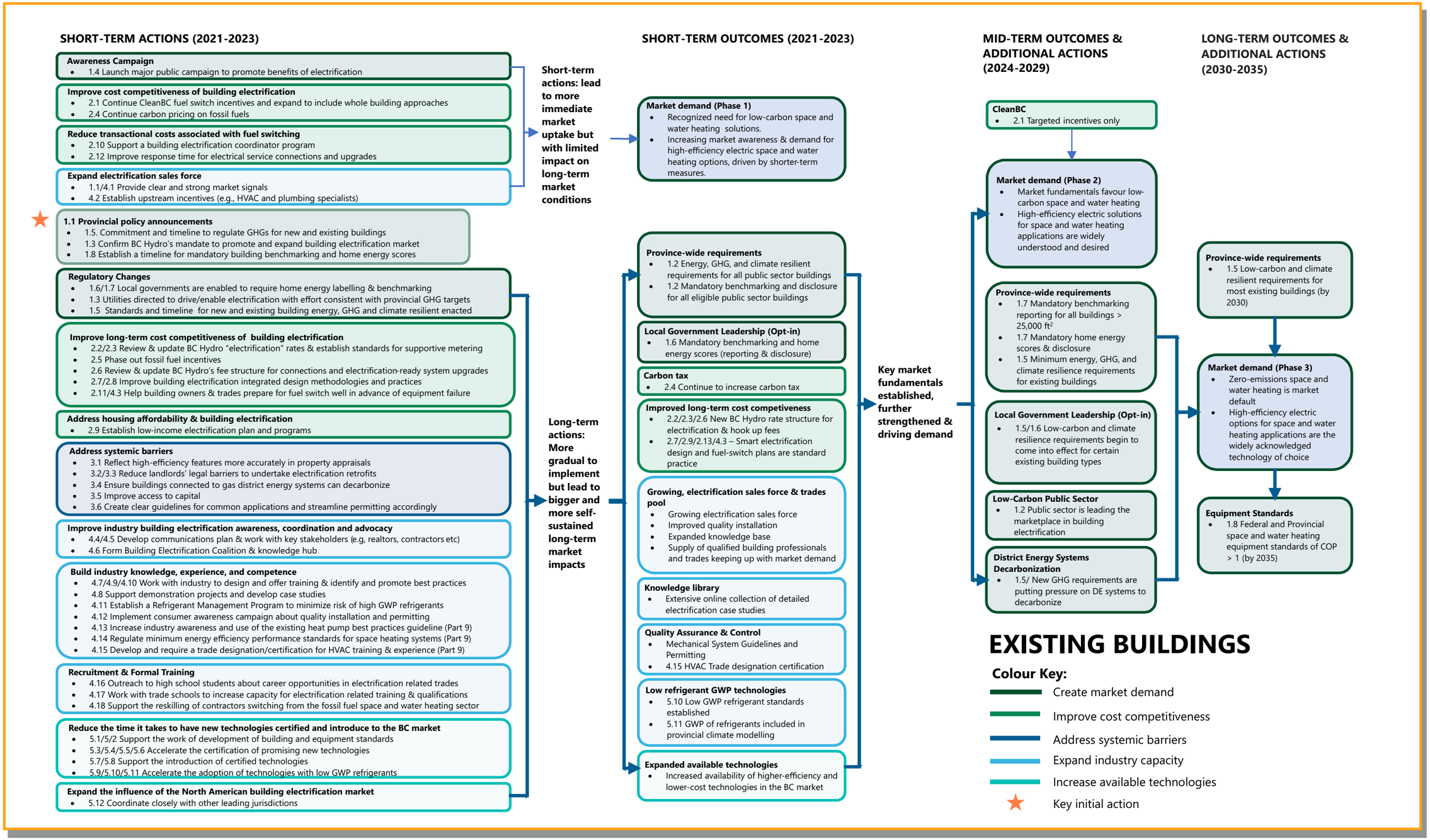
This will in turn demonstrate to industry that change is coming, bring new products into the market, and encourage training for these products. As more people use, design, and install these systems, market awareness will grow, industry capacity will improve, and costs will continue to decline because of increased competition, better products, and growing demand.

As the market for building electrification matures, it is recommended that incentives can gradually be phased out and replaced by regulations.

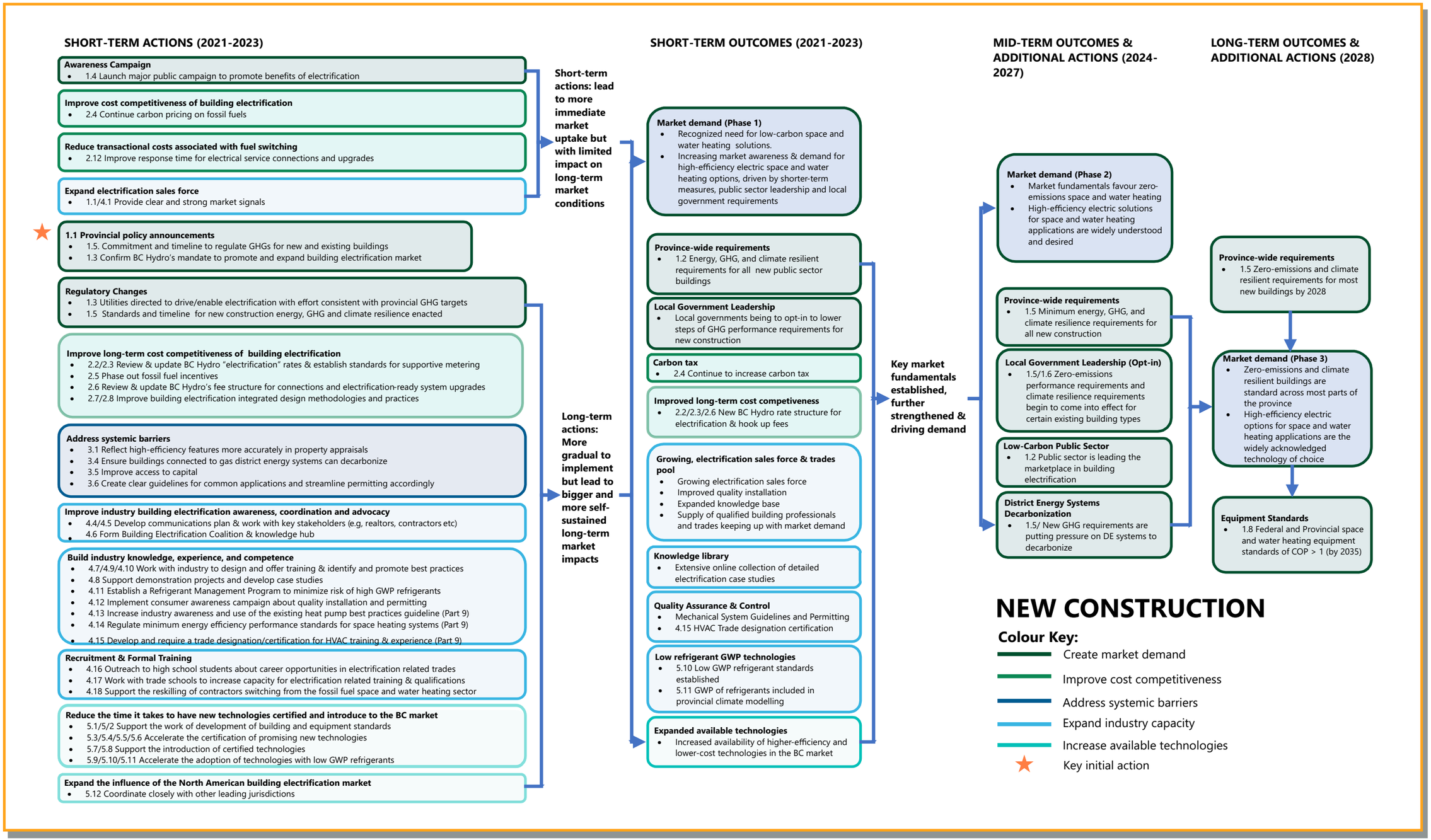
5 CORE STRATEGIES

STRATEGY	OBJECTIVE
Create Market Demand	• Demonstrate provincial leadership through messaging and market signals • Raise level of consumer awareness about the benefits of electrification • Require building GHG performance data reporting and disclosure • Set a minimum energy performance standard of co-efficient of performance (COP) >1 by 2035 for space and water heating equipment
Improve Cost Competitiveness	• Reduce equipment and whole building capital costs • Level the playing field between natural gas and electric operational costs • Reduce electricity connection and system upgrade fees • Address housing affordability and building electrification • Reduce transactional costs for consumers
Address Systemic Barriers	• Reflect high efficiency features more accurately in property appraisals • Reduce landlords' legal barriers to undertake electrification retrofits • Ensure buildings connected to district energy systems can decarbonize • Improve access to capital • Reduce permitting complexity and time for new heat pump systems
Expand Industry Capacity	• Expand electrification sales force • Improve building electrification awareness, coordination, and advocacy • Build industry knowledge, experience, and competence • Expand the use of trade certifications and energy performance guidelines • Support growth in the number of people in the building electrification trades sector
Increase Available Technologies	• Support the development of building and equipment standards • Accelerate the certification of promising new technologies • Support the introduction of certified technologies • Expand the market in North American for building electrification

The Building Electrification Road Map for Existing Buildings 2021-2035



The Building Electrification Road Map for New Construction 2021-2028



Ensuring a Successful & Smooth Transition

Key actions of the Road Map are sequenced over a 15-year period with incentives and other supports being gradually replaced by regulations.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By 2025, market demand is increasingly driven by market fundamentals, and less by short-term incentive offers. By the time that the market transformation reaches its final stage (around 2028 for new construction and 2030 for existing buildings), electrification is recognized as a reliable solution for achieving the Province's low-carbon building standards because of its cost-competitiveness, quality installation, and other resilience and environmental benefits.

The transition to BC's low-carbon building sector by 2030 will require many hands working together over the next ten years to implement the strategies and actions recommended by the Road Map.

Central to its success will be the leadership of the Provincial Government, utilities, and local governments. However, achieving the Road Map's ambitious vision to completely transform BC's building sector over the next ten years will require the sustained commitment of the building industry at large.

Fortunately, there are several factors that help to achieve the Road Map's vision, including the province's clean electricity systems, as well as federal, provincial, and local governmental support of building electrification as a strategy for achieving their long-term GHG emission reduction goals.

Perhaps most importantly, is that BC is home to many bright, dedicated, and experienced green building tradespeople, professionals, builders, developers, and equipment vendors.

While leadership from the Provincial Government, utilities, and local governments is necessary to lead the building electrification market transformation, it is the many members of the building design and construction industries who will make it happen on the ground – one project at a time, by thousands of hardworking individuals and organizations.

Summary of major actors and recommended roles for implementing the Building Electrification Road Map

ACTOR	RECOMMENDED ROLES
Provincial Government	• Announce strong support for building electrification & timelines for regulatory path to near-zero emissions buildings • Establish near-zero emissions regulations for new and existing buildings • Establish green public procurement programs that prioritize “electricity-first” designs – applies to Province, local governments. and crown corporations • Establish a strong and clear building electrification mandate for BC Hydro • Establish mandatory building benchmarking and home energy labelling • Enable local governments to take an early lead on specific building electrification requirements and policy implementation • Fund and administer the CleanBC low-carbon buildings incentive and support program • Maintain carbon tax on fuel • Support a strong building electrification awareness campaign and coalition • Support training and technology innovation initiatives • Work with other key actors to address persistent systemic barriers
Federal Government	• Support training and technology innovation initiatives • Work with other key actors to address persistent systemic barriers • Provide low interest financing for building electrification retrofits • Establish green public procurement programs that prioritize “electricity-first” designs for federal buildings
Local Governments	• Adopt near-zero GHG emissions building bylaws for new and existing buildings (as enabled) • Enforce near-zero GHG emissions building standards (as enabled) • Adopt mandatory building benchmarking and home energy labelling (as enabled) • Establish green public procurement programs that prioritize “electricity-first” designs for corporate buildings • Provide “top-up” incentives where possible • Support provincial, federal, and/or training, technology innovation initiatives • Support a strong building electrification awareness campaign and coalition

Summary of major actors and recommended roles for implementing the Building Electrification Road Map (cont.)

ACTOR	RECOMMENDED ROLES
Electricity Utilities	• Adopt building electrification mandate and culture Establish electrification rates and connection fees • Encourage best practices for electrification in both new and existing buildings • Coordinate with the Province to address electrification program gaps not already covered by the CleanBC program • Support a strong building electrification awareness campaign and coalition • Support provincial, federal and/or industry training and technology innovation initiatives • Work with other key actors to address persistent systemic barriers
Industry	• Ensure high quality design and installation • Provide training • Lead technology innovation initiatives • Work with other key actors to address persistent systemic barriers • Support a strong building electrification awareness campaign and coalition • Provide feedback to regulators and peers on progress being made and opportunities for improvement
Non-Governmental Organizations	• Lead and coordinate a Building Electrification Coalition • Support a strong building electrification awareness campaign and coalition • Support provincial, federal, and/or industry training and technology innovation initiatives • Work with other key actors to address persistent systemic barriers • Provide feedback to regulators and industry on progress being made and opportunities for improvement

Reducing Emissions in BC's Building Sector

The Building sector represents one of the most straightforward opportunities for a rapid transition to a low-carbon market sector

Buildings in British Columbia (BC) emit approximately 6.9 million tonnes of GHG emissions on an annual basis[1]. This represents approximately 10.7% of the provinces' total emissions, and makes the building sector one of the highest sector emitters – exceeded only by road transportation (27.1%) and the oil and gas sector (17.6%)[2].

The building sector, unlike transportation and oil and gas, is regulated entirely by provincial and local governments. It, therefore, represents one of the most straightforward opportunities for a rapid transition to a low-carbon market sector.

At the community scale, the GHG emissions attributed to buildings make up an even greater proportion of total GHG emissions (Table 1). For communities working to reduce their overall GHG emissions, rapidly reducing GHG emissions from the building sector is therefore a key strategy.

In recognition of this important sector, jurisdictions across BC have included a concerted focus on decarbonizing the building sector as a key part of meeting their ambitious emissions reduction goals and targets.

Table 1 Building Greenhouse Gas Emissions as Percentage of Total Community Emission by Major Region in BC[3]

Region	Community Emissions from Buildings
Vancouver Island & Coastal	30%
Lower Mainland	42%
Southern Interior	39%
Kootenay & Boundary	42%
North Central	38%

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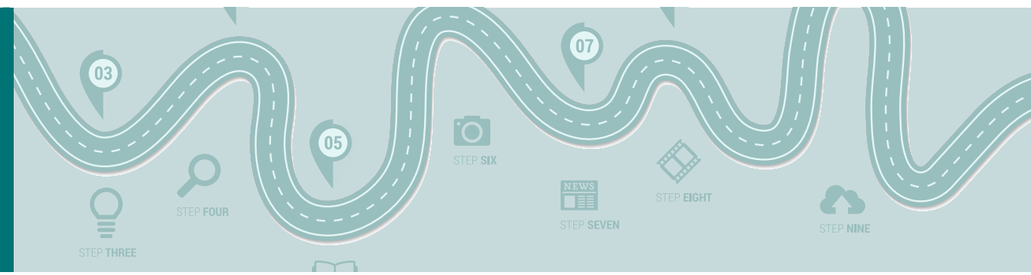
Reducing Emissions in BC's Building Sector

Building electrification refers to the replacement of fossil fuel-based building operating systems, (such as heating, domestic hot water, and cooking) with electric-powered systems.



At the provincial scale, the Province of BC's CleanBC Plan is the primary means through which the Province outlines a number of regulations, programs and rebates to help shift the sector towards higher energy efficiency and fewer emissions, including:

- Increasing energy efficiency standards for new buildings, until every new building is 'net-zero energy-ready' by 2032
- Placing a minimum requirement of 15% renewable gas for all natural gas used in buildings
- Setting new energy efficiency standards for space heaters, water heaters and residential windows
- Upgrading publicly owned buildings and facilities
- Offering rebates for high efficiency heat pumps
- Helping remote communities reduce reliance on diesel, and
- Supporting infrastructure efficiencies and fuel switching to biofuels[4].

The Province is also a signatory to an aspirational national target for all space heating technologies for sale in Canada to meet an energy performance of more than 100%[5]. This would effectively require all space heating equipment installed after this date to be either an electric or fossil-fuel heat pump.

Efforts to decarbonize the building sector are also being led by cities, especially the City of Vancouver. The City of Vancouver's recent Climate Emergency Response sets a target for all new and replacement heating and hot water systems in Vancouver to be zero emission by 2025. In addition to Vancouver, a number of other local governments have declared their intention to significantly reduce GHG emissions in new and existing buildings as well, including Victoria, Metro Vancouver, Burnaby, New Westminster, District of Squamish, Port Moody, and others.

Given the province's considerable size and diversity, provincial policies that enable these and other local governments to lead on building decarbonization are important conditions for accelerating an eventual province-wide adoption of similar building decarbonization policies and actions.

As nearly 95% of electricity in BC is generated from renewable energy[6], many of these efforts focus on the electrification of the building sector.

Why Do We Need a Building Electrification Road Map?

While provincial and local governments in BC are already exploring means of electrifying the building sector, there is a need for a clear pathway that shows the roles, responsibilities and steps that building industry members can and need to play in effecting a shift towards large-scale building electrification.

This Road Map is a tool through which a recommended set of tactical actions has been developed, including the sequence and steps to ensure that BC's building sector reaps the benefits of a clear and coordinated market transformation.

Market Transformation

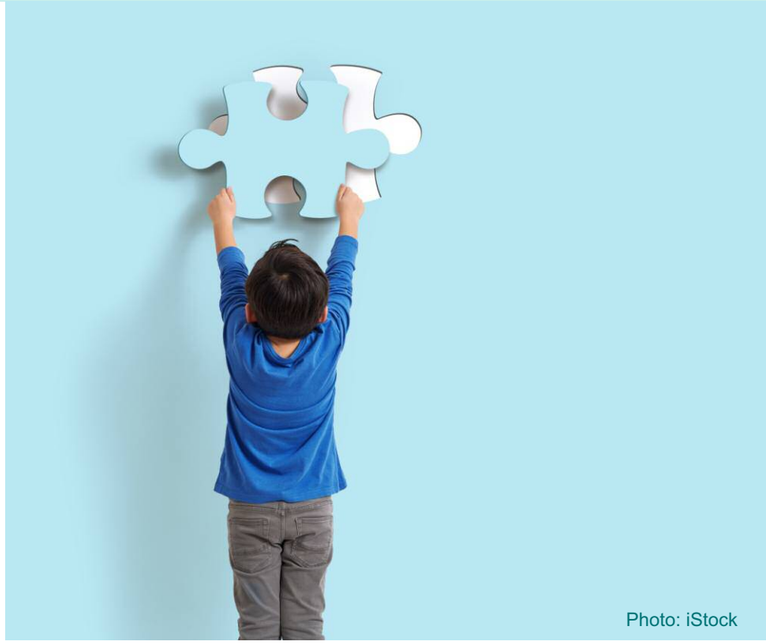
An approach to accelerating a desired technological change with a long history of use in the field of energy efficiency and conservation. The general idea is to intentionally shift market conditions to make them more favourable to a different technology that is deemed more desirable than the incumbent technology. Eventually the new technology replaces the incumbent one as the market standard, resulting in a market shift.

The overarching goal of this Road Map is to significantly reduce the greenhouse gas (GHG) emissions attributed to BC's building sector and to achieve the following vision:

By 2030, nearly all new and most replacement space heating and domestic hot water systems in BC's homes and buildings will be high-efficiency electric, in pursuit of a province-wide shift to low-carbon buildings.

It has been designed to provide recommendations to the Province and other key building sector stakeholders in BC to help identify the necessary steps in addition to what they are already doing to achieve their building sector climate goals for 2030 and 2050.

The process of developing the Road Map was also intended to start to build a coalition of support to help realize its implementation in the short, medium and long term.



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What Does the Road Map Cover?

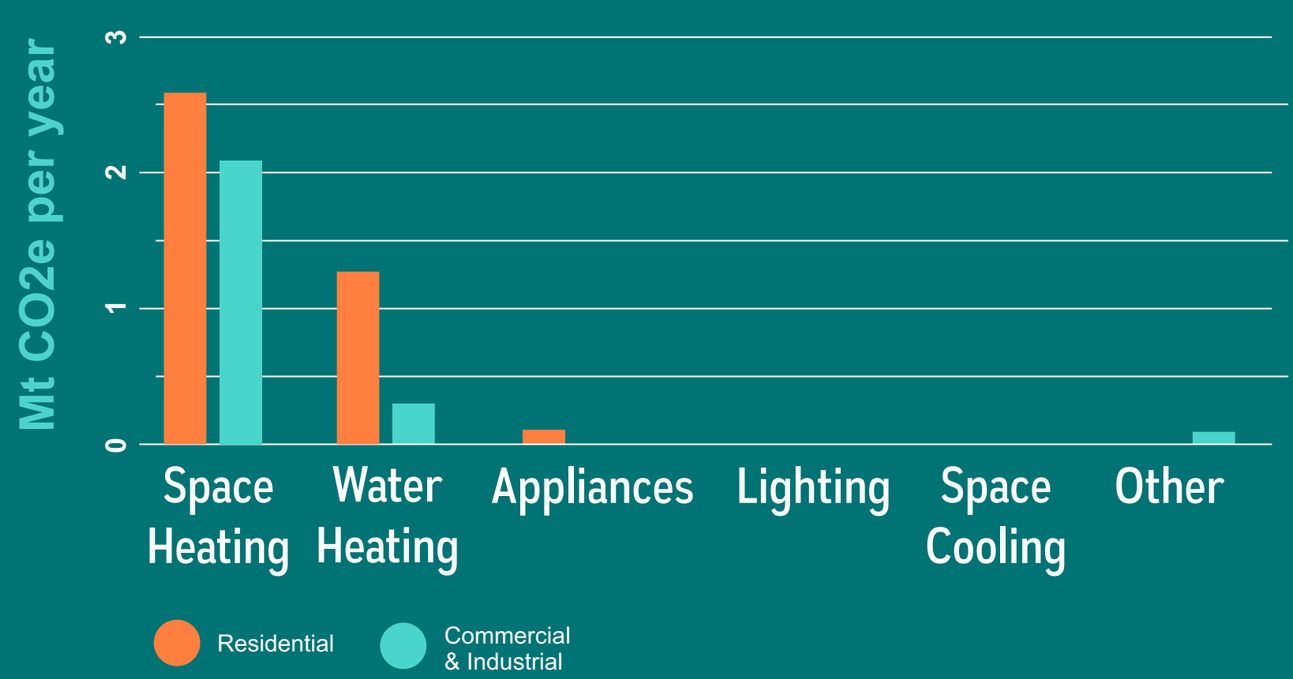
This Road Map identifies market readiness and recommends key actions to support building electrification of space heating and domestic hot water systems.

It identifies the means of accelerating uptake of high-efficiency electric equipment for space heating and domestic hot water in both new and existing buildings, primarily through the use of heat pumps and heat recovery systems. The rationale for this focus is because these two uses account for nearly all of the GHG emissions attributed to BC's building sector (see Figure 1)[7].

As heat pump and other technologies often make use of refrigerants with high Global Warming Potential (GWP), the Road Map also includes a secondary focus on the actions that can be taken to accelerate existing efforts to minimize the impacts of these technologies (e.g., the Federal Government's adoption of the Kigali Amendment to the Montreal Protocol[8]).

Figure 1

Distribution by end-use of GHG emissions in BC's Residential & Commercial/Institutional Building Sectors



What Does the Road Map *Not* Cover?

There are several other topics and sources of building emissions that are not covered directly by the Road Map. Some of these topics are being addressed separately – for example, the Province's development of a dedicated decarbonization strategy for remote communities, as well as Ecotrust Canada's recent study on issues and opportunities related to improving energy security for BC's rural, remote and indigenous communities[9].

Other topics not covered by the Road Map include cooking technologies (e.g. gas stoves); patio and hearth applications (e.g., decorative fireplaces); embodied carbon; electrification of the building site (e.g., electrified equipment); non-electric sources of renewable energy (e.g., renewable natural gas); industrial processes that take place within a building; and the decarbonization of district energy systems.

Each of these topics are important and warrant a detailed review and strategy for decarbonization of their own. It is anticipated that continued work in these areas will help to shape and inform the implementation of the Road Map over the coming years, and in turn for the Road Map to inform future work in these areas.

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Building Electrification in Other Jurisdictions

Building electrification is increasingly recognized in North America and around the world as a central strategy to significantly reduce or completely eliminate GHG emissions from the operations of buildings. Below are some examples of leading governments in building electrification.

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The Netherlands

The Netherlands' national government has set a target to fully phase out fossil fuels by 2050, including the 95% of the country's 7.8 million homes that are connected to gas. In the shorter term, it plans to covert more than 20 percent of its housing stock to be fully electric by 2030. Policy measures to achieve these goals include efficiency and electrification requirements for landlords; increasing taxes on natural gas and decreasing ones on electricity; incentives and favourable loans, and special assistance provided to lower income households[10].

Ireland

Ireland's Climate Action Plan intends to have 600,000 heat pumps installed in homes by 2030. 400,000 of these will be in the country's existing homes which currently number just over 2 million. A key motivation for doing this is to avoid the “carbon lock-in” that occurs when homes connect to the gas line[11].

California

In 2019, California's City of Berkeley became the first city in the US to adopt an ordinance to prohibit natural gas hook-ups in new buildings. One year later, there are now more than 40 cities in the state that have adopted some form of direct limits on the use of fossil fuels in new construction (some municipalities allow natural gas for cooking and fireplaces)[12][13]. Efforts are currently underway in the state to have an all electric requirement included in the State's updated building code for new homes (Title 24). For existing buildings, California's $1 billion Self-Generation Incentive Program includes $45 million for homeowners to switch from natural gas hot water systems to heat pump water heaters[14][15]. Senate Bill 1477 also provides $50 million annually to help Californians reduce energy costs, improve air quality, and cut GHG emissions. Funding from Bill 1477 will go toward innovations in new construction as well as incentives and training directed at the market development of low-emissions space and water heating[16].

New York City

New York City's 2019 Building Emissions Law sets emissions limits to begin in 2024 and increase in 2030[17]. This law requires buildings larger than 25,000 square feet to report on their energy use and make changes if they do not meet the requirements outlined for their building type. There are exceptions to this size threshold, particularly in the case of affordable housing. The Building Emissions Law encompasses about 60% of the current New York City landscape and is part of the city's strategy to reduce emissions by 40% by 2030 over a 2005 baseline. Retrofits and redesigns are supported through state PACE programs, advancement of the Retrofit Accelerator Program, as well as mandated training and education outreach through the program[18].

Nova Scotia Power

Nova Scotia Power has a number of heat pump programs on offer that help provide consumers with information on the benefits of heat pumps over fuel oil heating and electric resistance equipment, search a list of approved contractors, explore current promotions, and connect to financing. They provide homeowners with easy access to information and customer service.

How Was the Road Map Created?


Photo: iStock

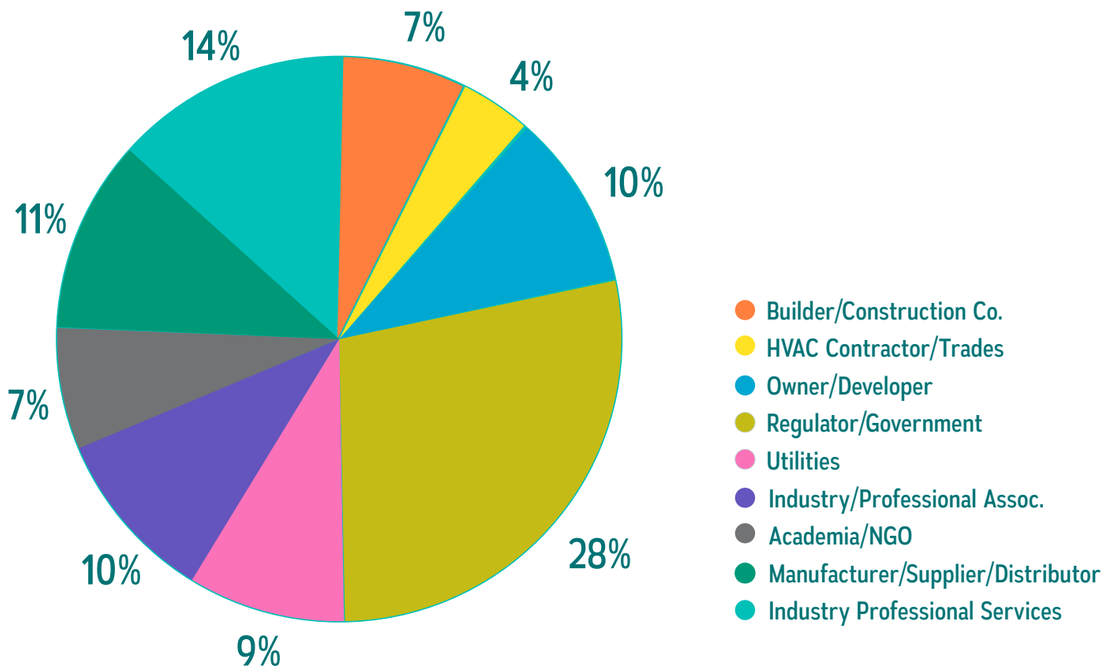
The Road Map was developed by the consultant with input from the project's Steering Committee members and over 150 key building stakeholders over a nine-month period in 2019-2020.

The Road Map's actions were derived from existing research and practice in the building industry, as well as a process of extensive stakeholder engagement with a range of different stakeholder groups (see Figure 2).

The schedule of engagement and methods used to collect input are outlined in Appendix A.

Road Map Participants

Figure 2.



From Road Map to Implementation

While the specifics of the Road Map's implementation are detailed in Section 5, there are a number of important considerations that will be key to the Road Map's overall success, and should be noted up front and include, in no specific order, the following points:

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- British Columbia is a large province, covering six major climate zones (4, 5, 6, 7A, 7B, and 8) and exhibiting considerable market differences between the heavily populated southwestern and south-central regions and its rural communities. Implementation of the Road Map's actions must consider these differences, with actions adapted as needed to ensure that they serve British Columbians, regardless of where they live, work, or play.

- The implementation of the Road Map must also recognize that there are major differences between different building types, especially in the existing building sector. Characteristics such as size, location, and vintage can have a dramatic impact on the cost and feasibility of different electrification solutions. Wherever possible, these differences should be identified, and the approach and timing of different actions adapted accordingly.

- Building electrification should not be considered in isolation of other important strategies to increase a building's efficiency and optimization. Good building design that ensures longevity, efficiency and other important outcomes remain of central importance.

- The successful implementation of the Road Map over a relatively short period of time will require the collection and use of quality data to appropriately design, develop, monitor and adapt programs and policies.

- The potential for building electrification to improve the resilience of buildings is as important as its potential to reduce GHG emissions. Communication, policies, and practices tied to building electrification need to therefore consider these benefits as much as they do climate mitigation.

- Building electrification that uses grid supplied electricity is one strategy for decarbonizing BC's building sector over a relatively short period of time. Other strategies, such as low-carbon district energy systems, renewable gas (e.g., methane, hydrogen), and on-site renewables (e.g., solar photo voltaic), should be assessed where appropriate, in additional to centralized electrification for their suitability to a particular building, project or district.

Reading the Road Map

The Road Map provides a recommended set of actions necessary to take the sector from its status quo to a new market dominated by low-emissions technologies and practices. These recommended actions were identified through an extensive survey of existing electrification knowledge and practice in BC's building sector.

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Report Contents

Section 2

A brief background on the primary electric technologies needed to make the transition to electrifying BC's buildings.

Section 3

An overview of the current state of the new and existing building market in BC for electrification.

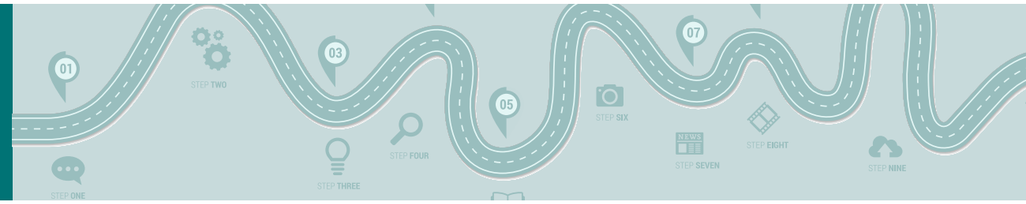
Section 4

Outlines the Road Map itself, including the five major strategies and 42 recommended actions necessary to realize the Road Map's vision.

Section 5

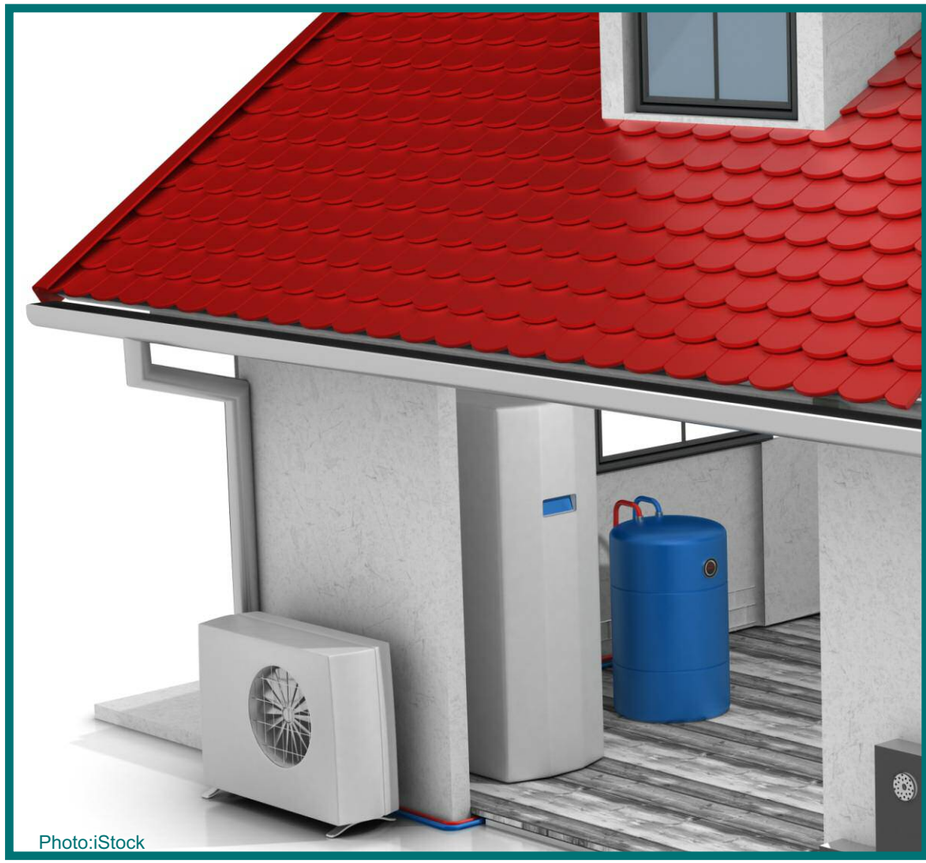
Details the overall sequence of the Road Map, its key players, and the means of tracking its progress over time.

Electrification Technologies



Before identifying the potential for electrification in BC's building sector, it is important to explore the readiness of key electrification technologies overall. For the purposes of this Road Map, this market assessment focuses on heat pumps for space and domestic hot water heating, as well as heat capture and recovery.

The assessment considered applications for the following building categories: ground-oriented residential (e.g., detached single family dwellings, duplexes, and rowhouses), multi-family apartment buildings, and commercial and institutional buildings. The assessment draws on the US Pacific Northwest market (i.e., California, Oregon, and Washington State), as well as BC.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Electrification Technologies

Space & Domestic Hot Water Heating

Heat Pumps

As can be seen in Table 2, high-efficiency space heating technologies are readily available for every major building type, including ground-oriented residential, apartment style residential, small to medium commercial, and larger commercial and institutional buildings and/or campuses.

In the ground-oriented residential sector, market-ready air-to-water, and cold climate air-source heat pump technologies do exist but the number of brands available in the North American marketplace is still limited. High efficiency electric technologies for central domestic hot water applications are less widely available, especially for larger commercial and institutional applications that require a regular high volume of hot water at 60ºC.

Overall, this brief review shows that many of the technologies needed to drive this market shift already exist.

For BC's market, the challenge lies more in continuing to improve the cost competitiveness of high-efficiency electric systems, improving the efficiency of buildings more generally, increasing consumer awareness of their benefits, and establishing the knowledge and skills required to ensure that these systems are designed, installed and operated properly, and the buildings that they operate in are optimized where needed to match the performance characteristics of these systems.

Table 2

Summary of the Market Readiness of leading high-efficiency electric technologies for space and domestic hot water heating

	Technology	Ground-oriented Residential	Apartment Style Residential	Small to Medium Commercial	Larger Commercial & Institutional
SPACE HEATING	Air Source Heat Pumps	●	●	●	●
	Hydronic Space & Water Heating	●	●	●	●
	Cold Climate (“Low-Ambient”) Heat Pumps	●	●	●	●
	Rooftop Air Source Heat Pump	N/A	●	●	●
	Variable Refrigerant Flow (VRF)	●	●	●	●
	Ground Source Heat Pumps	●	●	●	●
DOMESTIC HOT WATER	Heat Pump Water Heater (240V)	●	●	●	N/A
	Heat Pump Water Heater (120V)	●	●	N/A	N/A
	Central Heat Pump Water Heater	N/A	●	●	●
	Commercial Heat Pump Water Heater	N/A	N/A	●	●
	Ground Source Heat Pump with Desuperheater	N/A	N/A	N/A	●

● Market ready with multiple models available
● Market evolving. Limited models available
N/A Technology is not applicable for this building type

How Do Heat Pumps Work?

High-efficiency heat pumps are arguably the most promising technology for building electrification

The basic operating principle of heat pumps is based on the compressor, which circulates a pressurized refrigerant through a closed loop to move heat energy.[19] Refrigerators and air conditioners are both familiar examples of heat pumps. A heat pump simply moves heat energy, rather than converting or producing it.

This means that for every unit it takes to run the compressor that "pumps" the heat from one place to another, typically two to four units of heating or cooling energy is provided in the building space or hot water system. In contrast, an electric baseboard heater converts each unit of electrical energy into a single unit of heat energy.

For space and water heating purposes, an electric heat pump's performance is typically measured as coefficient of performance (COP). The COP is the ratio between the amount of electric energy needed to operate the compressor, compared to the amount of useable heat energy transferred. In certain applications and conditions (e.g., commercial and institutional building space conditioning), the COP of a heat pump can be as high as 4 to 5.

Photo courtesy of City Green Solutions

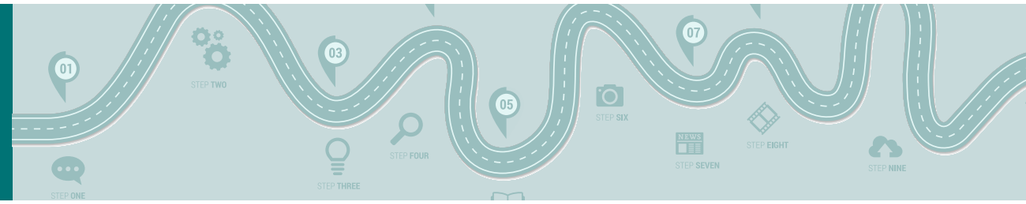
By way of contrast, the COP of a residential high-efficiency gas furnace is approximately 0.95 (0.05 is waste heat lost through the vent) and the COP of an electric resistance baseboard is 1 (simply a 1:1 conversion of electric potential energy into useful thermal energy).

Heat pumps can be categorized by the source from which they transfer heat from in winter heating (and the sink they transfer heat to in summer cooling).

The most common heat source/sinks are the ambient atmosphere (these heat pumps are categorized as air-source heat pumps), and from other earth sources including piping buried in boreholes or trenches to exchange heat with soil and rock, heat exchanged from groundwater, surface water, or wastewater (collectively these types of heat pumps are categorized as geoexchange heat pumps).

Heat Capture & Recovery

Heat recovery systems extract heat from sources of energy that would otherwise be considered waste heat.



Heat capture and recovery represents a second key type of technology for building electrification. Like heat pumps, they facilitate the transfer of thermal energy from one place to another.

However, a main difference is that heat recovery systems extract heat from sources of energy that would otherwise be considered waste heat (e.g., heated air vented out of a building for cooling and/or air quality purposes, chillers, industrial processes that require extremely hot water or steam, hot water drains and sewage).

For buildings that use fossil fuels for heating, heat recovery represents an important strategy for reducing the building's overall GHG emissions because there is now a smaller residual heating load that needs to be served.

Technologies for heat capture and recovery are readily available for all major building types. For new buildings, heat capture and recovery should already be a basic element of any well-designed mechanical system.

For many existing buildings, heat recovery represents a major potential for additional energy, GHG and cost savings as most building's mechanical systems were designed either prior to widespread industry adoption of heat recovery technologies or simply without considering the potential for heat recovery when designed (similar design oversight still happens all too frequently for new buildings).


Photo:iStock

Design Considerations

Holistic Building Design

In terms of energy output, a major difference between heat pump technologies and conventional natural gas and electric resistance heating is that the temperature of heat produced at any point in time will be lower for heat pumps. For newer buildings that are designed with high efficiency building envelopes and heat recovery systems, heat pumps' operating parameters are typically not major issues, as total building heating requirements are well within their range.

For some ultra energy efficient buildings, heating loads may be so low that it is preferable to use conventional electric resistance to meet the building's limited space heating requirements. However, heat pumps may still be desired given their potential for cooling.

For older and more energy intensive buildings, heat pumps' slow but steady qualities mean reducing a building's heating load through measures such as heat recovery and /or envelope upgrades is often a prerequisite to full building electrification.

Electrification of existing buildings, therefore, requires a holistic design approach to be considered, including measures of conservation and heat recovery. By taking a whole-building approach of efficiency plus electrification, heating equipment can be optimally sized, and a “brute force” electrification strategy can be avoided (along with the risk that it may not be able to reliably or affordably fulfill the building's required heating demand).

While heat pumps represent the most efficient building-scale technology for electrification, there are other design considerations that warrant additional discussion.

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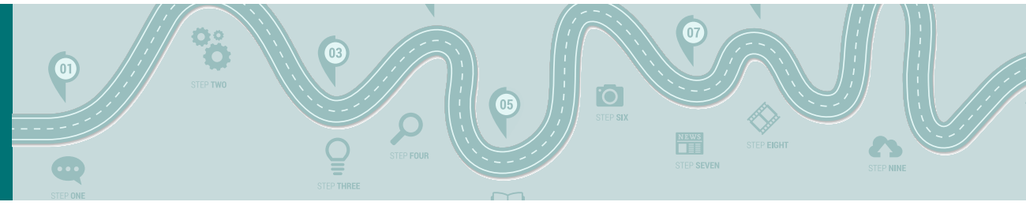
Design Considerations

Building Scale Demand Management



Another important design consideration tied to how heat pumps operate is the need to smooth a building's peak load requirements and match a building's daily load variations with the mechanical system's standard operating parameters.

Measures such as batteries, water tanks for thermal buffering, and the judicious integration of natural gas equipment or electrical resistance heated hot water to assist with quick temperature boosts or short peak load spikes, can help to ensure overall system consistency and mitigate the oversizing of heat pump equipment, or building electrical supply infrastructure.

These kinds of carefully considered measures can help to reduce capital costs, ensure better system operations, and reduce the need for expensive electricity distribution upgrades in areas where the existing electricity distribution network is already at or near capacity.

Photo courtesy of City Green Solutions

Design Considerations

Refrigerants

Heat pumps make use of refrigerants – fluids that can easily change state, from a liquid to vapor and then condense back to liquid. Unfortunately, many refrigerants have a high global warming potential (GWP), which represents the ability of GHG to trap heat into the atmosphere compared to CO_2 over a specific time period (typically 100 years).

GWP is calculated in CO_2 equivalent and is typically referred as carbon emissions.

The GWP given for refrigerants is associated with the leakage of 1kg into the air during the use phase, as the production stage impact is much smaller and 100% of the refrigerant is typically assumed to be recycled[22].

In general, the building industry and regulators can and should take a number of steps to minimize the negative impact of refrigerants, including:

- Ensuring heat pump equipment uses low GWP refrigerants and requires lower quantities of refrigerant to operate
- Reducing the heating load, and thereby the need for refrigerants, by building and retrofitting buildings to be higher efficiency
- Mitigating refrigerant leakages by using qualified installers and ensuring systems are properly checked and maintained
- Ensuring that end-of-life equipment is decommissioned and disposed of by a qualified contractor who will ensure refrigerants are properly recovered.

Reducing GWP

In 1987, the Montreal Protocol banned refrigerants with a high Ozone Depletion Potential (ODP) but did not address the Global Warming Potential (GWP) of the gases that would replace them.

Later in 2016, the Kigali Amendment to the Protocol set an agenda to phase out these high GWP refrigerant gases, but the reality is that such refrigerants are still widely used.

Slowly, alternative refrigerants with lower GWP are appearing on the market, driven by regulation changes in different regions of the world. For example, the European F-Gas Regulation aims to decrease HFC use by 79% by 2030 from 2015 levels.[20]

Canada, by comparison, is planning a reduction of 85% by 2036 over a series of targeted “step-downs”.[21]

Design Considerations

Refrigerants

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The GWP of refrigerants varies depending on their type:

Natural/hydrocarbon substances have a GWP of <5. These natural refrigerants are unlikely to have any unintended consequences, as they are known substances (e.g. Ammonia (R717), CO_2 (R744), and Propane (R290)). However, there are few products on the market that use these refrigerants.

Hydrofluorolefins (HFOs) have a GWP of <10. These are alternative low GWP refrigerants that are currently available commercially (e.g. R1234ze, R1234yf, R1233zd).

Mid-Level Hydrofluorocarbons have a GWP of <750. Most major manufacturers will now offer systems between 450 and 750 GWP (e.g. R454b, R513a and R32).

High-Level Hydrofluorocarbons have a GWP of >750. While there are still units available that use these refrigerants, these should be avoided whenever possible (e.g. (R410a, R407c and R134a).

Design Considerations

Type of Heat Pump


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For a given application, the most suitable type of heat pump system and the most suited configuration depends on a number of factors that need to be carefully considered, including site setting attributes, climate zone, heating/cooling load profile, site-specific constraints, and architectural considerations.

What kind of heat pump is used will depend on a number of factors that will need to be carefully considered, including, a building's climate zone, thermal massing needs, and specific location and architectural considerations. These factors are described in more detail here.

Climate Zone

In BC's more moderate climate zones (e.g., Climate Zones 4 and 5), the choice of heat pump system used is far less restricted by climate than in colder ones. Both air-source and geoexchange-source will typically perform well in the moderate climates. In colder climates, geoexchange heat pumps will offer higher efficiency because of the relatively stable temperature of geoexchange sources (soil, rock, groundwater surface water) compared to the outdoor ambient atmosphere. Emerging cold climate air source heat pump technology is becoming more effective, but the efficiency will swing considerably depending on the outdoor ambient temperature and may still require the use of a backup heating system to ensure heating throughout the year in cold climate zones.

Leveraging Thermal Massing Opportunities

For buildings or clusters of buildings interested in storing “waste” heat for future use or with simultaneous heating/cooling demand loads (e.g., recreation facilities with pools and arenas, hospitals, hotels), geoexchange heat pump systems hold certain advantages over standalone air-source systems. This is because the mass of soil, rock, groundwater or surface water that a geoexchange system is thermally coupled with can often accommodate heat storage. This can lead to opportunities for storing heat that is rejected from a building to the geoexchange sink during summer cooling periods and then allow for this same heat to be available for uptake during the heating season. Similarly, clusters of building connected to a common geoexchange loop system create an opportunity for heat to be transferred between buildings from a point of excess heat (e.g., an arena) to a point of heat demand (e.g., a pool). In these circumstances, the overall energy performance of heat pump systems can be significantly improved.

Other Considerations

Air-source heat pump systems avoid the added cost and logistical considerations associated with developing a geoexchange ground heat exchanger (often known as the ground loop). In some cases, the location of an air-source outdoor air unit may not be possible because of inadequate space, an inability to accommodate any outdoor fan noise, or exterior architectural constraints. In these cases, geoexchange heat pump options may be more desirable. For more information about suitability considerations for geoexchange heat pump systems, Geoexchange BC's Professional Guidelines for Geoexchange Systems in British Columbia is a valuable resource.[23]

The Benefits of Electrification

Reducing Greenhouse Gas Emissions

As noted in the Introduction, one of the major benefits of building electrification is the reduction of GHG emissions associated with the building sector. Electricity supplied by BC Hydro's electricity grid is more than 16 times “cleaner” from a GHG emissions perspective than natural gas, and nearly 23 times cleaner than heating oil (Figure 3). Electricity purchased in FortisBC's electricity service area is associated with even fewer greenhouse gas emissions, due to the higher concentration of electricity generated from renewable sources.

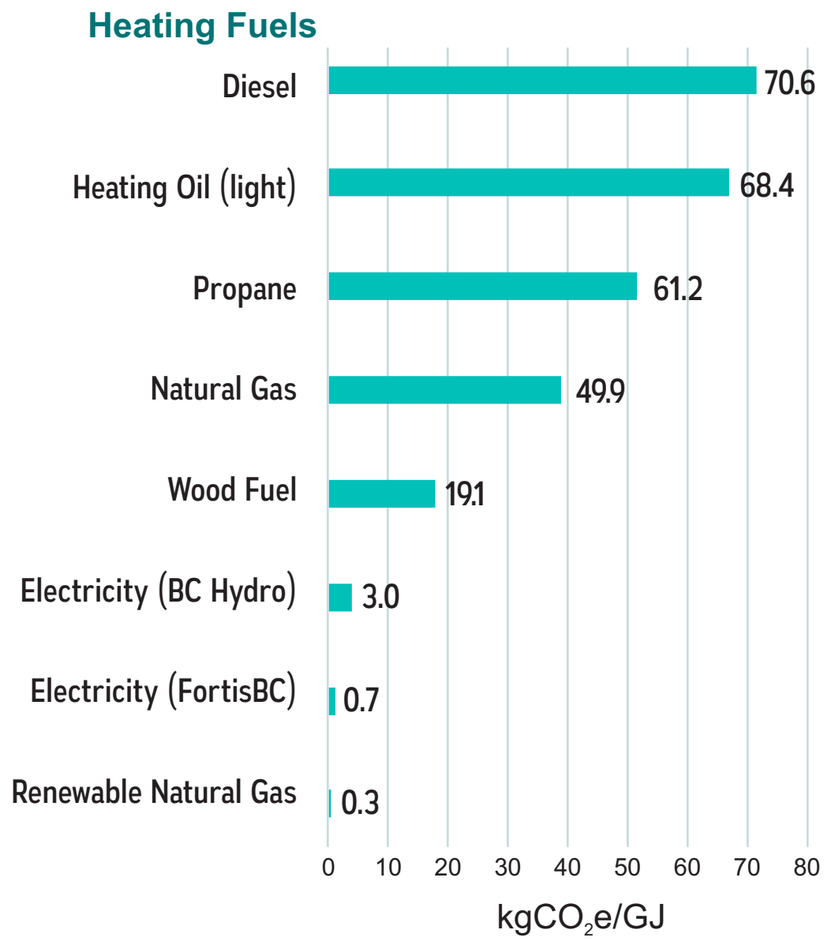
As shown in Figure 3, renewable natural gas (RNG) is another low-carbon source of energy in BC that can be used to decarbonize a portion of BC's building stock in the coming years.

The CleanBC Plan has set a goal for renewable gas to make up 15% of the province's natural gas supply by 2030. It currently accounts for about 0.2% of FortisBC's total natural gas supply.[24]

Given the scale of the energy shift needed to achieve the Province's climate targets (see Figure 4), it is not a question of whether clean electricity, or some other source of clean energy will be used in this energy transition. Rather, all and every viable low-carbon energy option will need to play a role.

Figure 3.

Greenhouse gas emissions factor for heating fuels used in BC



The Benefits of Electrification

Reducing Greenhouse Gas Emissions

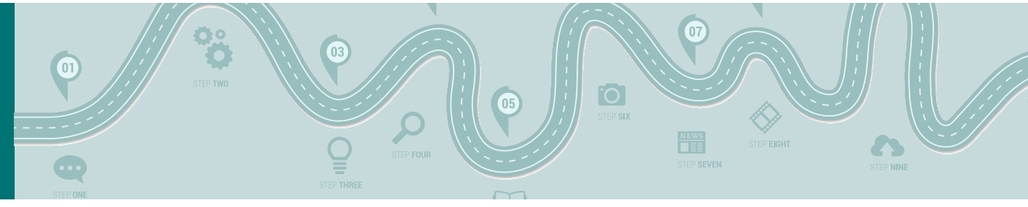
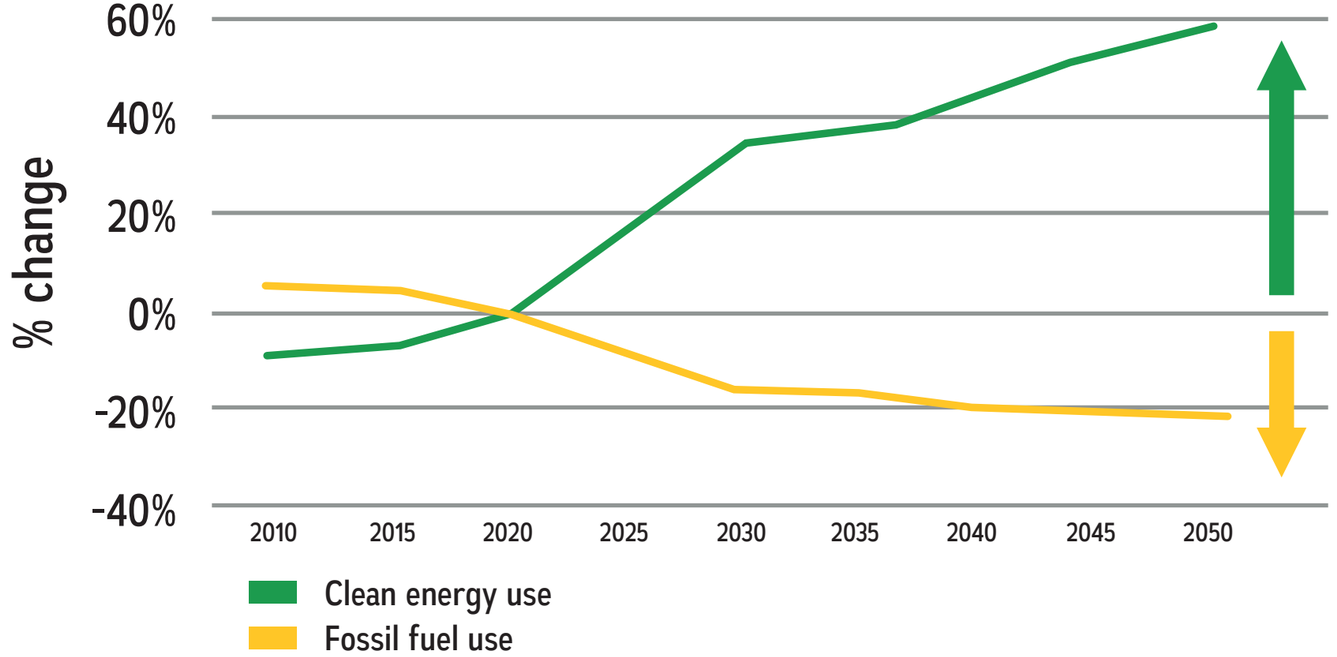


Figure 4.

Estimated energy mix change in BC between 2010 and 2050 that is needed to achieve the province's climate goals.

CleanBC Plan



The Benefits of Electrification

Increased Climate Resilience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Building electrification enables the use of heat pumps that provide cooling (air conditioning) and indoor air filtration as well as heating.

This provides resilience to projected regional climate impacts in the coming decades, such as: longer, hotter, drier, summers, as well as increased likelihood of wildfire smoke events that impact air quality.[25 26] For people working and living in buildings, the immediate impact of these changes will vary based on location.

However, changes that are likely to impact nearly everyone in the province will be an increase in the number of "tropical nights" (nighttime low temperature is greater than 2O^{O}C); "heat days" (when the daytime temperature exceeds 3O^{O}C); extreme heat events, and poor outdoor air quality resulting from smoke from larger and more frequent wildfires.

To avoid overheating and prolonged exposure to unhealthy levels of particulate matter from wildfire smoke, it is important that buildings can maintain thermal comfort without relying entirely on passive measures (e.g. operable windows) that may not be usable during poor air quality events.

When considering mechanical cooling solutions, the ability of heat pumps to both heat and cool a space means that buildings equipped with this technology will be resilient to extreme heat and poor air quality.

Although more conventional air conditioning systems can also provide these services, heat pumps provide the same benefit at a comparable cost and significant lower carbon footprint.

The Benefits of Electrification

Economic Stimulus

Many actions designed to support the electrification of BC's building sector are also likely to result in significant economic stimulus and job creation.

An economic impact study conducted for the City of Vancouver and the Province of British Columbia for a future BC Retrofit Code estimated that the Code alone would lead to the creation of more than 4,400 direct jobs and nearly 6,000 indirect jobs between 2019 and 2039 (net impact, full-time equivalent jobs) and contribute over $8.3 billion to the province's direct GDP.[27]

For new construction, a study commissioned by the Vancouver Economic Commission estimates that Vancouver and BC's zero emissions and net-zero energy ready building policies are stimulating a $3.3 billion market for high-performance buildings products and technologies in Metro Vancouver alone.[28]

The report specifically highlights the economic potential of mechanical equipment such as heat pumps and heat recovery ventilators.

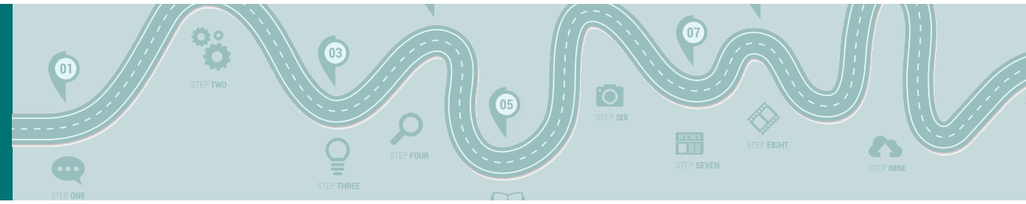
It estimates that the installation of this equipment will support 770 local jobs on average each year from 2019-2032. It also points out that the manufacturing of this equipment holds considerable future potential for job growth. Of the 925 annual jobs estimated for the manufacture of this equipment, only one third are currently located in BC.

More generally, it is estimated that every $1 spent on the kinds of energy efficiency measures included in the Pan Canadian Framework will result in $4 - $7 in net GDP impacts and every $1M in program spending will lead to 30 job-years of full-time equivalent employment.[29]

Similarly, a recent study on the jobs impact of market-wide building electrification in the State of California concluded that it will result in an average of 64,200-104,000 jobs annually by 2045, after accounting for losses in the gas sector.[30]

The Benefits of Electrification

Energy Efficiency



The electrification of BC's building stock with high-efficiency equipment and building envelopes over the next 10 to 15 years will make it one of the most efficient places to live, work, and play in the world.

As the co-efficient of performance for heat pumps continues to improve and the cost of this equipment continues to decrease, the lifecycle cost (i.e., capital and operation cost over a system's lifetime) will become more comparable to the current average for fossil-fuelled buildings.

The province's electricity utilities, meanwhile, will be able to make every unit of its clean energy resource stretch two to four times further than they do today. This is good news for the environment, businesses, and homeowners alike.

Photo:iStock

Building Sector Greenhouse Gas Emissions in BC

While the previous section laid out the overall rationale for why building electrification should be considered as a key tool for decarbonizing the building sector, this section turns to a description of the overall state of the building electrification market in BC.

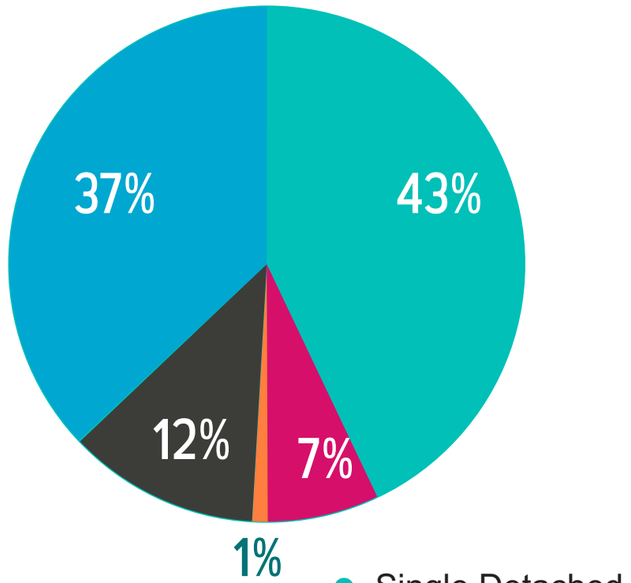
An important starting point for assessing the market for electrification is to understand the current building sector and its overall emissions and performance profile. As noted in the Introduction, buildings account for more than 10% of the province's emissions, and as much as 60% of municipalities' emissions profiles.

Breaking this down more granularly, single detached homes (43%) and the commercial and institutional building sectors (37%) combined account for about 80% of the GHG emissions attributed to buildings in BC (Figure 5). The remaining 20% of emissions are attributed to single-attached homes (7%), apartment buildings (12%) and mobile homes (1%).

This comparison shows that although GHG reductions are likely required across the existing building stock, the largest aggregate gains can be expected from the ground-oriented residential (single detached and single attached), commercial and institutional sectors.

Figure 5

Distribution of Greenhouse Gas Emissions Attributed to Buildings in BC[31]



Building Sector Greenhouse Gas Emissions in BC

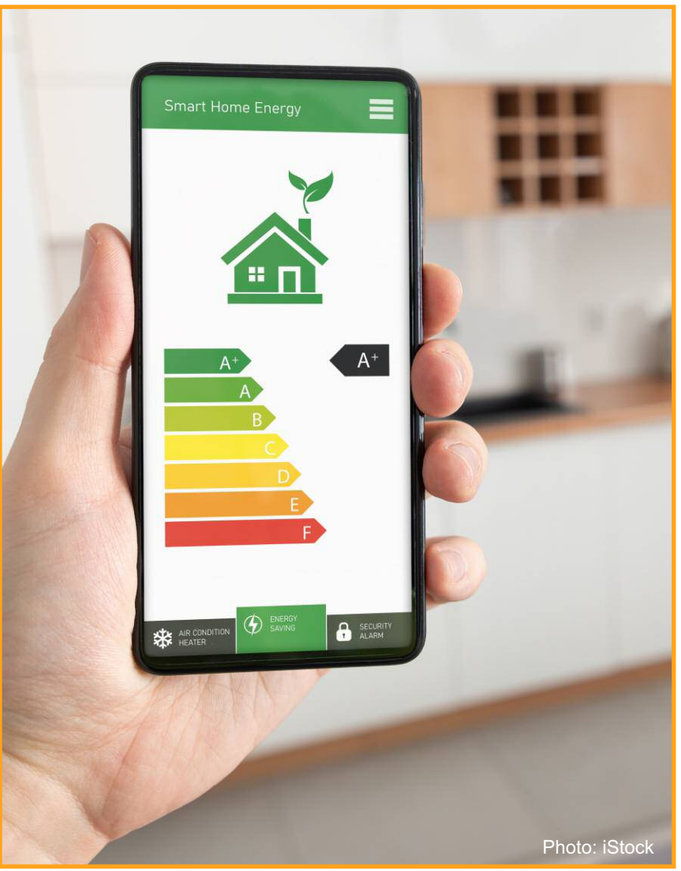


Photo: iStock

In terms of the types of energy used by BC's existing buildings, natural gas is the most widely used energy source for both space and water heating, followed by electricity across all building types (Figure 6 and Figure 7).[32]

Improving the overall energy performance of buildings and shifting them from conventional natural gas use to electricity and other low-carbon sources of energy will therefore be critical to achieving long-term climate targets.

Figure 6

Energy used for primary space heating in BC by building type

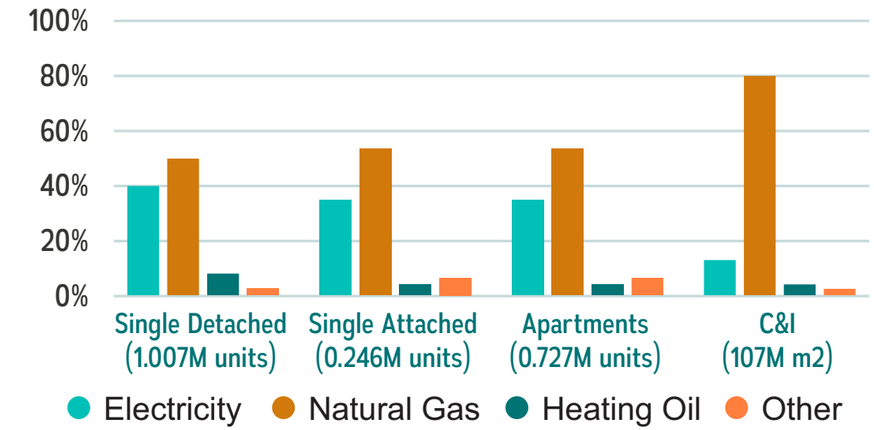
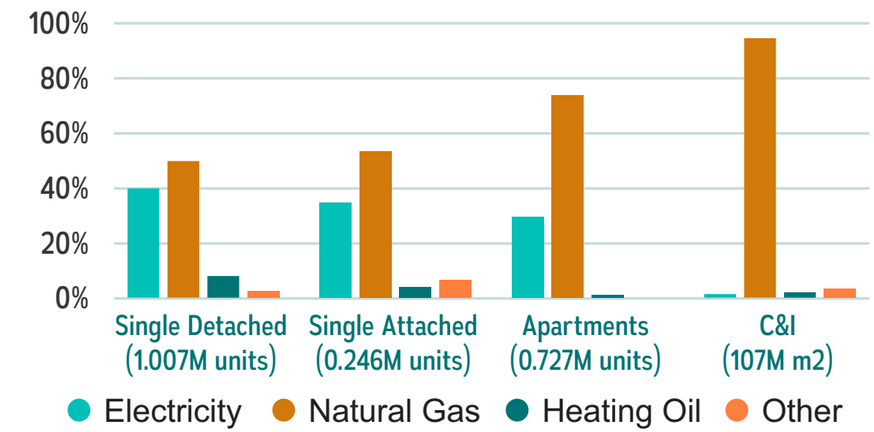


Figure 7

Energy used for domestic hot water in BC by building type



Building Sector Greenhouse Gas Emissions in BC

With respect to new construction, multi-unit homes (i.e., apartments and single-family attached) represent the fastest growing residential sector in many regions of the province. In 2019, nearly 9,000 new single detached homes and 34,600 new multi-unit homes were registered in BC. Of these, nearly 72% are located in the Metro Vancouver region.[33]

At the same time, BC's commercial and institutional (C&I) sector is also increasing, growing by nearly 80% over the last 30 years. In 1990, NRCan estimated that the sector included just under 60 million m^2 of floor space; today it accounts for almost 107 million m^2.

The level of growth in BC's new building sector demonstrates the importance of addressing GHG emissions in new developments as well as existing buildings for the province and local governments to achieve their GHG emissions reduction targets.

Once constructed, it is much more difficult and costly to reduce a building's emissions. Reducing GHGs of new buildings is therefore a critical first step to reduce emissions from the building sector.

Photo: iStock

Building Sector Greenhouse Gas Emissions in BC

The BC Energy Step Code serves as the primary provincial tool and pathway to net-zero energy-ready performance levels for new construction in BC, laying critical groundwork for both high efficiency building envelopes and mechanical systems.

Although the BC Energy Step Code (ESC) was originally intended to help reduce GHG emissions from new buildings, it does not include provisions for minimum GHG emissions standards and therefore precludes local governments from requiring new homes and buildings to achieve a minimum GHG emissions standard.

As a result, new buildings built to high levels of energy efficiency can still emit significantly higher emissions when using natural gas than if all systems are electric see (Figure 8 and Figure 9).[34]

This means that while the ESC is an effective tool for driving energy efficiency, it can nevertheless result in buildings that continue to emit GHG emissions over their lifetime. As such, while the inclusion of the ESC into the BC Building Code enables local governments to regulate energy performance, it does not allow them to directly regulate GHG performance for new buildings.

Fortunately, it appears that this issue will soon be addressed. In November 2020 the Premier's mandate letter to the BC Attorney General and the Minister responsible for Housing to support local governments to set their own carbon pollution performance standards for new buildings.

Figure 8

GHG Intensity by Mechanical Systems for Part 9 buildings
(average across all archetypes for Climate Zone 4)

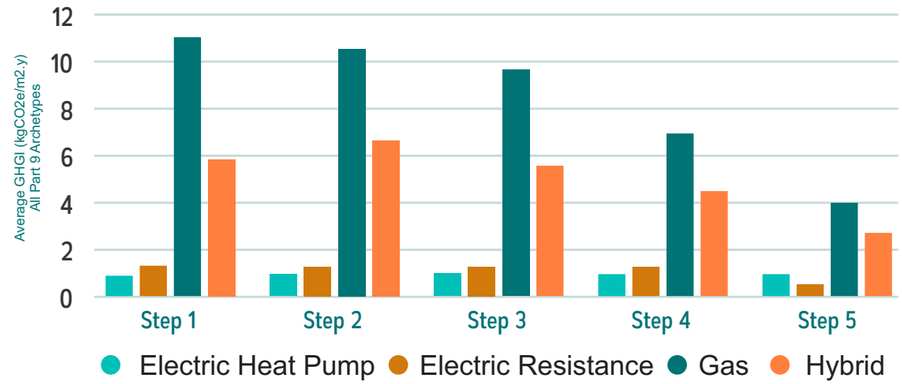
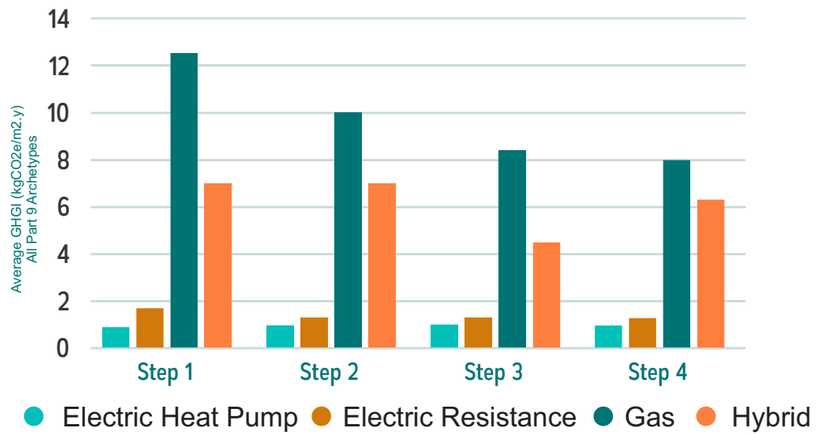


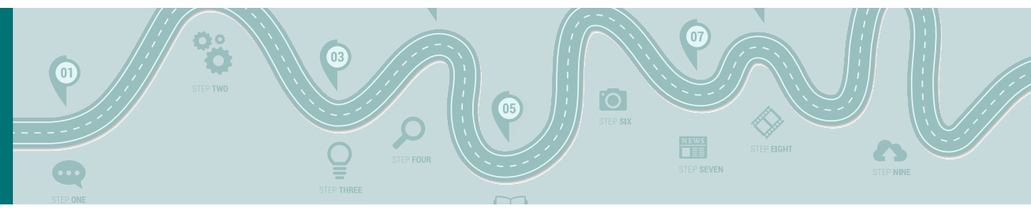
Figure 9

GHG Intensity by Mechanical Systems for Part 3 buildings
(average across all archetypes for Climate Zone 4)



BC's Electrification Opportunities & Challenges

Assessing the market readiness for building electrification requires a review of a market's ability to welcome in a new or less established technology, systems, and/or way of doing things.



Five criteria that have been used to characterize market readiness for energy efficiency technologies and that apply well to building electrification include the following:

1. Availability	Does the technology exist?
2. Awareness	Does the market know about the technology?
3. Accessibility	Does the market have access to the technology (e.g., it is supplied to local markets and building professionals and trades know how to design and install them)?
4. Affordability	Is the technology affordable (compared to a comparable alternative)?
5. Acceptance	Is the form, fit, and function of the technology acceptable as compared to what is already commonly used and expected by the market?

BC's new and retrofit markets for electrification were assessed using these five criteria, drawing on a combination of published studies of building electrification for the BC marketplace, interviews with BC-based subject matter experts, and feedback from a range of stakeholders in workshop and focus group settings.

While the data received was qualitative in nature (e.g., inventory surveys and costing analysis were not undertaken), there is a high level of confidence that the trends discussed below are an accurate reflection of the current BC marketplace for building electrification.

BC's Electrification Opportunities & Challenges

New Construction

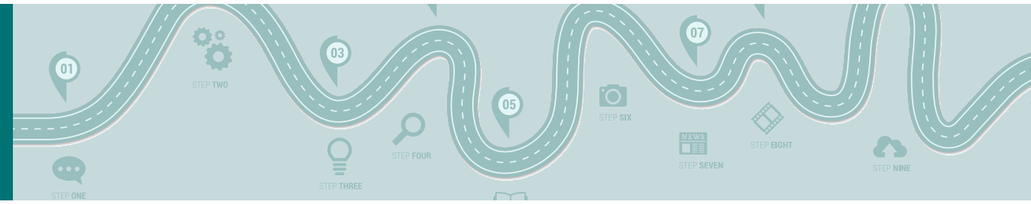


Table 3 provides a summary of the market readiness assessment for space heating and domestic hot water technologies in the new construction sector for ground-oriented residential buildings, apartment style residential buildings, including market rental and strata, and commercial and institutional buildings.

The data show BC's new building sector is in a strong position for achieving the vision of all new construction to use of high-efficiency electric equipment by 2028. Technologies for space heating are widely available and are increasingly improving, and the market is generally accepting of and able to make use of them.

Two significant advantages of high-efficiency electric solutions for new buildings is their reduced energy load requirements (as a result of the Energy Step Code and especially with regards to improved building envelopes), and their ability to meet the increasing demand for air cooling energy services in new buildings.

These conditions make it more straightforward for heat pumps to be used to adequately meet a building's heating load. The increased demand for cooling, meanwhile, helps to improve the cost competitiveness of heat pumps because a single mechanical system can serve both heating and cooling needs.

Table 3
Market readiness for building electrification in BC's new buildings by major building sector

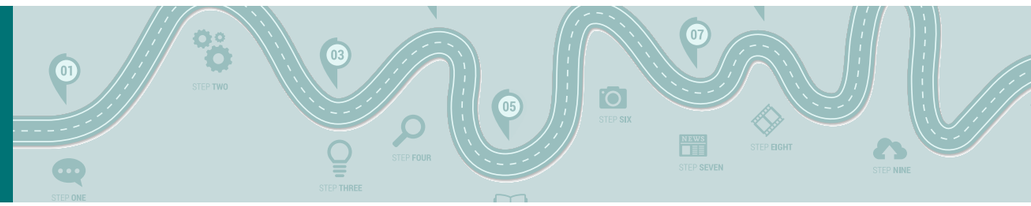
Market Condition	Space Heating			Domestic Hot Water		
	G	A	C	G	A	C
Availability	●	●	●	●	●	●
Awareness	●	●	●	●	●	●
Accessibility	●	●	●	●	●	●
Affordability	●	●	●	●	●	●
Acceptance	●	●	●	●	●	●

G: Ground-oriented residential
A: Apartment Buildings
C: Commercial & Institutional

● No significant barrier
● Moderate market barrier
● Major market barrier

BC's Electrification Opportunities & Challenges

New Construction



In terms of barriers, a general lack of awareness and demand for high-efficiency electric solutions are among the greatest facing the new construction sector. While buildings in BC's coldest climate zones may still face challenges in using air-source heat pumps for space and water heating, continued advancements in cold climate heat pumps continue to increase their overall feasibility

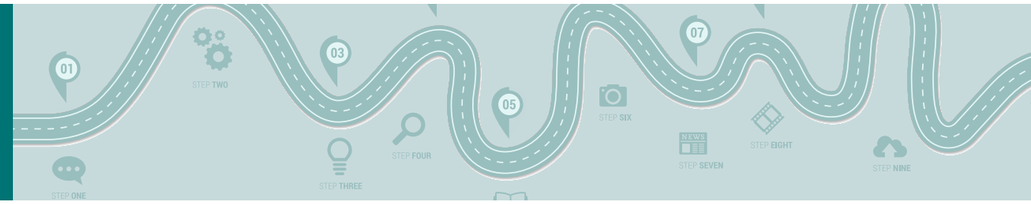
Geoexchange heat pump systems are also good options for cold climate electrification efforts. Domestic hot water represents a bigger challenge in terms of its level of awareness, accessibility, and affordability but technologies are available and continue to become more competitive.

Other specific barriers for electrifying the new construction sector include:

- Potential high electricity connection fees compared to natural gas and long process times
- Potential electricity capacity constraints, especially where a building is also installing electric vehicle charging stations
- A lack of awareness of high-efficiency electric solutions by HVAC contractors and other building professionals
- Limited technology options for certain applications (e.g., centralized domestic hot water for apartment buildings, air to water space heating systems, or specific sizes of equipment), and
- More onerous permitting process times and requirements for heat pump systems than buildings designed with conventional natural gas equipment.

BC's Electrification Opportunities & Challenges

Existing Buildings



A summary of market readiness for the existing building market shows significantly more challenges when it comes to transitioning the market to high efficiency electric equipment for space heating and domestic hot water (Table 4).

Like the new construction sector, technological solutions are available for most applications; however, the cost of providing these solutions, especially if additional energy efficiency upgrades are required, is still considerably higher when compared to simply replacing one fossil fuel system with another. This is especially the case where an existing system uses very hot water or steam, and/or is situated in a building with high heating loads.

In these cases, significant retrofits are often required before a high-efficiency electric system is feasible.

Table 4
Market readiness for building electrification in BC's existing buildings by major building sector

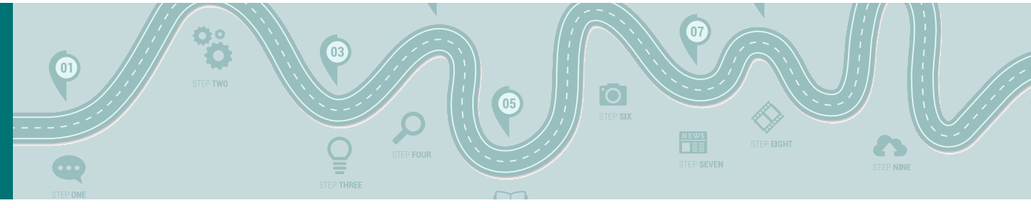
Market Condition	Space Heating			Domestic Hot Water		
	G	A	C	G	A	C
Availability	●	●	●	●	●	●
Awareness	●	●	●	●	●	●
Accessibility	●	●	●	●	●	●
Affordability	●	●	●	●	●	●
Acceptance	●	●	●	●	●	●

G: Ground-oriented residential
A: Apartment Buildings
C: Commercial & Institutional

● No significant barrier
● Moderate market barrier
● Major market barrier

BC's Electrification Opportunities & Challenges

Existing Buildings



In addition to a general lack of awareness, other barriers for electrifying existing buildings include:

- Potential for high electricity upgrade fees if a panel or transformer upgrade is required as well as the additional planning, effort and time needed to complete these
- The historically low rates for natural gas, a two-tier residential electricity rate that penalizes customers who consume more electricity, and a fixed demand charge for commercial customers that will increase if electrification leads to an increase in their building's peak load requirements
- Low level of interest and experience with high-efficiency electric systems among many HVAC specialists and buildings professionals – in most cases the easiest, quickest, least risky, and most profitable option is a "like for like" replacement
- Unexpected system replacements that need to happen in an emergency (e.g., a furnace failing in winter) leave little time to consider an alternative solution unless it was planned for in advance
- Low level of awareness / knowledge about electrification options and their benefits among building owners, developers, and the general population
- Few trained contractors and professionals to meet a potential increase in demand for electrical solutions
- Limited technology options for certain applications (e.g., hydronic hot water systems)
- Legal challenges in leaving long-term service agreements with district energy providers for commercial buildings

Will there be enough electricity for electrification?

A frequently raised concern with regard to electrification is the question of whether a sufficient supply of electricity will be available to support the simultaneous electrification of buildings and transportation.

Modelling conducted for the 2018 *CleanBC Plan* showed at that time that measures included in the Plan will require an additional 4,000 GWh of electricity over and above the projected demand, or approximately an 8% system-wide increase in capacity.

This increased demand is expected to be met using existing and planned clean, renewable power projects in the short term, but will require substantial additional volumes of new clean electricity to meet the Province's targets beyond 2030.[35]

A few different initiatives are currently underway that will provide insight over the next year into how increasing demand may be met.

1. The Province's **Phase 2 BC Hydro Review** has the objective of developing "recommendations that will strategically position BC Hydro for long-term success, while meeting the province's climate goals, keeping rates affordable for British Columbians, furthering reconciliation with Indigenous Nations, and supporting quality economic development."[36] Results of this review are expected by winter 2021.

2. BC Hydro's updated **Integrated Resource Plan** (IRP) will be filed with the BC Utilities Commission by September 2021. The IRP application will provide important information about the utility's projection for future load growth, as well as its options and preferred plan for addressing any potential supply gap. It is worth noting that one of the IRP's draft objectives is "reducing greenhouse gas emissions through clean electricity", which will be considered as part of the IRP's electrification analysis.[37] The IRP will therefore consider a range of electrification demand scenarios and the resources that may be advanced in response.

3. In June 2020, the Province announced its intention to remove BC Hydro's self-sufficient provision from the **Clean Energy Act**. The removal of this provision would provide BC Hydro with more flexibility to include clean electricity generated outside of the province in its upcoming IRP.

These and other key changes and resource planning documents will provide a better understanding of the likely resources that will be available to achieve broader electrification and its associated costs.

Will there be enough electricity for electrification?

In addition to these planning and policy initiatives, another important consideration for the availability of supply is the potential to integrate building electrification with distributed generation and localized capacity-based DSM solutions to reduce potential grid pressures experienced as a result of increased demand for clean electricity.

Capacity-based solutions may include building battery storage and other connectable devices and building energy management systems that can support grid management and flexible loads. Measures such as these will increase overall grid resiliency and smooth out the amount of power generated to meet peak demand.

More work will need to be undertaken, though, to understand what upgrades will need to be made to local distribution systems and standards developed to accommodate this kind of dynamic smart grid approach.

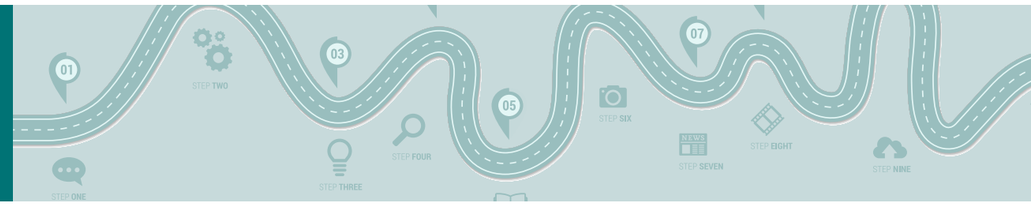
Overall, improving building energy efficiency performance will continue to play an important role in helping to manage the rate of electricity demand growth over the coming years. The high efficiency nature of heat pump technologies means that every gigajoule of fossil-fuel based space or water heating energy that is replaced by clean electricity will need only a quarter to a half as many electrically supplied gigajoules.

In a similar vein, the gradual replacement of electric resistance equipment with heat pumps will significantly reduce the energy demand of existing electrically heated homes, freeing up electricity for new load sources. Ongoing efforts to continually improve the minimum energy performance requirements of heat pumps and other technologies will therefore continue to be important for governments, utilities and industry to support.

Photo: iStock

BC's Rural Communities

New & Existing Homes



The market readiness of the new and existing building markets will certainly vary from one region to another, but apply somewhat equally for all urbanized regions of the province. In contrast, rural communities in BC represent their own particular blend of challenges and opportunities for building electrification, and warrant their own treatment.

For the purpose of the Road Map, rural communities are considered to be those that are connected to the provincial electricity grid, have a population of less than 30,000, and are located at a distance from major equipment supply and distribution centres.

Using these parameters, rural communities represent nearly 15% of the province's total population, or approximately 750,000 people.[38]

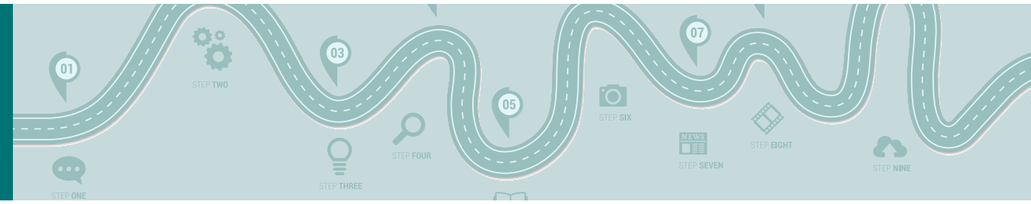
With respect to the type of homes being constructed and the energy sources used for space and water heating, there is little data available for new home construction in rural communities.

However, a review of local government adoption of the BC Energy Step Code shows that of the 66 local governments listed on the Energy Step Code website as "Consulting on the BC Energy Step Code", 23 are from communities that are considered rural as per the definition provided above.[39] Of these 23, only four – Kimberley, Sparwood, Rossland and Pemberton –currently reference the Energy Step Code in a policy, program or bylaw.

It is reasonable to conclude from these few statistics that there is likely considerable room for growth for high-efficiency electric new homes in BC's rural communities. That said, there are at least two all electric, high-efficiency apartment buildings that are either completed or under construction in rural communities, indicating some market penetration.[40] [41]

BC's Rural Communities

New and Existing Commercial & Institutional buildings



No data are currently available on market trends for new commercial and institutional buildings in rural communities. However, BC Hydro's Commercial End Use Survey represents some of the best data available for existing commercial and institutional sector buildings.

The fuel mix for space and domestic hot water for existing commercial buildings who participated in the survey and located in the province's southern interior and north show that other than domestic hot water use in the north (where electricity is widely used), natural gas is the more widely used fuel type for commercial space and water heating (Table 5).

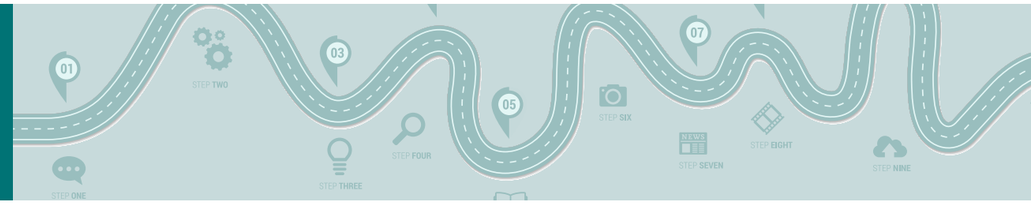
Table 5

Fuel Type Used for Space Heating and Domestic Hot Water (Commercial Sector)

Primary Source of Fuel	Southern Interior		North	
	SPACE HEATING	DOMESTIC HOT WATER	SPACE HEATING	DOMESTIC HOT WATER
Electricity	43%	32%	39%	55%
Natural Gas	44%	52%	55%	38%
Heating covered by another organization	7%	7%	10%	4%
Other	6%	2%	4%	2%

BC's Electrification Opportunities & Challenges for Rural Communities

New & Existing Homes



Overall, many of the opportunities and challenges for building electrification identified in the more general BC assessment above hold true for rural communities. However, distance from the market may create some additional barriers for accessibility and affordability, as well as other unique challenges:

- Rural communities in BC cover all six of the province's major climate zones. In general, communities located in warmer climate zones will generally have a wider selection of air-source heat pump technologies available to them than those in colder ones.

  Although cold climate air source heat pump technologies do exist, the number of manufacturers and models available are fewer across the province. Ground source heat pumps, by contrast, are available and well suited to all of BC's climate zones.

- Supply-related issues that are expected to exist include a lack of local warehousing, sales force, and equipment specialists trained in the design, installation, and maintenance of high-efficiency electric equipment.

  These issues can make it more difficult for people and businesses in rural communities to purchase, install and have regular maintenance and repairs completed for some technologies and brands.

- Increased shipping requirements may increase prices in some circumstances.

- Back up and/or peak-load space heating options will especially be important in colder climate zones and rural areas which may experience more frequent power outages.

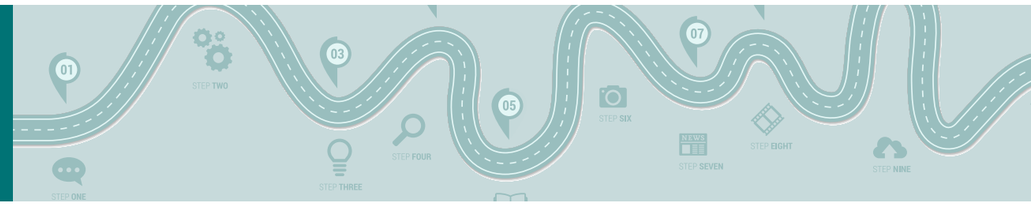
Special consideration will need to be given to communities in colder climate zones to ensure safe and secure heating during extreme cold events.

On the plus side, closer knit communities increase opportunities to rapidly build awareness and train local contractors, home builders and distributers of technologies at the same time. Similarly, close relationships between contractors and builders can also provide opportunities for accelerated training and market influence.

These features can also provide an opportunity to test new approaches for program messaging and rapid delivery at a community scale.

BC's Electrification Opportunities & Challenges for Rural Communities

New & Existing Homes



For existing homes, data collected for BC Hydro's Residential End Use Survey provides a breakdown of different housing types in BC's southern interior and north (Table 6), and shows that single detached are the most prevalent in these regions followed by "other", apartments, and single attached (e.g., duplexes and rowhouses).

Homes represented in the "Other" category tend to be permanently parked mobile homes, recreations vehicles and travel trailers that take direct electrical service.[42]

A breakdown of the energy mix used in residential buildings in the southern interior and north shows that fossil fuels are used by over 60% of households for space heating (Table 7). For domestic hot water, this figure is 50%, but it likely higher as most central DHW systems are also fossil fuel based. Such numbers also show considerable room for fuel switching in the existing rural residential building sector.

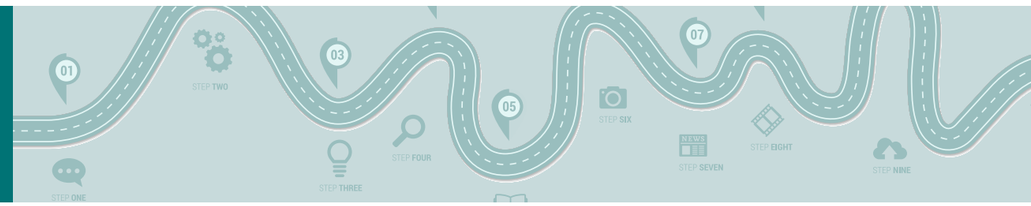
Table 6 Distribution of Residential Housing Types in BC's Southern Interior and North

Housing Type	Southern Interior	North
Single Detached	66%	68%
Single Attached	10%	7%
Apartments	12%	11%
Other	12%	14%

Table 7 Fuel Type Used for Space Heating and Domestic Hot Water (Residential Sector)

Primary Source of Fuel	Southern Interior		North	
	SPACE HEATING	DOMESTIC HOT WATER	SPACE HEATING	DOMESTIC HOT WATER
Electricity	30%	39%	24%	45%
Natural Gas	56%	49%	58%	45%
Propane	4%	2%	2%	1%
Oil	1%	<1%	3%	0%
Wood	9%	0%	12%	0%
System not in home (centrally provided)	N/A	9%	N/A	7%
Other	5%	1%	1%	2%

Summary of the Current State of BC's Building Electrification Market



The trends presented above show that from the perspective of market size and technological availability, there is considerable potential for building electrification in BC.

In the short term, the new building sector has a number of advantages over existing buildings, including the potential for integrated, high-efficiency building design, the normalization of cooling loads, and more competitive capital costs.

While challenges do exist in ensuring sufficient industry capacity to meet rapidly growing demand for electrified buildings, building electrification is nevertheless well positioned for a market transformation in the coming years.

Existing buildings undoubtedly present a greater challenge overall for efficient building electrification. This is especially the case where high-efficiency electric solutions are applied to building systems originally designed for higher-temperature and quick response fossil-fuel based mechanical systems.

In cases where a building's existing heating loads fall comfortably within the range of heat pump operating systems, the exchange of one system for another can be reasonably straightforward.

However, if broader building system improvements are also required (such as envelope and heat recovery upgrades), the complexity and costs associated with a fuel switch may quickly become prohibitive under current market conditions.

In the short term, efforts are likely best directed to building market awareness, improving the cost-competitiveness of high-efficiency electric technologies compared to natural gas alternatives, collecting data that can be used to identify and eventually customize programs to target lower barrier market niches, and using these as a platform for broader training, awareness building and acceptance.

Table 8

Summary of Market Barriers to Electrification

MARKET CONDITION	CURRENT BARRIERS
Availability	• Low motivation of manufacturers and vendors to bring leading-edge proven technologies to the North American market because of its perceived current small global market share, slow rate of growth, equipment certification processes, and the various market related costs associated with bringing these technologies to a new market (new and existing)
Awareness	• Very low general level of awareness about the benefits of electrification that translates into low market demand (new and existing)
Accessibility	• A lack of awareness of high-efficiency electric solutions by HVAC contractors and other building professionals (new and existing) • Low level of interest and experience with high-efficiency electric systems among many HVAC specialists and buildings professionals – in most cases the easiest, quickest, and least risky, is to install a natural gas system (new and existing) • The rate of technological change for high-efficiency electric space and water heating equipment is higher than conventional natural gas equipment, requiring increased effort by professionals and trades to stay abreast of new technology developments (new and existing)
Affordability	• High electricity connection fees and process times compared to new gas connections (new) • High electricity upgrade fees where a panel or transformer upgrade is required (existing) • High efficiency electric systems often have a higher capital cost than comparable natural gas ones (although these costs are reduced when space cooling services are also taken into account) (new and existing) • Low cost of natural gas compared to electricity (new and existing) • Electricity rates that increase for higher use (“Tier 2”) residential customers and higher peak demand for commercial customers (new and existing)
Acceptance	• Electricity capacity constraints, especially where a building is also installing electric vehicle charging stations (new and existing) • More onerous permitting process times and requirements for heat pump systems than buildings designed with conventional natural gas equipment (new) • System replacements that are rushed after an existing system has unexpectedly failed, leaving little time to consider an alternative solution unless planned for in advance (existing) • Legal challenges in leaving long-term service agreements with district energy providers for commercial buildings (existing) • The high energy loads associated with certain kinds of existing mechanical and building envelope systems (i.e., high temperature hot water and/or inefficient building envelopes) require a whole building approach (e.g., deep retrofit, heat recovery) to be undertaken as a prerequisite for electrification (existing) • Designers and contractors perceive higher levels of financial and legal risk when a client installs a high-efficiency electric system instead of a natural gas one (new and existing)

Strategies & Actions

Effectively addressing the barriers to market transformation and a widespread adoption of building electrification will require a concerted effort on the part of multiple stakeholders across the province. It will also require careful coordination to ensure a wise use of resources, reduce the potential for increased burden or costs to home and building owners and tenants, and ensure the benefits of electrification are reaped equally across BC's communities

The Building Electrification Road Map outlines these core recommended actions, building on five key strategies that will need to be simultaneously pursued to significantly accelerate the uptake of high efficiency technologies over the next ten years.

It is important to consider these recommended strategies as a complete package with each one reinforcing the others. For example, actions taken to reduce the capital and operational costs of installing a high-efficiency electricity system will increase the demand for these systems.

Similarly, as demand increases, so will the interest by industry to become more knowledgeable about these systems, thereby increasing industry capacity. In other words, each piece of the recommended strategy should reinforce and complement the others. Appendix B contains a complete list of the Road Map's strategies, objectives, and actions.

KEY STRATEGY		OBJECTIVE
1	Create Market Demand	• Demonstrate provincial leadership through messaging and market signals • Raise levels of consumer awareness about the benefits of electrification • Establish GHG performance and climate resilience requirements • Require building energy and GHG performance reporting and disclosure • Set a minimum energy performance standard of co-efficient of performance (COP) > 1 by 2035 for space and water heating equipment
2	Improve Cost Competitiveness	• Reduce equipment and whole building capital costs • Level the playing field between natural gas and electric operational costs • Reduce electricity connection and system upgrade fees • Address housing affordability and building electrification • Reduce transactional costs for consumers
3	Address Systemic Barriers	• Reflect high-efficiency features more accurately in property appraisals • Reduce landlords' legal barriers to undertake electrification retrofits • Ensure buildings connected to district energy systems can decarbonize • Improve access to capital • Reduce permitting complexity and time for new heat pump systems
4	Expand Industry Capacity	• Expand the electrification sales force • Improve building electrification awareness, coordination, and advocacy • Build industry knowledge and competence • Expand the use of trade certifications and energy performance guidelines • Support growth in the number of people in the building electrification trades sector
5	Increase Available Technologies	• Support the development of building and equipment standards • Accelerate the certification of promising new technologies • Support the introduction of already certified technologies • Accelerate the adoption of low Global Warming Potential refrigerants • Expand the North American market for building electrification

KEY STRATEGY #1 Create Market Demand

A critical early priority of the Road Map is to create a sustained market demand for high-efficiency electric buildings, and to ensure that this demand is matched with ongoing improvements in the four other strategic areas. Demand is created through a combination of consumer awareness building on the benefits of high-efficiency electric space and water heating options, consistent government messaging of the intention to gradually limit GHG emissions in buildings backed by regulatory action, and the collection and dissemination of building-level energy data and opportunities to reduce energy and GHG emissions.

OBJECTIVES	Targeted Actions
Demonstrate Provincial leadership	**1.1** Announce and set provincial commitment **1.2** Lead with public sector buildings **1.3** Establish a key role for BC Hydro
Raise levels of consumer awareness	**1.4** Undertake a broad public awareness-building campaign, targeted to homes and businesses about the options and benefits of electrification
Establish GHG performance and climate resilience regulatory requirements	**1.5** Set and enact GHG requirements for the Energy Step Code **1.5** Set and establish GHG performance requirements for existing buildings **1.6** Enable municipal leadership for GHG requirements & other measures
Require building GHG performance reporting & disclosure	**1.7** Establish mandatory home energy labelling that includes both energy and GHG emissions performance **1.7** Establish mandatory building benchmarking that includes both energy and GHG emissions performance
Set minimum performance equipment standards	**1.8** Set a co-efficient of performance of greater than one (COP > 1) as the minimum energy performance standard for all space and water heating equipment by 2035, in alignment with the Federal Government's aspirational market transformation goal

Demonstrate provincial leadership

The Province has legislated a 40% province-wide reduction in GHG emissions by 2030 and 80% reduction by 2050 over 2007 levels. As indicated in the CleanBC Plan, wide-scale electrification of the industrial, transportation, and building sectors will be necessary to achieve these targets. Of these three sectors, solutions for building sector electrification are arguably the most readily available and should therefore be pursued as quickly as possible to help ensure that the province's economy-wide targets will be achieved.

Despite the many benefits of building electrification, including its high potential to significantly reduce GHG emissions in the province, existing market conditions in BC do not favour building electrification or low-carbon building energy systems more generally. Many different factors contribute to this problem, including entrenched investments in fossil fuel resources, infrastructure and supply chains; consumer and building industry technology path dependence that favours the continued use of familiar natural gas systems; the low cost of natural gas compared to electricity; and the challenges associated with translating public concern about climate change into meaningful and permanent change.

In short, if left to its own devices, the current market will not make the necessary changes needed to drive significant reductions in GHG emissions over the next few years.

Action 1.1

It is recommended that the Provincial government show **strong and sustained leadership**, including establishing firm and successive building sector GHG reduction targets for both new and existing buildings over the next 30 years. It is further recommended that the targets should align with all new buildings in BC to be near zero-emissions by 2028 and for all existing buildings to be near zero-emissions by 2045.

The concrete strategies and actions included in the Road Map provide a clear pathway for getting us there. Progress towards these targets will need to be monitored and publicly reported on a regular basis to help ensure change is taking place at a rate that is consistent with these targets and to provide opportunities to adapt the plan to achieve them if we are not. The targets and the province's commitment to take the actions needed to achieve them should be signalled as early as possible to consumers and industry to ensure both certainty and cooperation about where we're heading and what we will need to do to get there together.

Demonstrate provincial leadership (cont.)

Action 1.2

The Province can demonstrate **public sector leadership** to industry and provide an early market for building electrification by adopting GHG performance requirements for public sector buildings in advance of province-wide building requirements. These recommended actions will support the CleanBC target to reduce public sector building GHG emissions by 50% by 2030.

Local governments can help lead the transition to electrification of public sector buildings by adopting stringent corporate policies that are in line with their Climate Action Charter commitments of becoming carbon neutral in their corporate operations. To help with the implementation of these policies, public procurement standards and template processes can be developed so public building owners can easily and cost-effectively incorporate electric solutions in their projects.

The Provincial Government has been reviewing the role of BC Hydro in CleanBC implementation as part of their Phase 2 Government Review. At the time of writing, results and recommendations of the review have not been issued. Industry and local government stakeholders are seeking more information on how BC Hydro is supporting electrification and what additional Provincial direction will be given to the utility in order to help the utility further drive electrification.

To date, BC Hydro has been administering CleanBC incentives on behalf of the Province, undertaken market pilots, and has worked with regulatory organizations on policy and code opportunities. Stakeholders voiced support for the Province to direct and empower BC Hydro to work further in the realm of building electrification, including supportive rates fees and connection processes.

Action 1.3

The Province should further direct utilities to drive and enable building electrification in a timeline and scale that is consistent with the Province's climate goals, including supportive rates, fees and connection processes.

Raise levels of consumer awareness

A major challenge facing building electrification is a general lack of public, consumer and industry awareness about the opportunities and benefits of high-efficiency electric systems over fossil-fuel based systems.

Action 1.4

Significant efforts to **raise awareness** about the benefits of high-efficiency electric solutions over fossil-fuel based space and water heating are necessary. It is recommended that the level of promotion required by governments and electric utilities should at least match that used by natural gas utilities to promote the benefits of their product. Included in this messaging should be information about environmental and resiliency benefits of electrification over fossil fuel use. Most electrification messaging to date in BC tends to avoid these topics, but they represent key rationales for switching to electricity.

Establish GHG performance & climate resilience regulatory requirements

Factors such as strong consumer and industry familiarity with fossil fuel space and water heating systems, entrenched natural gas technology and building systems, the low cost of natural gas relative to electricity, and low consumer awareness about and demand for low-carbon space and water heating systems all result in little motivation on the part of consumers and the building sector to actively seek or provide solutions to reduce GHG emissions from building operations.

Action 1.5

It is recommended that the Province establish province-wide **near-zero GHG and climate resilience regulatory requirements** for all new and most existing buildings. A clear and well-communicated commitment by the Province will help to focus and prioritize market and government building electrification activities. Without these kinds of strong and sustained regulatory markers in place, it is unlikely that the market will move quickly enough on its own to achieve widespread electrification and other building decarbonization measures in a timeline that is consistent with provincial targets.

Establish GHG performance & climate resilience regulatory requirements (cont.)

Action 1.5 (cont.)

GHG emissions requirements should be performance-based to ensure maximum flexibility across industry and supported by building level performance data. New requirements should reflect important differences between major building types, especially as they pertain to the existing building sector and its diverse range of building vintages and systems. They should also consider regional differences that exist across different areas of the province, as well as changes in climate.

Minimum targets should be set well in advance of their effective date and be clearly communicated to consumers and industry to give them ample time to prepare and respond well in advance. Targets should also be scaled up incrementally over time to help ensure both a smooth transition as well as steady market activity toward near-zero emissions buildings.

Although more work will need to be done before final targets can be set, many stakeholders expressed that **a province-wide near-zero emissions requirements for new construction by 2028 and 2032 for most existing buildings** seemed reasonable given a) the province's climate targets, and b) the market readiness assessment completed in Chapter 2 of the Road Map. As evidenced by the work that preceded the establishment of the BC Energy Step Code, setting an appropriate timeline and requirements for zero or near-zero emissions buildings will take time and require in depth engagement with a wide range of actors. It is therefore critical for this work to begin as soon as possible.

Wherever possible, efforts should be made to make it straightforward for a building's owner to comply with a new performance threshold well in advance of it coming into effect. When this is not possible, the requirement should be flexible enough to allow equipment upgrades in non-compliant buildings to take place at or near their natural end of life. Non-compliance fees collected could be used to administer the program and/or support affordable housing building electrification programs throughout the province.

In addition to GHG emissions, information shared and collected as a result of the climate performance regulation should also look for opportunities to promote and encourage upgrades that will increase the building's resilience to predicted changing climate conditions (e.g., more hot weather days). For new buildings this can be easily addressed by the BC Building Code. For existing buildings, climate resilience improvements will likely be voluntary for the foreseeable future for most building types and uses. However, building performance data collected as part of a regulation will make it easier to see how buildings perform under different conditions. Over time, this will allow the highest priority opportunities for improved climate resilience to be identified and advanced.

Given the diversity of climate zones, local capacity, and building types across the province, some local governments in BC will be more ready than others to adopt more ambitious GHG reduction requirements sooner than the province-wide targets discussed above. Early leadership by local governments is important because it helps ensure that municipal governments are able to achieve their own GHG targets; encourages quicker adoption of province-wide requirements by demonstrating to all levels of government and stakeholders how these policies can be effectively used; and builds important industry capacity and market demand for building decarbonization solutions.

Action 1.6

The Provincial Government should **enable and support local governments** to opt into adopting more stringent GHG emission requirements for new and existing buildings earlier than the scheduled province-wide timeline. At the same time, it will need to ensure special support is provided to those regions of the province where uptake of the new requirements will likely face the biggest challenges.

Require building GHG performance reporting & disclosure

The development and implementation of a GHG performance regulation for new and existing buildings will be predicated on the ability to receive good quality building performance data. At present, there is virtually no reliable building-scale data on energy performance and energy-related building assets in British Columbia. The most extensive publicly available data source is National Resources Canada's (NRCan) Comprehensive Energy Use Database but this relies heavily on modelling extrapolations from self-reported surveys and other generalized data sources. Utility data could provide more accurate building-level information, but they are heavily protected in BC because of privacy concerns. This lack of high-quality building and market data makes it extremely difficult to accurately understand the current state of the market and to pinpoint and communicate opportunities for improved efficiency and electrification.

Action 1.7

Mandatory home energy and GHG performance labeling and building benchmarking that include information about GHG emissions are foundational steppingstones on the path to building electrification. There are currently no requirements in BC for either home energy labelling or building benchmarking. However, in November 2020 the Premier's mandate letter to the Minister of Finance included direction for the Minster to work with the Minister of Energy, Mines and Low-

Require building GHG performance reporting & disclosure

Action 1.7 (cont.)

Carbon Innovation to require realtors to provide energy efficiency information on listed homes. If implemented, this would be an important step forward for home energy labelling in the residential sector. It is also recommended that GHG information be included as part of the disclosed package of information.

Unfortunately, there was no similar direction provided for mandatory disclosure of building energy scores for existing commercial and institutional buildings. As a first step, it is recommended that the the Provincial Government enable local governments to opt into mandatory building benchmarking programs for their communities and to support the collection and dissemination of data for this purpose. As a second step, the Provincial Government should set a timeline for province-wide implementation of mandatory reporting requirements for all homes and buildings.

The launch of a province-wide requirement would ideally take place at least two years prior to the first tier of a provincial GHG building performance requirement for buildings coming into effect. The early provision of this information would help to establish a reasonable minimum requirement for the regulation and provide building owners with an indication about whether they will need to make upgrades in order to comply with the ensuing regulation.

For existing home and building owners, these tools provide important feedback about their building's energy and environmental performance. For prospective buyers, renters and leaseholders, they provide a way for the market to differentiate between varying levels of performance and value them accordingly. For utilities and governments, they provide critical market data that can be used for more accurate and targeted program and policy development, as well as to track progress towards the sector's building electrification goals.

In the case of GHG performance requirements for existing buildings, early data collected from these tools will be critical to establishing reasonable performance requirements for different building classifications and geographies. Once implemented, they will also likely play a foundational role in ensuring compliance with a minimum performance standard. For new construction, mandatory home energy labelling and setting up building benchmarking profiles would allow a baseline for new buildings to be established and tracked over time in terms of trends in installed space and water heating systems.

Platforms used for home performance labelling and benchmarking should strive to be both accurate and cost-effective. For complex Part 3 buildings, Energy Star Portfolio Manager (ESPM) is a strong candidate as it is relatively straightforward to set up and use. It is also already used by several jurisdictions in Canada and the United States for mandatory energy performance reporting. New York City is currently using ESPM to regulate its minimum energy performance requirements and the Cities of Washington and Vancouver are planning to follow suit.

For smaller residential buildings, technology advances are making cost-effective virtual energy and emissions rating schemes possible that require few, if any, direct inputs from a homeowner or an in-person energy audit. The City of Vancouver is currently working with Natural Resources Canada to pilot a Virtual Energy Rating System (VERS). Vancouver has indicated that once tested, the VERS could serve as the initial emissions compliance metric for its planned GHG performance regulation. The same or a similar system could act as the information backbone for province-wide home energy labelling and GHG performance requirements.

Set minimum performance equipment standards

The recommended province-wide adoption and enforcement of GHG performance regulatory requirements, along with other measures included in the Road Map, will ensure that by 2030 most new space and water heating equipment installed in British Columbian homes and buildings will be low-carbon energy systems of one kind or another. However, as long as it is possible to purchase conventional fossil fuel equipment, there is a risk that a portion of owners will continue to install equipment that will be out of compliance with the provincial GHG performance requirement long after 2030.

Action 1.8

To help ensure full compliance with the province's GHG emissions objectives for the building sector, it is recommended that the Province and the federal government should continue to work together to adopt **energy efficiency standards by 2035 that will require nearly all space and water heating equipment sold in British Columbia to have a co-efficient of performance (COP) that is greater than one (COP >1)**. In practice, this standard will allow only heat pump technologies (electric or natural gas) to be installed in BC after this date.

It is important to note that equipment standards typically require a significant proportion of the market to already be using a technology that complies with the proposed standard before it is given serious legislative consideration. Given this, it will be essential to build up the heat pump market well in advance of a COP >1 equipment standard coming into effect. This standard should therefore be considered as a backstop action by the Province rather than a leading one.

KEY STRATEGY #2 Improve Cost Competiveness

There are a number of cost related barriers that will need to be reduced over the coming years, especially for existing buildings, before building electrification technologies can compete more directly on economic terms with natural gas space heating and domestic hot water systems. As high-efficiency electric equipment and whole building solutions become more widely understood, used, and demanded, some of these cost-related barriers will likely be reduced. Similarly, as more energy efficient and cost competitive technologies are introduced to the BC market, the cost differential between fossil fuel and high-efficiency electric options will become more competitive. In the interim, it is recommended that steps be taken to level the economic playing field between these competing systems. Through the stakeholder engagement process, the Road Map has identified at least five objectives that should be pursued to help improve the cost competitiveness of building electrification.

OBJECTIVES	Targeted Actions
Reduce equipment & whole building capital costs	**2.1** Incentives & low-cost financing
Level the playing field between natural gas capital and operational costs	**2.2** Review & update utility rates accordingly **2.3** Work with standard-making organizations to advance metering devices that can support electrification rates **2.4** Continue carbon pricing on fossil fuels **2.5** Phase out fossil-fuel equipment incentives
Reduce electricity connection and system upgrade costs	**2.6** Review & update utility processes accordingly **2.7** Review & update the Canadian Electrical Code to optimize minimum electrical servicing requirements **2.8** Integrate whole building design with utility demand management
Address housing affordability and building electrification	**2.9** Establish low-income electrification plan and programs
Reduce transactional costs	**2.10** Support a Retrofit Coordinator Program **2.11** Help home and building owners to prepare for a fuel switch well in advance **2.12** Improve the response time for electrical service delivery

Reduce equipment and whole building capital costs

The installed capital cost of high efficiency electric mechanical systems and whole building solutions are frequently higher than natural gas alternatives. Unless the additional costs can be captured through energy savings, it is difficult for many consumers to justify the added cost of using an electric system.

Action 2.1

Incentives to help offset the incremental capital cost of high-efficiency electric solutions are critical to the success of electrification efforts in the near term, especially for existing buildings. However, as the cost differential between natural gas and electrification systems narrows, the need for incentives will diminish. The existing CleanBC fuel switch incentives offer a good start in this regard,[43] but to make these incentives more effective in terms of their uptake, incentive amounts should be increased and expanded to include **whole building electrification solutions**. This is especially important for older existing buildings, as their overall heating loads will likely require significant reductions before high-efficiency electric solutions become a realistic option for them to consider. To help accelerate the uptake of equipment with low GWP, incentive programs should, wherever possible, stipulate a low GWP requirement and/or provide a higher incentive for low GWP technologies.

In addition to the taxpayer-based CleanBC incentive program, the Provincial Government needs to explore **other funding mechanisms for supporting building electrification incentives**. Additional funding measures will help to increase the resilience of incentives in the market and ensure greater market stability for building owners, contractors, and other key industry stakeholders.

Level the playing field between electric & natural gas operational costs

In BC, one gigajoule of electricity is approximately three times more expensive than a gigajoule of natural gas. This means that high-efficiency electric systems need to operate, on average, three times more efficiently than equivalent natural gas systems in order for the operating costs of both systems to be equivalent. Although this level of efficiency is possible to achieve, it is difficult for many systems to maintain throughout the year.

Level the playing field between electric & natural gas operational costs (cont.)

For BC Hydro's residential rate class customers, this rate differential is compounded by its two-tier rate system, originally created to encourage conservation by applying a higher rate after a certain threshold of energy consumption is reached. For dwellings that convert from natural gas to electricity for their heating loads, the jump in electricity consumption could bump a portion of their energy usage load into the higher rate tier.

Action 2.2

To address these issues, stakeholders identified the need for an **"electrification" rate** where a portion of the building's electric load can be attributed to its new, low-carbon heating demand. BC Hydro could also consider reverting back to a single-tier rate structure to ensure electrified buildings are not paying a higher rate than ones that use fossil fuels. In the short term, **BC Hydro should review its rate structure** to assess how it can be designed to encourage electrification, followed by the development of rate design options to better support building electrification through an application to the BC Utilities Commission (BCUC).

Action 2.3

Metering technologies exist that can differentiate between electricity loads within a building and could be used by BC Hydro and other electric utilities for the purpose of implementing an electrification rate. However, before these technologies can be approved for use by utilities, they will need to be certified for this purpose by Measurement Canada in order to demonstrate to the BCUC their accuracy and consistency for use in this way.

BC Hydro, the Provincial Government and other key stakeholders should work with Measurement Canada to **certify metering equipment** that could be used by utilities to implement an electrification rate, including amending the relevant metering standards/policies to enable "purpose of use" metering. The electrification rate could then be applied to the proportion of a building's space and water heating load that is the result of a fuel switch to electricity from a carbon-intensive energy source.

The negative environmental and health impacts of fossil fuels are not adequately reflected in their price. The 2006 Stern Review by British economist Nicholas Stern, estimated the social cost of carbon at approximately CAD$120 per tCO2 in today's currency. BC's carbon tax currently sits at CAD$40 per tCO2e which equates to $2.00 per gigajoule of natural gas.

A recent World Bank study shows that there are over 60 carbon pricing initiatives in place or scheduled for implementation across the world. The rate of pricing varies widely across these countries, with roughly three quarter of the initiatives listed falling below the BC carbon tax rate. The highest rates are found in France, Norway, Finland, Switzerland, and Sweden and range from about CAD$64 per tCO2e in France to CAD$155 per tCO2e in Sweden. By way of comparison, both Metro Vancouver and the City of Vancouver use an internal carbon price of $150 per tCO2e. The Canadian Federal Government, meanwhile, announced in December 2020 a policy to increase the federal carbon tax to $170 per tCO2e by 2030.[47]

Action 2.4

The Province should continue to **increase the carbon tax** in BC to a level that properly reflects the social cost of carbon in the price of fossil fuels. In doing so, it should continue to ensure that measures are taken to minimize the burden of the increased tax on lower income individuals and families.

Action 2.5

It is recommended that the Province **phase out incentives on fossil fuel space and water heating equipment** offered through the CleanBC program by the end of 2021 and utility energy efficiency programs by the end of 2022. These incentives artificially reduce the cost of natural gas equipment and encourage the continued and expanded use of fossil-fuel heating equipment. Fossil fuel equipment efficiency should be instead driven by continuing to increase minimum energy performance requirements for this equipment through the Canadian Energy Efficiency Regulations, the BC Energy Efficiency Standards Regulation, and the BC Building Code.

Incentives for buildings that use fossil fuels should instead target building scale efficiency gains that reduce their total heating demand load. These building efficiency incentives will have the effect of reducing GHG emissions in the short term and preparing these building for electrification at a future date.

Reduce electricty connection & system upgrade costs

Electricity connections and upgrade fees that result from buildings that use electricity for all of their space and domestic hot water needs can pose a significant additional cost to electrified buildings. This issue is further compounded by a push to provide electric vehicle charging stations in homes and buildings.

BC Hydro's Electric Tariff currently includes provisions to recover the estimated cost for distribution system additions or upgrades to meet a customer's request for new or increased service. Under the current policy, the first party requesting new or upgraded service carries most of the distribution system upgrade costs, even though subsequent customers may benefit from this work. While there may be an opportunity for building owners to recover funds from BC Hydro associated with subsequent customer connections, these recoveries are generally not proportional to the original investment.

For large buildings, the distribution system upgrade costs associated with accommodating additional building electrification loads can be significant. However, the scope of distribution system upgrades and the associated costs cannot be confirmed until the building's electricity supply requirements and in-service date are known, which typically happens later in the project lifecycle. This is another electricity supply issue raised by larger building participants leading to their inability to estimate the total electrification costs at an early stage of a project. The default strategy to minimize this uncertainty is to specify fossil fuel based mechanical systems. This current status quo is clearly counter to the goals of the Building Electrification Road Map.

For smaller residential customers, concerns were similarly raised about the cost of connection and upgrade fees (especially compared to natural gas). BC Hydro's current connection policy includes fixed connection fees for service requests up to 200A per lot. For service requests beyond this threshold, the customer may also be required to pay distribution system upgrade costs. For residential customers looking to switch from natural gas to electricity for space and water heating and potentially electric vehicle charging, the possibility of having to first pay hundreds or even thousands of dollars to upgrade their existing electrical panel followed by BC Hydro service upgrade fees, can be enough to make a homeowner decide against the switch. The $500 incentive from CleanBC to offset this cost was identified as a positive short-term step but does not alleviate the need for a more permanent solution.

Action 2.6

It is recommended that BC Hydro **review its fee structure for connections and electrification-ready upgrades** in large buildings to assess how they can be designed to encourage electrification. This should be followed by the development of options to minimize upfront costs for electrification customers and to provide greater cost certainty for large projects through an application to the BCUC.

Action 2.7

The Canadian Electrical Code (CEC) has strict requirements for electrical service sizing. The systemic over calculation of minimum electric service requirements, when it exists, results in inefficient use of a building's electrical equipment, and can significantly, and unnecessarily, drive up the cost of an electric system connection and/or upgrade. To ensure that the CEC is not routinely requiring capacity service levels that far exceed the actual load demand of buildings, federal, provincial and municipal code writers need to work closely with utilities to regularly **review and update the methodology used by the CEC to calculate minimum conductor ampacities** for consumer's services, feeders and branch services. The calculations used should also take into consideration the availability of utility and behind the meter (customer owned) automated load controls as a tool to manage and help shape a building's maximum load demand to ensure maximum allowable loads are not exceeded.

Action 2.8

The building design community needs to **take a whole building design approach** for building electrification. Buildings designed to use more consistent levels of electricity over the course of an entire day will have lower electricity capacity needs than similar buildings with large spikes in demand. The integration of practices such as efficient envelopes, heat recovery, thermal and battery storage, and the slow but steady use of heat pumps should therefore be of paramount consideration for building electrification projects. This will help to minimize a building's total capacity requirements, reduce the need for electrical upgrades, and optimize the operating parameters of heat pump systems. When blended with utility demand management, these measures have the potential to completely change how electricity is distributed, stored and used in BC's communities.

Address housing affordability & building electrification

The high cost of housing in BC is an ongoing and prominent issue across the province, and one that could be exacerbated by electrification efforts if not approached with care. Lower-income households may be unable to pay for building electrification upgrades, and as such would have disproportionately low access to the various climate, health, and resilience benefits associated with these upgrades. Low-income households also run the risk of being unintentionally in violation of future GHG performance requirements where they are unable to afford the upgrades needed. Finally, the risk of higher utility bills where the energy efficiency savings from an electrified system are insufficient to cover the higher per unit cost of electricity may push some households further into debt or energy poverty.

Action 2.9

As a first step to ensuring that all British Columbians can participate in and benefit from building electrification, the Province, utilities and other key stakeholders must work together to establish an **affordable housing electrification strategy**. Many lessons can be taken from the work already being undertaken by BC governments and utilities to address energy efficiency in the affordable housing sector. A recent study by Ecotrust Canada provides a good summary of major energy poverty issues in the province and recommendations for updating existing bill protection measures.[48] Inspiration can also be drawn from jurisdictions such as the State of California, which are investing heavily in customized, low-carbon programs for the affordable housing sector.

Reduce transactional costs

Transactional costs generally refer to the time and effort it takes to research a problem, identify and select a preferred option, find and hire someone to implement the option, oversee the project and fill out any paperwork along the way. For many individuals and organizations, the effort needed to effectively carry out these tasks means that many good intentions to do something differently will simply never get implemented. In the case of building mechanical systems, the transactional costs are amplified by the novel technical nature of the problem and the risk assumed by the relatively high financial cost of the project.

Action 2.10

To reduce transactional costs, the Province and/or its key partners should establish a no- or low-cost program to provide several **retrofit coordinator or "concierge" services** to homeowners and less sophisticated building owners, including unbiased suggestions to homeowners, less sophisticated building owners, and small developers about their electrification options; a straightforward way to find and hire qualified and trusted contractors to undertake the work, and an easy and quick way to apply for incentives or financing. The CleanBC Energy Coach program and FortisBC's Residential Apartment Efficiency Program (RAP) are examples of how some of these services are already being offered in the BC marketplace. To align with the ambitious scale of electrification necessary to meet provincial targets, the scope and scale of these programs, especially the CleanBC Energy Coach, should be significantly increased over the next few years.

Action 2.11

Wherever possible, utilities, local governments, and retrofit coordinators need to work with homeowners and less sophisticated building owners to **establish an electrification plan well in advance** of the time that existing space and water heating equipment needs to be replaced. The replacement of existing space and water heating equipment is often not given much thought until it fails. The natural replacement cycle of existing fossil fuel equipment is the best time for a building to electricity. However, if the fuel switch requires complementary service upgrades to be made at the same time (e.g., electrical panel upgrade, ducting improvements, heat recovery), additional time to plan and install will likely be needed. If the equipment fails during an emergency situation (e.g., a furnace fails in winter), there may be in sufficient time to do the planning and upgrades needed to electrify.

Action 2.12

Effort needs to be made by electric utilities and local governments to improve their response time for providing service upgrades and permits to new and existing projects that require it for building electrification. Projects that require electric service upgrades are more complicated in the sense that they need additional trades and interactions with its electric utility provider. If there is a potential for electric upgrades to lead to significant project delays and/or complexity, there is a risk that the project team will decide to forgo building electrification measures in favour of natural gas or other sources of heating if it means the project does not need to wait for electrical service upgrades.

KEY STRATEGY #3 Address Systemic Barriers

Systemic barriers represent 'rules'-based issues that can unintentionally work against building electrification in a variety of circumstances, and that can prevent a consumer or other key industry actor from moving forward with building electrification even if they are interested in doing so. These may range from legal complications, to entrenched trends or ways of doing things, to regulatory barriers. While it is challenging to identify all of the major systemic barriers facing building electrification in BC, it is important to identify and address as many as possible, and continue to do so on an ongoing basis.

OBJECTIVES	Targeted Actions
Reflect high-efficiency features more accurately in property appraisals	**3.1** Review & Update Finance Sector Appraisal Processes to Better Support Building Electrification
Reduce landlords' legal barriers to undertake electrification retrofits	**3.2** Review & Update Landlord-Tenant Legislation to Support Building Electrification **3.3** Establish guidelines for landlords to access tenants' suites for building electrification retrofits
Ensure buildings connected to gas district energy systems can decarbonize	**3.4** Review and Address Issues Associated with Building Electrification and Existing District Energy Agreements
Improve access to capital	**3.5** Offer alternative financing mechanisms
Reduce permitting complexity and time	**3.6** Establish guidelines for common heat pump applications and streamline the permitting processes accordingly

Reflect high-efficiency features more accurately in property appraisals

The high-efficiency aspects of new and existing homes are generally not valued by property appraisals that are required by mortgage lenders. This makes it difficult for the home seller to recoup the cost associated with these upgrades and can therefore discourage their adoption.

Action 3.1

Governments and key residential building sector stakeholders should **work with the financial sector to understand the current appraisal methodology** applied to high-efficiency/low-carbon property upgrades and update the approach to ensure that they are more accurately valued.

Reduce landlords' legal barriers to undertake electrification retrofits

The Residential Tenancy Act currently limits the opportunities for landlords to recoup the capital cost of building electrification retrofits. As a result, landlords are unlikely to make retrofits that do not provide them with a short payback or are not required by regulation. It also limits the opportunities for landlords and their contractors to access a tenant's suite to make upgrades, including building electrification related upgrades. The complications that can arise due to scheduling restrictions may dissuade landlords from moving forward with building electrification retrofits.

Action 3.2

Industry and the Province are reviewing the **permissible capital recovering approach** for landlords. Building electrification retrofits should be considered as part of this review and any potential update to relevant regulations and/or guidelines.

Action 3.3

Industry, the Province, and other relevant stakeholders should review the ability of landlords and their contractors to access tenants' suites for the purpose of undertaking building electrification retrofits and **establish guidelines** to balance the rights of tenants and efforts to update a building's space and water heating mechanical systems with high-efficiency electric solutions. If updates to the Residential Tenancy Act are necessary in order for landlords to abide by these guidelines, consideration should be given to amending the Act accordingly.

Ensure buildings connected to natural-gas powered district energy systems are able to decarbonize

Heating for certain larger buildings, typically located in dense urban areas, is provided by natural gas-powered district energy systems. The contractual agreements for these services can make it very difficult for a building owner to switch part or all of their heating load from the GHG intensive district energy system to low-carbon alternatives. There is therefore little practical opportunity for these buildings to decarbonize in a meaningful way without cooperation with the district energy utility provider.

Action 3.4

Minimum GHG performance standards for buildings should require buildings that currently use district energy heating services to switch to a low-carbon heating source (electric or otherwise). This need for cleaner sources of energy should spur district energy system providers to accelerate their plans to transition to low-carbon fuel sources. To ensure a smooth transition, district energy system utilities, the Province, relevant local governments, district energy utilities, and building stakeholders should establish a **district energy (DE) transition strategy** to align with scheduled minimum GHG performance standards for buildings.

Improve access to capital

An inability or unwillingness to directly pay for or finance building electrification upgrades may prohibit many home and building owners from participating in this market. This barrier could become particularly problematic in cases where a whole building electrification approach is required because of the additional capital costs associated with a more wholistic solution (i.e., reduce heating loads first and then use heat pump technologies).

Rental, strata, and commercial properties may be further reluctant to take on a loan for building electrification if it risks violating their allowable debt to equity ratio and/or reduces their ability to undertake other competing capital upgrades in the short to long term.

Action 3.5

Having more readily available and designated financing options available will encourage more property owners to participate in building electrification upgrades. Property Assessed Clean Energy (PACE) financing and on-bill financing are **alternative financing mechanisms** for building electrification upgrades. In the case of the former, loans are tied to the assessed property, while in the latter they are tied to the utility metre. Some advantages of these alternative financing mechanisms for building electrification include:

- The home or building owner can secure a long-term loan with terms that more closely match the asset's useful life.
- The loan is not tied to the owner which means it is less risky for them to finance a capital project with a longer payback period.
- For homeowners with limited access to capital, whether through personal savings or financing, a residential PACE (R-PACE) loan is generally more straightforward to access because it is based on the assessed value of the property rather than the individual's credit score.
- For rental and commercial properties, a commercial PACE (C-PACE) loan is often considered to be “off balance” sheet which means it does not apply against their debt to equity ratio. The owner, therefore, is less likely to have to choose between building electrification and another capital upgrade.
- For properties with tenants who are responsible for their own utility bill, it is more straightforward for the landlord to recoup capital upgrade costs that are tied to the property or utility metre.

In September 2020, the Province announced $2 million to support a pilot for a PACE financing program. A subsequent Request for Proposal issued by the Province in October indicated a broader review of financing mechanisms to support building decarbonisation in BC will take place in the first half of 2021. Most importantly, in November 2020, the Premier issued mandate letters to the Minister of Energy, Mines, and Low Carbon Innovation and the Minister of Municipal Affairs that included direction for the ministers to enhance energy efficiency programs and incentives for residential and commercial buildings, including PACE financing.

These are important first steps. The research carried out will undoubtedly provide important additional recommendations to expand retrofit financing options throughout the province. The province is encouraged to make the report and its recommendations publicly available. It should then plan to consult on these recommendations and act quickly to implement those measures with the highest potential in terms of their overall market impact and ability to assist electrification efforts in low-income and harder to reach market segments.

Streamlined permitting

The uncertainty and time of local government permitting requirements (e.g., building permits and electrical permits) for installation of high-efficiency, electric HVAC systems was identified as a barrier to some building electrification projects moving forward because of concerns about potential delays.

Action 3.6

Steps need to be taken by the provincial and local governments to **increase the certainty of heat pump installation guidelines and associated permitting requirements and processes**. The reduction of uncertainty and potential delays will in turn help to reduce the cost associated with the design and permitting of these systems.

By way of example, the City of Vancouver is taking a number of steps to streamline its heat pump permitting process for a variety of systems for small and larger residential buildings. It has done so by issuing specific guidelines for a number of common system and placement conditions (such as central rooftop heat pumps, units on balconies for larger buildings, pad mounted residential heat pumps, balcony mounted mini-splits, and roof mounted central heat pumps). It has then aligned a streamlined permitting process for each of these conditions.

The City has also released a “Neighborly Noise Guideline” that will help owners and contractors select and install systems that they know are considered quiet and therefore reduce concerns about potential noise complaints. Overall, the publication of these guidelines should help to significantly reduce the time to takes to move a heat pump system from concept to installation.

The publication of similar model guidelines by the province would make it more straightforward for other local governments to quickly adopt and implement similar measures. A first step is the recent release of the Low Carbon Building Policy Toolkit for local governments. The Toolkit provides recommendations and best practices to assist local governments in reducing barriers to low carbon building practices, including improved approvals regimes for heat pump implementation.

KEY STRATEGY #4 Expand Industry Capacity

A critical element of widespread building electrification will be the ability of the building sector to meet the rising demand and instill market confidence with high-quality products, installation, and servicing – especially the HVAC and plumbing sectors. One of the biggest challenges for achieving this strategy will be to increase the knowledge, experience, and preference for high-efficiency electric systems with mechanical system designers, salespeople, and contractors. Shifting this workforce from its current set of practices and reliable revenue streams will require thoughtful and sustained coordination with the sector itself.

OBJECTIVES	Targeted Actions
Expand the electrification sales force	**4.1** Provide clear and strong market signals **4.2** Upstream offers (eg. HVAC and plumbing specialists) **4.3** Work with the trades to include electrification solutions as a standard emergency replacement option
Improve building electrification awareness, coordination, and advocacy	**4.4** Develop a communication plan to raise awareness across the building sector about governments' climate and electrification efforts **4.5** Implement targeted HVAC industry communications **4.6** Establish a building electrification coalition & knowledge hub
Build industry knowledge and experience	**4.7** Work with industry to design & offer relevant training **4.8** Support demonstration projects & develop case studies **4.9** Identify and promote best practices in heat pump design **4.10** Develop and offer building electrification training for the building design community **4.11** Establish a Refrigerant Management Program to address the GWP of refrigerants
Expand the use of trade certification and technical guidelines for energy performance best practices	**4.12** Implement consumer awareness campaign about quality installation and permitting requirements **4.13** Increase industry awareness and use of the existing heat pump best practices guidelines (Part 9) **4.14** Regulate minimum energy efficiency performance practices for space heating systems (Part 9) **4.15** Continue to develop and require a trade designation/ certification for HVAC training and experience (Part 9)
Support growth of building electrification trades	**4.16** Outreach to high school students **4.17** Increase capacity of trades schools **4.18** Reskilling and professional development for people currently working in the fossil fuel space and water heating sector

Expand the electrification sales force

In the ground-oriented residential and small commercial and apartment style building sectors most HVAC and plumbing systems are designed and installed by the same people and companies who sell them. For companies that have traditionally sold and installed mainly natural gas heating equipment, the easiest path to securing a profitable sale is to continue recommending the ongoing use of natural gas equipment to their customers. Having more people in this market who are interested in selling high-efficiency electric equipment is critical to accelerating the transformation to all-electric buildings.

Action 4.1

There are currently very few concrete signals to the marketplace that there will be a concentrated and tangible shift away from fossil-fuel space and water heating equipment over the next ten years. **Strong commitments and policies** from the Provincial Government, utilities, and local governments that signal this shift would help to start getting the attention of industry that a change is coming, and it is time to seriously consider updating their training and equipment offerings accordingly.

Action 4.2

In the short- to medium- term, HVAC and plumbing specialists who work with home and building owners to change from a natural gas to a high-efficiency electric system are likely to have increased costs associated with training, consumer awareness building, and additional design and installation time. To help offset some of these additional costs and risks borne by this contractor sales force, the Provincial Government, utilities and local government should develop and provide **upstream offers** to contractors to encourage them to recommend high-efficiency electric solutions to their customers.

If twinned with a minimum training requirement, such as the current CleanBC Program Registered Contractor program, the upstream incentives could also help to increase uptake in the program and expand best-practice design, installation, and verification practices.

Many homeowners and building owners/managers do not plan the replacement of their existing space and water heating equipment in advance. Instead, they use the failure of the equipment as the trigger for replacement. These unplanned events can quickly turn into emergency situations if they result in potential property damage, or the loss of a critical space and water heating services at a time that is extremely inconvenient or even dangerous (e.g., replacing primary heating equipment in winter). One result of this situation is the need for a

Expand the electrification sales force (cont.)

quick replacement that leaves little time or interest in exploring alternative options (such as the replacement of a fossil-fuel furnace with an electric heat pump). Over the course of a couple of days or less, a decision can be made that will determine what fuel source is used to heat a building for the next 10 to 25 years.

As discussed in Action 2.11, one important pathway to increase the opportunity for home and building owners to electrify their building, is for governments, utilities, and retrofit program coordinators to work with them to plan and prepare for a switch to electrification well in advance of their equipment failing. Even with this action, there will inevitably still be many owners who will fail to plan in advance. In these cases, the companies and individuals called on to replace failed equipment will represent the last chance for an electrification retrofit.

Action 4.3

Electrification program offers and information should be developed, in conjunction with key industry stakeholders, to help contractors quickly assess when a high-efficiency electric solution may be a viable option and to encourage them to make the owner aware of this option and its benefits. In practice, this means having **contractors who are trained in and carry both fossil fuel and electric heating equipment**. Many of the other actions included in the BERM will also help to raise awareness around this potential, increase the motivation of owners to fuel switch, and, over time, reduce the occurrences of such unplanned events.

Improve building electrification awareness, coordination, and advocacy among key industry stakeholders

Policies, programs and technologies associated with building electrification mark a significant change in the space and water heating marketplace over a relatively short period of time. Contractors and other professionals working in this space will need time to prepare for these changes.

Action 4.4

It is recommended that the Provincial Government, local governments, utilities, and key industry associations work together to develop a **comprehensive general communications plan** to raise awareness about the province's and cities' low-carbon plans and targets and the implications of these for the building sector.[49]

Improve building electrification awareness, coordination, and advocacy among key industry stakeholders (cont.)

Action 4.5

Local governments, utilities, and key industry associations should develop and implement a **targeted messaging** campaign for the HVAC industry and the building design community to provide some lead time to undertake the technical training and building the community of practive that will be needed to support a sustained building electrification market shift.[50]

A successful building electrification market transformation will require the coordinated effort of a broad range of stakeholders across all levels of government, utilities, and the new and existing Part 3 and Part 9 building sectors. There is currently no organization in British Columbia, short of the provincial government with a mandate to oversee, track and advance this critical work.

Action 4.6

Key stakeholders should form a non-governmental **building coalition** to coordinate, track, and advise on the implementation of building electrification. The Coalition's membership should include all relevant building electrification stakeholders, including, industry experts and professionals, manufacturers, vendors, all levels of government, BC Hydro and other electricity utilities in BC.

The coalition should be member driven and work closely with its membership and other stakeholders to address barriers to electrification and inform policy and regulation that support the corresponding market transformation. The coalition's services should also include the creation of a knowledge hub that includes easily accessible building electrification best practices and case studies. The California Building Decarbonization Coalition provides a tangible example of how the BC organization could function.[51]

Build industry technical knowledge and experience

As identified in a recent Trades Readiness Needs Assessment report that was commissioned by the City of Vancouver, there is a need to develop new skills in the trades in order to ensure the quality installation and performance of new low-carbon space conditioning and water heating systems.[52]

Action 4.7

All key stakeholders need to promote **technical training** offered through suppliers and manufacturers, education and training institutions, and industry associations and consider providing training incentives for small service-based HVAC companies with the goals of readying trades for the new technologies being specified.[53] It is important to recognize that interest in technical training will be strongly influenced by the level of market demand for building electrification systems that is anticipated. In other words, simply providing opportunities for expanded training will not be sufficient to motivate tradespeople and professionals to update their knowledge and skills. Technical training and qualifications should include best practices with regards to refrigerant management (i.e., Red Seal Refrigeration Mechanic qualifications) to ensure proper awareness and skills for minimizing the GWP of installed and decommissioned equipment.

The rate of technological change with high-efficiency electric equipment is relatively fast compared to more conventional space and water heating technologies. This makes it challenging for tradespeople, building professionals, and developers to stay informed of these changes and maintain their direct knowledge and experience with this equipment. There is considerable interest among building industry members in obtaining better information about the options available, the technical considerations of these options, and their cost implications. However, there is also a general lack of communication about these issues and no easy to find source of information about best practices, examples of BC specific electrification projects, and emerging technologies.

Action 4.8

It is recommended that all levels of government, utilities, and educational institutions **should support demonstration projects and the publication of case studies** from demonstration as well as existing building electrification projects. Case studies and other materials can be curated and made available via the Building Electrification Coalition that is proposed above. New case studies should be published on an ongoing basis starting in 2021.

For complex (Part 3) building, there is a need for the engineering community to more adequately acknowledge practical performance constraints of heat pump technology and to adapt an informed and methodical design approach that leads to more robust and reliable system operation. Heat pumps generate supply heat in a fundamentally different way than natural gas combustion boilers. Although heat pump technology continually improves, heat pumps are far more efficient when they are integrated into systems that can accommodate significantly lower delivery temperatures than combustion boilers typically deliver (ideally less than 50°C). For proper heat pump performance, many additional factors relating to temperature thresholds, flow control, and buffering capacity need to be carefully taken into account as compared to combustion boiler system design. Heat pumps are susceptible to shortened service life when they are required to serve higher temperature loads and when they are subjected to frequent on/off stage cycling. Therefore, attention to well-informed and methodical design is particularly important for all hydronic heat pump systems (whether air-source or geoexchange-source).

Action 4.9

The engineering community will need to take a coordinated effort to **identify and promote best practices in heat pump design** and to disseminate this information accordingly. This is critical for the Road Map's success since poorly designed systems will have a strong potential to unfairly turn public perception against heat pump systems. The forthcoming update to the Engineers and Geoscientists of BC's (EGBC) Guidelines for Mechanical Engineering Services for Building Projects is an appropriate place to provide overarching support and guidance for this. The practice guideline sets the standard of practice. It is therefore important that it represents the most progressive set of guidelines for mechanical engineers.

Build industry technical knowledge and experience (cont.)

Action 4.10

EGBC and other professional training entities should **develop and offer training for heat pump system sizing and design for space and water heating**, as well as on other topics deemed relevant to building electrification.

The new BC Professional Governance Act has made the reporting of continuing education hours mandatory for professional associations regulated by the Act. To increase awareness and participation in building electrification related training, the training offered should qualify as Continuing Education credit that participants can report to their professional regulatory bodies as part of their minimum annual professional training requirements.

To increase the speed with which courses are developed and to further encourage participation by lowering the cost to register, the provincial government, utilities and other funding agencies should support part or all of the development of a series of heat pump related courses that qualify as Continuing Education Programs.

The use of high GWP refrigerants is a major concern for building electrification efforts. Although federal regulations exist to reduce the GWP of these refrigerants over time, this regulatory transition will be slow. In the meantime, every effort should be taken by key stakeholders to expedite the shift to low GWP refrigerants and ensure minimal leakage from existing systems.

Action 4.11

A full suite of mechanical equipment refrigerant management resources, training, and requirements should be developed by the Provincial Government to help **ensure a quick market transition to low GWP technologies and best practices**. These should be developed in close coordination with industry. California's Refrigerant Management Program provides a good example of the kinds of practices that can be developed in BC.[54]

Expand the use of trade certification and technical guidelines

For Part 9 buildings in BC, there is general lack of energy performance design and installation standards for HVAC systems, and a lack of enforcement of the standards that do exist.

Existing HVAC standards are regulated under three different provincial legislations: the Safety Standards Act, the Building Act (via the BC Building Code), and the Energy Efficiency Act (via the Energy Efficiency Standards Regulation). Under the Safety Standards Act and Regulations, Technical Safety BC oversees the safe installation of HVAC systems, but not energy efficiency requirements, which are not covered under these regulations. The BC Building Code applies to new construction and major renovations, including heat system replacement. It includes minimum energy performance requirements for equipment as well as a minimum modeled system performance requirement (i.e., mechanical energy use intensity) for homes built under the Energy Step Code. However, the Building Code provides limited guidance that would allow a building inspector to verify if a project followed design and installation best practices from an energy performance perspective. Similarly, the Energy Efficiency Standards Regulation includes minimum energy performance standards for most HVAC equipment sold in BC but does not extend to HVAC system design and installation considerations.

In short, there is no organization in BC that is tasked with the responsibility of ensuring that energy performance best practice guidelines for HVAC system design and installation are understood and followed by contractors. This leads to an 'uneven playing field' where quality contractors who follow best practice guidelines must compete with others who do not.[55] This is an issue because it can discourage the application of best practices if they are viewed as eroding a contractor's cost competitiveness. Although this issue applies to all HVAC systems, the more specific operating requirements of high-efficiency electric equipment means the consequences of a poorly designed and installed system (e.g., higher-operating costs and insufficient heat) will likely be more acutely felt than they are with conventional gas and electric systems. This in turn can erode the market's confidence in the suitability of these systems for BC.

Action 4.12

The Provincial Government, local governments and utilities should work with the Home Performance Stakeholder Council (HPSC) and other key industry groups to develop and implement an awareness campaign to **improve consumer knowledge** of home performance and basic quality installation qualifications and practices.

Expand the use of trade certification and technical guidelines (cont.)

Action 4.13

The Provincial Government, local governments, utilities and trade association should **continue to increase industry awareness and use of the existing guidelines** - *Heat Pump Best Practices Guide for Existing Homes and Heat Pump Best Practices Guide for Existing Homes – Supplemental Resources"*[56] - that were developed by the HSPC in collaboration with key industry, government and utility stakeholders.

One step that could be taken relatively quickly by local governments to help in this regard is to enforce the BC Building Code's existing requirement for an overall building heat loss and heat gain calculation to be completed by a contractor and used to demonstrate the minimum corresponding heating output for the new heating system that they are intending to install.

The City of Kelowna's building permitting office has been enforcing this requirement for years to ensure new and replacement heating systems in the city are properly sized. Before a contractor can install a new heating system in Kelowna, they need to first apply for a "heating permit". The permit requires the submission of the heating load calculation. The City's inspection staff then inspect 100% of newly installed heating equipment to ensure that the buildings heating system meets the Code's minimum heat load requirements. The City of Vancouver and at least one other local government are also considering a thermal conditioning permit that would ensure that any mechanical system is sized and installed correctly before a permit is issued.

Action 4.14

To really increase the awareness and uptake of heating system best practices for Part 9 buildings, local governments should work with provincial officials and industry associations to expand the use of **energy performance permitting requirements for mechanical systems** installed throughout BC. They should then ensure municipal and other permitting offices are adequately staffed and trained to undertake the corresponding permitting inspections of these systems in a timely manner.

In this vein, the Provincial Government should review with Technical Safety BC and key industry partners, the potential to **regulate minimum energy efficiency performance standards for space heating systems under the *Safety Standards Act* and Regulations**. If design and installation energy performance best practices were included within such a standard, it would make these practices mandatory across the province. It would also give TSBC and the local governments that issue electrical and gas permits, the authority to inspect heating systems for compliance with these performance requirements. The inclusion of energy performance requirements in the Safety Standards Act and Regulations would represent an expansion of TSBC's safety mandate to include climate change as a safety risk, and GHG emission reduction as a risk-reduction strategy. No organization in BC is as well suited as TSBC is to understand and undertake these kinds of technical inspections across the entirety of the province. This single action would go a long way to ensuring that every Part 9 heating system installed in BC was designed and installed to a high performance standard.

Another advantage of expanding TSBC's authority into the realm of energy performance is that it already has a system of **enforcement** in place that, among other things, allows designated inspectors to audit the sales records of contractors (e.g., work orders, invoices). Although used sparingly, this enforcement mechanism makes it more straightforward to identify contractors who are undertaking unpermitted work because these sales documents can then be compared against the permits filed by the same contractor. A pattern of inconsistencies between the two would indicate chronic non-permitted work and the contractor could be penalized accordingly. The judicious use of this authority would help to discourage the occurrences of non-permitted work that is correlated with higher safety risk. This would in turn help to level the playing field for contractors who regularly follow best practice guidelines with those who currently do not.

Action 4.15

The Provincial Government, utilities, and industry associations should continue to work together to develop a residential **HVAC Technician trade designation** that incorporates home performance (house-as-a-system and building science).[57]

A proposed company accreditation and installer/technician certification criteria model for the residential HVAC retrofit industry has been developed by the Home Performance Stakeholder Council's (HPSC) HVAC Sector Council; which includes representatives from the Thermal Environmental Comfort Association (TECA) and Heating Refrigeration and Air Conditioning Institute of Canada (HRAI).[58] The HPSC Registered Contractor network will build on and expand the CleanBC Program Registered Contractor program currently being used. Linking contractor qualifications to program criteria is an important first step to creating a demand for the HPSC Registered Contractor network.

Building on Action 4.14, if TSBC's mandate was expanded to include the oversight of minimum energy performance standards for heating equipment, it could then make the residential HVAC Technician a mandatory or essential trade designation for undertaking this work. Once

Expand the use of trade certification and technical guidelines (cont.)

designated as mandatory or essential, the HVAC Technician trade designation could be more readily supported and promoted across the province by trade associations and training programs. Similar mandatory designations already exist for electrical, gas fitting, plumbing and electrical refrigeration field safety representative (FSR) certifications – all of whom may work on a building's heating system. However, none of these current designations take energy performance into consideration.

In 2014, the BC Industry Training Authority (ITA) supported a similar HVAC Technician trade designation but the trade at that time was not designated to be mandatory or essential. ITA ceased its active support for this trade two years later due to limited industry take up. This past experience underscores the need for the trade to be recognized as mandatory or essential as a prerequisite to generating broad market interest and uptake.

Support the growth of the building electrification trades sector

Many of the participants in a recent City of Vancouver Trades Readiness Needs Assessment for low-carbon energy systems, identified a shortage in skilled HVAC technicians.[59] Pressure on the trades and other skilled services to provide building electrification solutions will only continue to grow over the coming years.

Action 4.16

Key stakeholder groups should support **outreach to high school students** by providing key messages and resources to the Industry Training Authority Youth Department's campaign for trades growth. Echo the key messages from this and other campaigns in provincial, local government, and utility communications with the goal of inspiring more students to enter HVAC trade programs.[60]

Action 4.17

The Building Electrification Coalition should look for opportunities to advocate alongside industry associations for **increased funding to trades schools** to increase their capacity with the goal of raising the number of HVAC Technicians available throughout the province.[61]

The shift to electrification for most of BC's building sector over the next 10 to 20 years is going to result, at least in the mid-term, in a major retraining of trades and contractors who currently work almost exclusively on designing and installing natural gas heating systems, especially plumbers and pipefitters who extend gas lines. As discussed in Chapter 2, in the longer-term, national and provincial studies consistently show a net positive economic impact associated with decarbonizing the economy. As noted above, a recent study on the jobs impacts of building decarbonization, specifically, in the State of California forecasted an average of 64,200-104,000 jobs annually by 2045, after accounting for losses in the gas sector.[62] Despite these expected economic gains, actions will still need to be taken to make the transition as smooth as possible for the trades and contractors who will be impacted most directly by it.

Action 4.18

It will be important for the Province and other governments to signal well in advance that the shift is taking place to give companies and individuals sufficient time to prepare for it. **Retraining people whose trades will be the most heavily impacted by the transition should be prioritized**. Wherever possible, accelerated recertification pathways should be created to minimize the amount of time it will take these tradespeople to be fully reemployed. For HVAC contractors, the focus for many will need to be more on gradually shifting their current business focus from fossil-fuel heating systems to electric ones. Again, strong market signals and a clear timeline will be critical to ensuring a smooth transition for all.

KEY STRATEGY #5 Increase Available Technologies

Critical to the broad electrification of the building sector will be the continuous improvement of high efficiency electric systems with regards to their availability, quality, operating efficiency, low GWP, and capital costs. Many of the actions that fall under the other four strategies will help to grow market demand and competitiveness of building electrification technologies. These outcomes alone will go a long way to increasing the number of new technologies that equipment vendors are willing to introduce to the BC marketplace. However, these conditions will take time to develop. In the meantime, a thoughtful and well supported technology acceleration strategy will be needed to increase the rate that new technologies are introduced into the BC marketplace with strong potential to improve efficiencies and decrease installation and operational costs.

OBJECTIVES	Targeted Actions
Support the development of building and equipment standards	**5.1** Support the work of standards making bodies (e.g., Canadian Standards Association **5.2** 5.2 Improve testing standards to help identify higher performing equipment (e.g., cold climate test standard)
Accelerate the certification of promising new technologies	**5.3** Conduct an annual survey of leading existing technologies, post findings in a central website, and make local market aware of the findings **5.4** Provide certification support services for high-potential technologies **5.5** Support on-site certification and pre-certification trial projects **5.6** Explore a stepped certification acceptance of the European CE Mark as equivalent to a CSA mark
Support the introduction of already certified technologies	**5.7** Establish a comprehensive suite of measures to reduce some of the cost and risk borne by industry when introducing new technologies **5.8** Establish a building electrification Centre of Excellence
Accelerate the adoption of low GWP technologies	**5.9** Advocate to the Federal Government to accelerate the phasing out of high GWP refrigerants **5.10** Explore adding minimum GWP refrigerant requirements in the Energy Efficiency Standards Regulation **5.11** Add GWP refrigerant climate impacts to provincial climate modeling
Expand the market in North America for building electrification	**5.12** Coordinate closely with other leading jurisdictions

Support the development of building and equipment standards

Performance codes and standards are the minimum allowable requirements that equipment, products, and buildings must meet in order to be used in the jurisdiction where they apply. To be effective, it is critical for these codes and standards to accurately and consistently measure whatever quality of a building or product they are intended to reflect. Given the very technical nature of codes and standards and their importance for establishing an acceptable and level playing field for the marketplace, they typically take many years to develop and involve the contribution of a wide range of government, utility, and industry stakeholders.

The rate of change in high performance building and electric space and water heating equipment means it is more challenging than ever for codes and standards to keep up with new advances. In cases where a standard does not yet exist for a new and promising technology or existing standards need to be updated to properly account for it, the process to establish an agreed upon standard can delay the introduction of the technology for years.

Action 5.1

It is recommended that the development of **standards for new and promising building electrification technologies** be adequately resourced by government, utilities, and industry to ensure that effective standards are developed in the shortest time possible. The federal and provincial governments, the City of Vancouver, and BC's utilities are already actively involved in supporting the development of standards. Given the environmental and social benefits of building electrification, priority in terms of resources and time should be given to the development of codes and standards that will apply directly to low carbon building and high-efficiency electric equipment.

Action 5.2

In addition to establishing new standards, it is equally important for work that reviews and improves upon standards for existing technologies continues to be supported by governments and utilities. One example of the importance of this work is the Cold Climate Heat Pump test specification, led by BC Hydro and key stakeholders in Canada and the U.S. The standard was developed to address concerns that the main efficiency test standard for heat pumps did not include a low temperature testing point below 17°F (-8.3°C) and to provide a metric that better reflects how equipment performs in the field. The new specification helps to ensure that appropriate technologies are being installed by identifying air source heat pumps that are best suited to heat efficiently in cold climates (i.e., climate zone 4 and higher).[63] The Cold Climate specification is currently a voluntary standard that, if more broadly accepted, is expected to become a national standard that can be used to regulate space conditioning heat pumps.

Support the development of building and equipment standards (cont.)

A new area for standards improvement is for utilities to work with standard-making organizations, such as the Canadian Standards Association (CSA), to advance new standards and communication control protocols related to demand response and other flexible load/response initiatives that would apply to Smart Buildings, Smart Technologies and electric vehicle charging energy management. Measures such as these will increase overall grid resiliency and smooth out the amount of power generated to meet peak demand. This capability is important to help ensure that electrification is balanced with the most efficient use of available electricity resources.

Accelerate the certification of promising new technologies

There is currently no readily accessible central source of information about high-potential new technologies that are in use elsewhere but not currently available in BC. Without this information, it is difficult for governments, utilities, and industry stakeholders interested in accelerating the introduction of new technologies into the BC market to know where to target their efforts and resources.

Action 5.3

To help assess what promising new building electrification technologies exist in the global market, the Provincial Government and the Vancouver Economic Commission should commission an annual survey to i**dentify and assess the market readiness of high potential technologies** that are in use elsewhere but not currently available in BC. A technology's potential could be assessed by a number of criteria, including, cost-competitiveness, operating efficiency, suitability for use in BC, and track record in other markets. The report should be published in a central website along with other critical building electrification information (e.g., demonstration projects, training requirements and opportunities etc.). This information could then help governments, utilities, and industry stakeholders determine where they should target their efforts for working together to bring new products into the BC market faster than they might otherwise on their own.

Even when test standards already exist for a promising new technology, the testing process required to have a technology successfully demonstrate compliance with the standard and thereby certified for use in the accompanying jurisdiction can be very costly and time consuming for a manufacturer or vendor. The time and resources required for certification testing can therefore act as a significant barrier to introducing new technologies into the Canadian and BC market.

Action 5.4

Supports in the form of financial incentives, certification process guidance, and technical aid should be provided by governments and utilities to manufacturers and vendors who have been identified as having a **promising pre-certification technology** and are interested in having it certified for use in the BC market. The Government of BC's former High Performance Window Certification Program is a good example of how this kind of program could function for other building electrification products.[64]

For vendors with technologies that have been proven and certified in other jurisdictions (e.g., Europe, Japan) but not in Canada, a critical service can be to work with these vendors to adjust their specifications to suit Canadian standards. Having technical experts available who understand Canadian requirements and certification requirements can save a vendor considerable upfront time and effort. Information collected about the ease of certification for different pre-certified technologies would also help to prioritize where additional supports can be provided for those technologies deemed to have the highest potential for rapid certification and use in the BC market.

Action 5.5

All levels of government, utilities and industry stakeholders should work together to increase the use and ease of **on-site field certification** for promising new building technologies that have not yet been certified in Canada. Field certification can help to advance the timing and numbers of proven installations of a technology in BC while the technology is still going through the certification process. The real-world data collected from these installations are critical for vendors, contractors, and designers interested in promoting the use of these technologies in building projects.

Accelerate the certification of promising new technologies (cont.)

Action 5.6

Building off of the previous action, Provincial and Federal governments, utilities, and key industry stakeholders should explore the potential of using a multi-phase, on-site certification program as an accelerated pathway to **accept Europe's Conformité Européenne (CE) Mark as equivalent** to Canada's Canadian Standards Association (CSA) mark for certain technologies.

The following provides an example of how such a program could work in BC:

- Phase 1: Allow up to 20 trial projects of a product with the CE Mark with no certification fee.
- Phase 2: Allow up to 2000 additional projects of a product with the CE Mark. These projects pay a $200/unit fee to CSA to be held and applied towards certification costs once sought.
- Phase 3: Local Canadian certification is required after 2000 units are placed as a condition of the product being allowed to continue to be used in the Canadian market.

For foreign companies interested in bringing a new technology into the North American market, the option to use this kind of certification pathway would help to reduce their risk of certifying a product in the North American marketplace because on-site trials are built into the process. For BC interests, the CE Mark provides confidence that there is a minimum recognized standard for entry into the program. Finally, for vendors, designers, and contractors interested in promoting the use of new building electrification technologies to their customers, the trial projects provide the valuable information about the cost and efficacy of these technologies that they will need to do so.

Support the introduction of already certified equipment

Manufacturers, vendors, designers, and contractors bear the brunt of the cost and risk associated with bringing a new technology into a market. The cost of bringing a new technology into a market can include establishing new supply chain channels and processes, awareness campaigns, ongoing training and technical support, manuals and other support materials, and additional sales and promotion time. In addition to these more predictable costs there are a number of risks, including increased warranty claims, supply-chain delays, additional client management, reputational damage, and litigation in cases where problems that arise cannot be resolved independently. Given these costs and risks, most space and water heating manufacturers, vendors, designers, and contractors are very cautious about how quickly they introduce new technologies into the marketplace.

Action 5.7

To accelerate the rate that new high potential building electrification technologies are introduced into the BC market, all levels of governments and utilities should ensure that a **comprehensive suite of measures is put in place to reduce some of the cost and risk** borne by supply-chain and other industry stakeholders involved in these efforts, including:

- Support for multiple demonstration/proven installation projects to get key costing and performance data for a new technology from what is generally recognized by industry as an acceptable portfolio of projects;
- The publication of demonstration project results and case studies;
- Support for industry training and technology awareness building campaigns that are directed to industry professionals, tradespeople, and consumers
- Special incentives to encourage the uptake of the product by early adopters
- Public sector procurement that encourages the use of innovative technologies
- Responsive building code and permitting exemptions where needed

Previous government programs such as the CleanBC Building Innovation Fund[65] and the jointly funded Provincial and Federal Net-Zero Energy-Ready Building Competition[66] are examples of actions governments have taken in the past to support the adoption of certified new technologies. Although these are good starts, achieving the Road Map's vision will require actions that are broader in scope and sustained over time.

Action 5.8

It is recommended that the province, utilities and manufacturers, in partnership with the federal government, establish a **Building Electrification Centre of Excellence** that includes testing facilities to better understand the capabilities of different heat pumps technologies and how best to apply them. The information from such a facility will increase capacity in the country for equipment certification testing, provide valuable knowledge to industry about equipment installation practices and performance, and help the province and utilities to establish policies and programs that are based on the best available equipment performance data.

Accelerate the adoption of Low Global Warming Potential Refrigerants

High-efficiency electric space and water heating equipment with high GWP represent a serious concern for efforts to reduce GHG emissions attributed to the building sector. New technologies with low to virtually no GHG impacts exist and continue to be developed. Every effort should be made to ensure that these are encouraged in BC and adopted as quickly as possible.

Action 5.9

The Provincial Government and other leading building electrification stakeholders should a**dvocate to the Federal Government to accelerate its planned phased reduction of HFC refrigerants with high GWPs**. The GWP of HFC is regulated in Canada under the Ozone-depleting Substances and Halocarbon Alternatives Regulation.[67] Canada's current commitment under this regulation is to reduce the use of HFCs by 85% over 2015 levels by 2036 over a series of targeted “step-downs”. This rate of reduction is in keeping with the country's obligations established under the Kigali Amendment to the Montreal Protocol. Other leading jurisdictions, most notably Europe and California, have regulations in place that exceed the Kigali Amendment schedule. For example, the European F-Gas Regulation aims to decrease HFC use by 79% by 2030 from 2015 levels. Similar accelerated schedules should be adopted in Canada to avoid the potential of “product dumping” in the Canadian market of equipment with higher GWPs and to ultimately minimize the long-term risk that this equipment poses on Canada's climate goals.

Action 5.10

The Provincial Government should explore the **inclusion of a minimum GWP refrigerant standard in the Energy Efficiency Standards Regulation**. This standard can act as a backstop to the Federal Regulation to ensure technologies with low GWPs are prioritized for use in BC's building sector.

Action 5.11

The Provincial Government and local governments should establish a protocol to **include emissions associated with high GWP refrigerants in their climate modelling projections**. This provision will help governments and industry to better plan for and manage these emissions.

Expand the North American electrification market

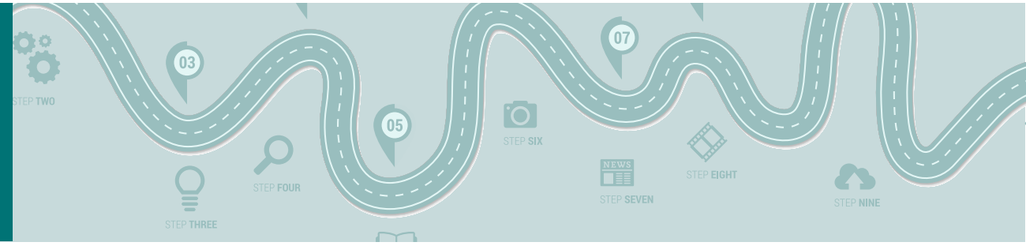
The high-efficiency electric space and hot water equipment manufacturing and supply chain is a global market. Within this global market, BC and even the western coast of the United States (including the states of California, Oregon, and Washington) are generally viewed as relatively small and still within the early adoption phase of development. One result of this is that many of the most advanced technologies are being developed for and introduced into more mature markets such as Japan and Europe. For the time being, there appears to be little sense of urgency from manufacturers and vendors to introduce these leading technologies into North America.

Action 5.12

The Province, BC Hydro and the Vancouver Economic Commission have a long-standing record of working closely with other jurisdictions in areas of climate and energy policy integration and equipment standards and certification. The successful acceleration of high potential new building electrification technologies into BC will benefit greatly from continued coordination with regional partners, such as California, and other leading jurisdictions in Canada and the U.S.. One example of what this kind of coordination looks like for building electrification is the Advanced Water Heater Initiative (AWHI) that is a shared project of the States of California, Oregon, and Washington.[68] The initiative holds promise to advance one of the trickier heat pump applications for new construction – central domestic hot water for apartment buildings.

Proposed Implementation Timeline

The Road Map's successful implementation over the next ten years will depend on the careful sequencing of recommended actions and coordination between its key actors.



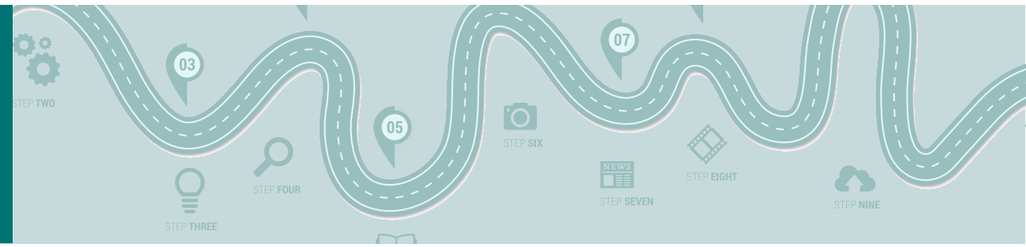
In the first three years, short-term market demand must be largely driven by a small number of actions:

- **An awareness-building campaign that targets consumers as well as home and building owners about the benefits of building electrification**
- **Communication with key industry groups about the province's commitment to building electrification, how this may impact their businesses, and the plan for ensuring a smooth transition**
- **Enhanced capital incentives**
- **Sets of actions intended to remove sector specific systemic barriers**

While these more immediate but temporary actions to encourage market growth are being pursued, more foundational recommended actions must be simultaneously and gradually implemented, including:

- **GHG requirements for new and existing buildings, initially led by leading local governments but also with a schedule of step ups in province-wide minimum performance requirements, and a commitment to ongoing tracking and reporting of overall markte progress**
- **Mandatory building benchmarking and home energy labelling**
- **Competitive electrification mandates for utilities, including appropriate rate, connection, and load control changes**
- **A growing electrification sales force**
- **Improved quality assurance and control and**
- **More available technologies**

Proposed Implementation Timeline



By the mid-term point of the Road Map, market demand will be increasingly driven by market fundamentals, and less by short-term incentive offers. Progress will be carefully tracked and monitored against predefined key indicator targets and actions adapted accordingly.

The continued growth of these fundamentals, as well as the rapidly growing market share of building electrification solutions will give local and provincial governments the confidence they need to continue to require more stringent low-carbon performance standards.

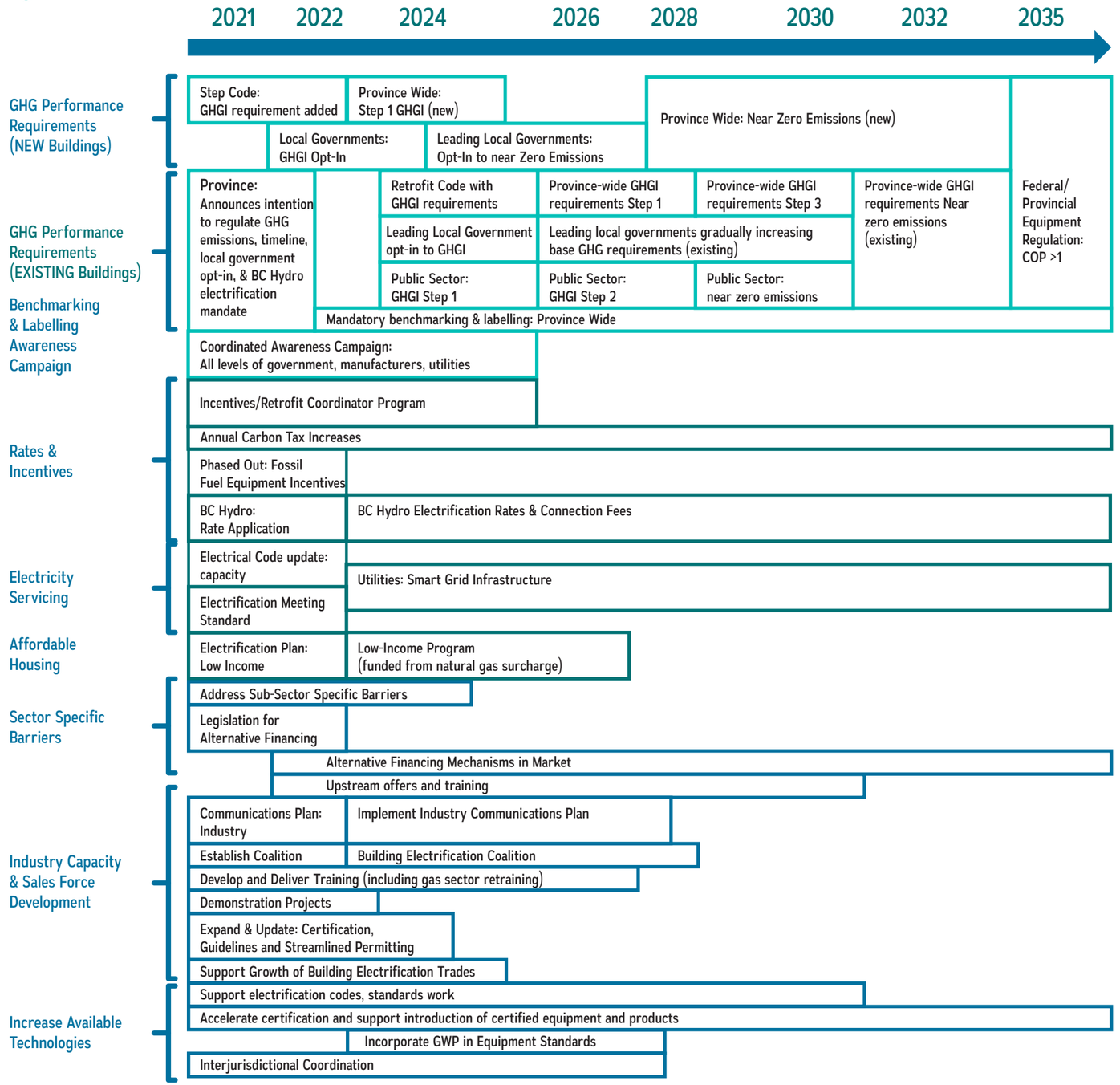
By the time that the market transformation reaches its final stage, electrification will be recognized as a reliable solution for achieving these low-carbon standards because of its cost-competitiveness, quality installation, and other key resilience, and environmental benefits.

On the following page, **Figure 10** shows the expected timing of some of the major elements of the Road Map, while **Appendix C** provides a more detailed “logic map” of the Road Map's sequence of activities.

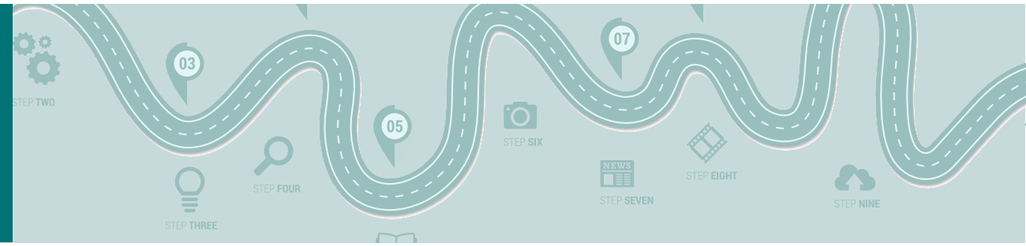
Photo:iStock

Abbreviated Road Map & sequential implementation of key elements 2021-2035

Figure 10



Regulatory Timeline

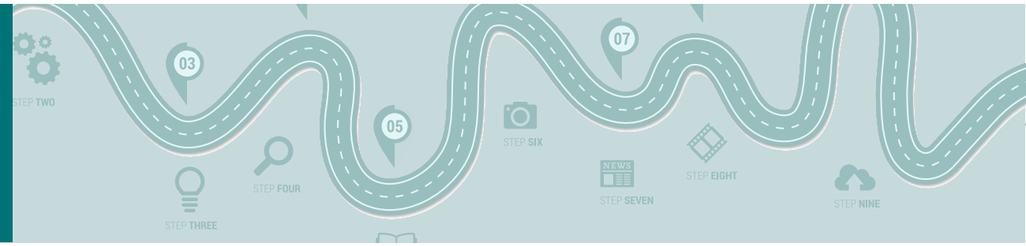


While there are several actions needed to support this market transformation, most stakeholders agreed that regulatory action will be critical to shifting the marketplace over the next ten years. This is especially the case, given the many market barriers that building electrification currently faces. Government regulation must play a central role in driving market change.

The recommended regulatory changes differ between new and existing buildings, as do their timing. The new construction sector's more straightforward path to achieving building electrification is reflected in an earlier end date for a near zero-emissions regulation, and a later date for most existing buildings. For existing buildings, the Road Map's end goal is also intentionally left more open-ended by stating that “most” replacement space heating and domestic hot water will be high-efficiency electric by 2030.

As noted above, the implementation of the Road Map will need to take into consideration major differences between regions, building sectors, vintages, and other qualities. Defining what these differences are and how they will be reflected in a future province-wide near zero GHG performance requirement will need to be established for both new and existing buildings, but will be particularly important for the latter.

Regulatory Timeline



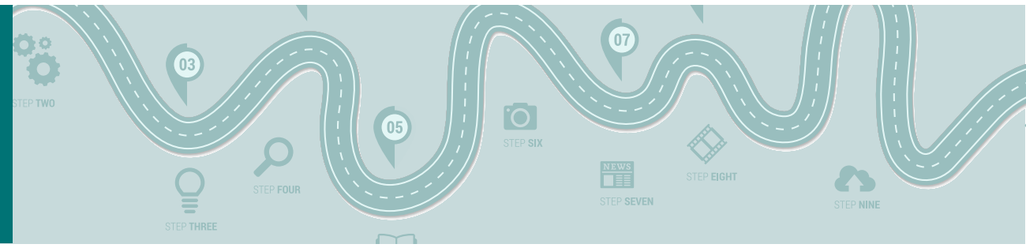
Opportunities should also be created by the province for leading local governments to voluntary require a higher-level of performance in advance of the provincial target. This will help local governments to stay on track for achieving their own emissions targets and prepare the market for a smooth transition to an eventual province-wide requirement.

An important recommended backstop for the Road Map is an equipment standard that would require all space and water heating equipment sold in BC after 2035 to have a minimum co-efficient of performance that is greater than one. This would effectively require all equipment sold to be either an electric or natural gas heat pump.

This standard would be especially important for the existing building sector as it would eventually pick up any building not yet in compliance with the building-scale GHG performance requirement when it came time to replace their existing equipment.

Photo:iStock

Summary of Key Initiatives and Actors



Building electrification represents a major opportunity to significantly reduce the GHG emissions attributed to the operations of buildings in BC over a relatively short period of time (10 to 20 years). On the following page, Table 14 provides a summary of the Road Map's key initiatives and suggests the critical actors that are likely needed to move each initiative forward.

Notably, strong commitments and signals from the province, electric utilities and other levels of government to move the market toward a zero-carbon emission standard within the next ten years are fundamental to the Road Map's success. Without this kind of strong and sustained commitment from government, it is unlikely that the market will move quickly enough on its own to achieve the Road Map's 2030 vision.

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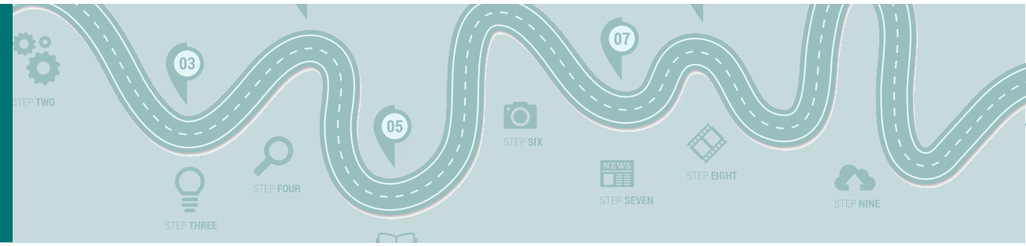
Table 14

Key recommended initiatives and actors for advancing the Road Map 2020-2022

	Key Initiatives	BE Coalition	Province	BC Hydro	Other electric utilities	Manufacturers	Government of Canada	Local Governments	Economic Development	Workforce Associations	NGOs	Other Industry Associations
Market Demand	Provincial policy commitments & timeline	●	●	●								
	General marketing campaign	●	●	●	●			●			●	
	GHG performance reporting & disclosure		●	●	●			●				●
	GHG performance requirements development		●	●				●		●	●	●
	Enabling legislation for local government leadership		●				●	●				
Cost Competitiveness	Electrification incentives		●	●	●			●			●	
	Phasing out natural gas incentives		●									
	Electrification utility rates & service fees		●	●								
Systemic Barriers	Home financing property appraisal processes	●										●
	Rental property investment barriers		●					●			●	●
	Natural gas district energy systems – decarbonization		●	●				●				●
	Alternative financing mechanisms	●	●	●	●		●	●			●	
	Streamlined permitting	●	●	●				●		●		
Industry Capacity	Upstream offers for contractors		●	●		●				●		
	Targeted industry messaging	●	●	●	●			●		●		
	Building electrification coalition	●	●	●	●	●	●	●	●	●	●	●
	Design and Inspection Guidelines and Training		●	●				●		●		
	Industry training, resources, demonstration projects, etc.	●	●	●		●		●		●		●
	Electrification trades enrollment campaign		●	●				●		●		
Technology Availability	Development of building and equipment standards		●	●		●						
	Certification of promising new technologies	●	●	●		●	●	●	●	●	●	
	Introduction of certified technologies	●	●	●		●	●	●	●			
	Low Global Warming Potential Technologies		●	●		●						●
	North American market for building electrification	●	●	●		●	●		●			

Tracking Progress



An important means of tracking and ensuring good progress in the Road Map's implementation over time and at a scale of change that is consistent with its vision, is to track and report out on key performance indicators (KPIs).

Table 15 on the following page lists examples of some of the performance indicators (PIs) that could be used for this purpose. Besides the first row (Provincial GHG Impact), each of the PIs listed is aligned with a specific strategic element of the Road Map to help identify how well each of the areas is advancing and which ones may need additional attention.

For many of these PIs, data sources already exist and could theoretically be used to start tracking progress. However, many of these require the owner of that data to give permission for their use, as they are not otherwise publicly available. Others are more aspirational in nature; for example, future benchmarking and home energy scores would greatly improve the accuracy of tracking the progress of market potential and change over time.

The ability to track progress over time would also benefit from annual reports, such as an annual industry survey and global technology review, which do not currently exist.

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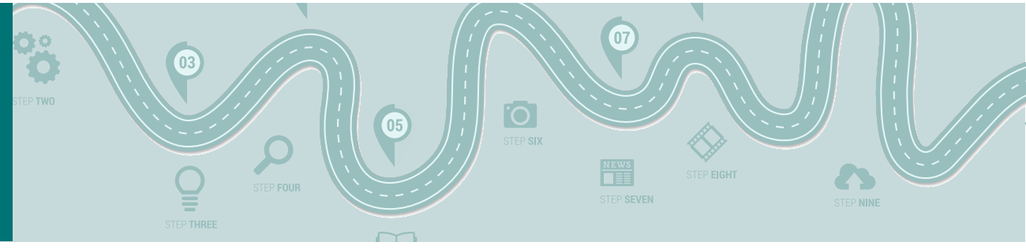
Table 15

Potential performance indicators to help track the Road Map's progress over time

Market Element	Key Performance Indicator	Data Source	Date is Currently Collected
Provincial GHG Impact	tCO_2e attributed to the building sector	Provincial GHG inventory	Yes
Create Market Demand	Numbers of high-efficiency electric equipment sold in BC	HRAI & CIPH shipment data Technical Safety BC Municipal mechanical system permits	No
	Incentive take up	CleanBC Utilities	Yes
	Aggregate BC Hydro account activity	BC Hydro	Yes
	Building level GHG intensity scores (medium term KPI)	Benchmarking Home Energy Scores	No
	Number of reported heat pump systems and fuel switches	Residential End Use Survey & Commercial End Use Survey (medium term KPI)	Yes
	Number of municipalities adopting minimum GHG performance requirements (medium term)	BC Government	No
Improve Cost Competitiveness	Number of products, efficiency ratings and purchase cost	Shelf/industry survey	No
	Net present value of newly installed high-efficiency electric systems in buildings	Various	No
Address Systemic Barriers	Number and diversity of sector specific projects	Annual industry survey	No
Expand Industry Capacity	Number of firms operating in BC	North American Industry Classification Systems (NAICS) company registry	Yes
	Number of CleanBC Program Registered Contractors in different regions of BC	BC Government	Yes
	Annual membership of Building Electrification Coalition	Coalition	Yes
Increase Technology Availability	Number of new products – year over year	Shelf/industry survey	No
	Number and types of products going through certification process	Canadian Standards Association (CSA)	No

Additional Research

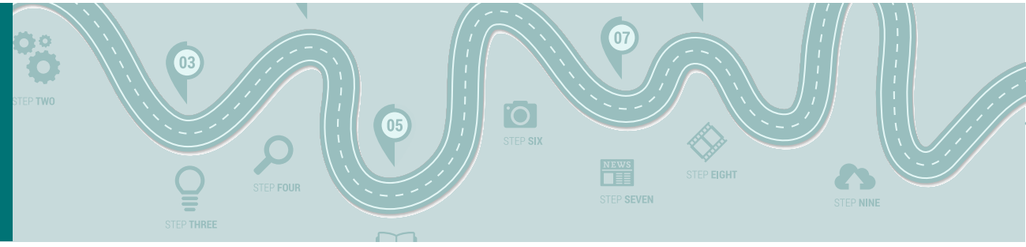


Although extensive efforts were made over the course of the Road Map's development to identify and address as many issues related to achieving its ambitious vision, there are inevitably a number of topics identified as warranting further research.

Suggested areas for further investigation include:

- Life cycle costing and GHG modelling of different building electrification options for major building types
- Building decarbonization modelling that shows the multiple pathways for getting to zero emissions buildings in BC over the next 20 years and the associated GHG abatement costs of each pathway.
- Further details on how to ensure an equitable building electrification market transformation that is accessible to allow British Columbians regardless of their income, geography, and ethnic origin.
- Detailed analysis on establishing GHG performance requirements for new and existing buildings across multiple climate zones and building types
- A public procurement standards and process template to make it more straightforward for public sector building owners to easily and cost-effectively incorporate electric solutions in their projects
- Electricity generation, transmission and distribution options for electrification that takes into account building, vehicle, and industrial market transformation as well as opportunities for smart grid integration

Moving Forward



The transition to BC's low-carbon building sector by 2030 will require many hands working together over the next ten years to implement the strategies and actions included in the Road Map.

Central to its success will be the strong and sustained leadership of the Provincial Government, BC Hydro and other utilities as well as local governments.

However, achieving the Road Map's ambitious vision to completely transform BC's building sector over the next tens year will require the sustained commitment of the building industry at large.

Fortunately, there are several factors that help to achieve the Road Map's vision, including one of the world's cleanest electricity systems, as well as federal, provincial, and local governmental support of building electrification as an important strategy for achieving their long-term GHG emission reduction goals.

Perhaps most importantly, BC is home to many of the world's brightest, most dedicated, and experienced green building tradespeople, professionals, builders, developers, and equipment vendors.

While leadership from the Provincial Government, utilities, and local governments is necessary to lead the building electrification market transformation, it is the many members of the building design and construction industries who will make it happen on the ground – one project at a time, by thousands of hardworking individuals and organizations.

With the Road Map complete, it is now time for all of the key actors identified to turn to their attention to the task of implementing it.

Appendix A: Schedule of Stakeholder Engagement

Appendix B: Complete List of Strategies, Objectives & Actions

Appendix C: Logic Maps for Building Electrification

Appendix A: Schedule of Stakeholder Engagement

Date	Method	Details
Dec 2019-Feb 2020	Jurisdictional Scan & Technology Review	A jurisdictional scan and technology review were undertaken by the New Building Institute (NBI). The jurisdictional scan focused on activities being taken in several leading U.S. jurisdictions to advance building electrification. The technology review assessed the market availability of heat pump technologies for space and domestic water heating for four categories of buildings: small residential, multi-unit residential, smaller commercial, and large commercial and institutional.
Feb 2020	Interviews: Subject Matter Expert x 6	Integral Group conducted interviews with six building electrification subject matter experts. The interviews focused on the state of the market in BC for building electrification in the following sectors: 1 & 2) ground-oriented residential – new & existing; 3 & 4) commercial and institutional buildings – new and existing; 5 & 6) apartment style residential buildings – new and existing.
March 2020	Stakeholder Workshop #1	58 stakeholders participated in a full day workshop that was led by Susanna Haas Lyons and included both in person and remote access participation. The key objectives of the workshop were: 1) introduce the project; 2) get feedback on the market readiness assessment for building electrification, and 3) begin to identify and prioritize key Road Map actions on a 10-year timeline. The results from the workshop were used to develop a first draft of the Road Map.
May-June 2020	Industry Focus Group x 4	Four half-day, remote-access focus groups were held by Integral Group with industry stakeholders. The four focus groups were: ground-oriented residential (12 participants), apartment style residential (19 participants), commercial and institutional buildings (13 participants), and rural communities (11 participants). Given the intention to keep the total number of focus group participants relatively small, an effort was made to prioritize participation from industry representatives. The focus group members were provided with a pre-meeting package that included the draft Road Map. The primary objectives for each session were: 1) Review and provide feedback on the focus group's draft Road Maps for new and existing buildings; and 2) identify key actors and roles for implementing the Road Map. Feedback received from the focus groups was used to complete the second draft of the Road Map.
June 2020	Stakeholder Workshop #2	103 stakeholders participated in a full-day, remote-access workshop that was led by Susanna Haas Lyons. The key objectives of the workshop were: 1) review and provide feedback on the second draft of the Road Map; 2) identify key actors and role for implementing the Road Map; and 3) provide information to participants about related activities being undertaken in BC, Canada, and in the United States. Feedback received from the focus groups was used to develop the third draft of the Road Map.
Aug 2020	Technology Innovation Survey	A short survey was sent out via email to 32 individuals from 18 different organizations. Five of the organizations were government organizations or utilities and the remaining 13 were heat pump vendors or manufacturers. The survey asked seven questions about accelerating the introduction of new technology into the BC marketplace. Responses were received from representatives of 16 of the 18 organizations (4 government/utility, and 12 vendor/manufacturer). Feedback received from the survey helped to shape the set of objectives and actions included in the Road Map's “Increase Available Technology” strategy.
Aug 2020	Steering Committee Review	In August 2020, Steering Committee members provided feedback on the third draft of the Road Map. Feedback received was used to develop the penultimate draft.
Sept 2020	Stakeholder Survey	The penultimate draft of the Road Map was shared with all stakeholders who participated in at least one phase of the Road Map's development. Participants were asked to participate in an anonymous survey that asked them 1) how supportive they were of the Road Map as a path forward to achieve its 2030 vision; 2) to provide any final feedback to help improve the Road Map; and 3) whether and how they would like to be involved with implementing parts of the Road Map. 65 participants responded to the survey. 87% either somewhat or strongly supported the draft Road Map. Almost every respondent provided written comments about the Road Map's strength and suggestions for improvement. Effort was made to take as many of these suggestions as possible into consideration for the final version.

Appendix B: Complete List of Strategies, Objectives & Actions

KEY STRATEGY #1 Create Market Demand

OBJECTIVES	Targeted Actions
Demonstrate Provincial leadership	**1.1** Announce and set provincial commitment **1.2** Lead with public sector buildings **1.3** Establish a key role for BC Hydro
Raise levels of consumer awareness	**1.4** Undertake a broad public awareness-building campaign, targeted to homes and businesses about the options and benefits of electrification
Establish GHG performance and climate resilience regulatory requirements	**1.5** Set and enact GHG requirements for the Energy Step Code **1.5** Set and establish GHG performance requirements for existing buildings **1.6** Enable municipal leadership for GHG requirements & other measures
Require building GHG performance reporting & disclosure	**1.7** Establish mandatory home energy labelling that includes both energy and GHG emissions performance **1.7** Establish mandatory building benchmarking that includes both energy and GHG emissions performance
Set minimum performance equipment standards	**1.8** Set a co-efficient of performance of greater than one (COP > 1) as the minimum energy performance standard for all space and water heating equipment by 2035, in alignment with the Federal Government's aspirational market transformation goal

KEY STRATEGY #2 Improve Cost Competiveness

OBJECTIVES	Targeted Actions
Reduce equipment & whole building capital costs	**2.1** Incentives & low-cost financing
Level the playing field between natural gas capital and operational costs	**2.2** Review & update utility rates accordingly **2.3** Work with standard-making organizations to advance metering devices that can support electrification rates **2.4** Continue carbon pricing on fossil fuels **2.5** Phase out fossil-fuel equipment incentives
Reduce electricity connection and system upgrade costs	**2.6** Review & update utility processes accordingly **2.7** Review & update the Canadian Electrical Code to optimize minimum electrical servicing requirements **2.8** Integrate whole building design with utility demand management
Address housing affordability and building electrification	**2.9** Establish low-income electrification plan and programs
Reduce transactional costs	**2.10** Support a Retrofit Coordinator Program **2.11** Help home and building owners to prepare for a fuel switch well in advance **2.12** Improve the response time for electrical service delivery

KEY STRATEGY #3 Address Systemic Barriers

OBJECTIVES	Targeted Actions
Reflect high-efficiency features more accurately in property appraisals	**3.1** Review & Update Finance Sector Appraisal Processes to Better Support Building Electrification
Reduce landlords' legal barriers to undertake electrification retrofits	**3.2** Review & Update Landlord-Tenant Legislation to Support Building Electrification **3.3** Establish guidelines for landlords to access tenants' suites for building electrification retrofits
Ensure buildings connected to gas district energy systems can decarbonize	**3.4** Review and Address Issues Associated with Building Electrification and Existing District Energy Agreements
Improve access to capital	**3.5** Offer alternative financing mechanisms
Reduce permitting complexity and time	**3.6** Establish guidelines for common heat pump applications and streamline the permitting processes accordingly

KEY STRATEGY #4 Expand Industry Capacity

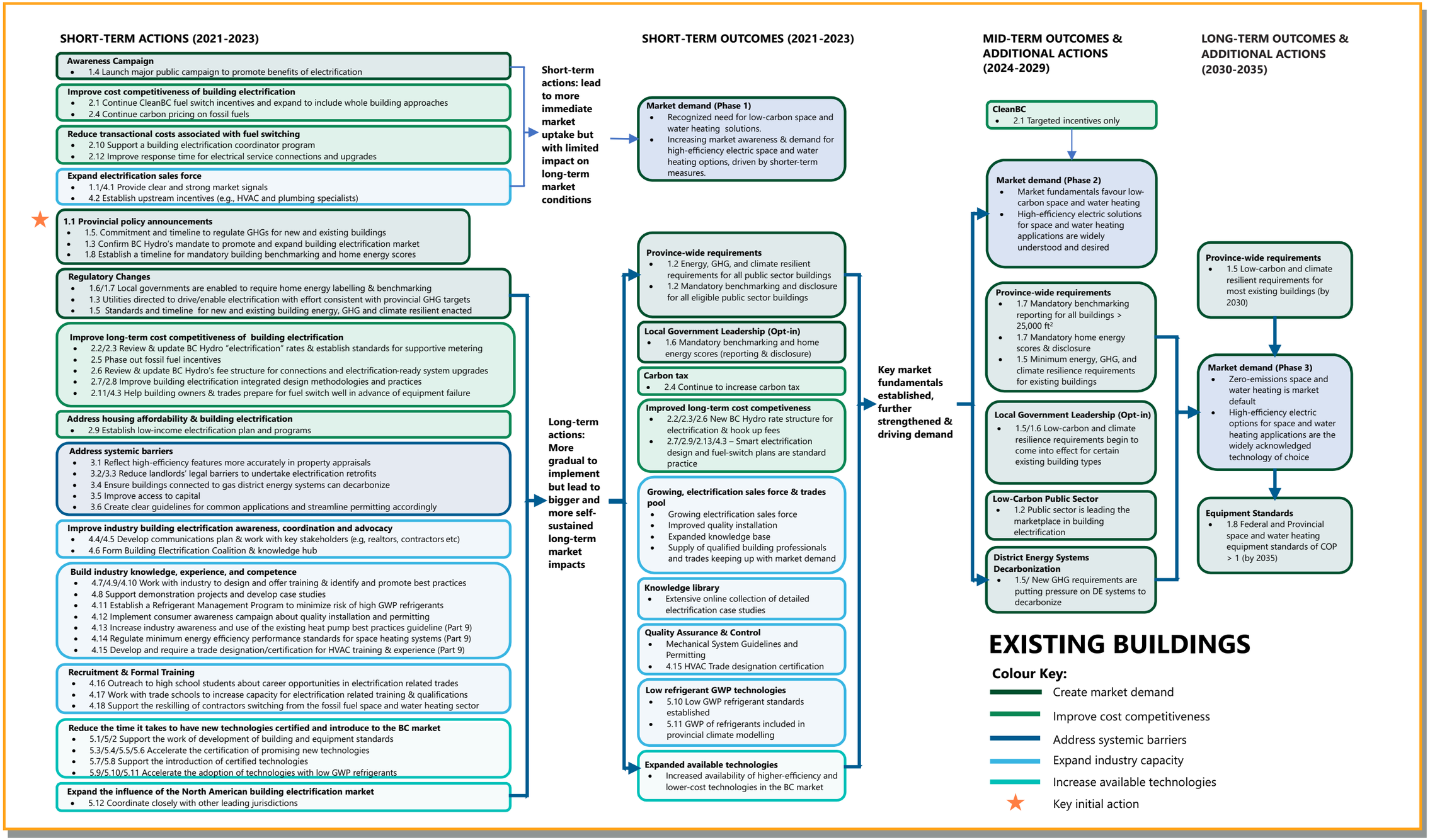
OBJECTIVES	Targeted Actions
Expand the electrification sales force	**4.1** Provide clear and strong market signals **4.2** Upstream offers (eg. HVAC and plumbing specialists) **4.3** Work with the trades to include electrification solutions as a standard emergency replacement option
Improve building electrification awareness, coordination, and advocacy	**4.4** Develop a communication plan to raise awareness across the building sector about governments' climate and electrification efforts **4.5** Implement targeted HVAC industry communications **4.6** Establish a building electrification coalition & knowledge hub
Build industry knowledge and experience	**4.7** Work with industry to design & offer relevant training **4.8** Support demonstration projects & develop case studies **4.9** Identify and promote best practices in heat pump design **4.10** Develop and offer building electrification training for the building design community **4.11** Establish a Refrigerant Management Program to address the GWP of refrigerants
Expand the use of trade certification and technical guidelines for energy performance best practices	**4.12** Implement consumer awareness campaign about quality installation and permitting requirements **4.13** Increase industry awareness and use of the existing heat pump best practices guidelines (Part 9) **4.14** Regulate minimum energy efficiency performance practices for space heating systems (Part 9) **4.15** Continue to develop and require a trade designation/ certification for HVAC training and experience (Part 9)
Support growth of building electrification trades	**4.16** Outreach to high school students **4.17** Increase capacity of trades schools **4.18** Reskilling and professional development for people currently working in the fossil fuel space and water heating sector

KEY STRATEGY #5 Increase Available Technologies

OBJECTIVES	Targeted Actions
Support the development of building and equipment standards	**5.1** Support the work of standards making bodies (e.g., Canadian Standards Association **5.2** 5.2 Improve testing standards to help identify higher performing equipment (e.g., cold climate test standard)
Accelerate the certification of promising new technologies	**5.3** Conduct an annual survey of leading existing technologies, post findings in a central website, and make local market aware of the findings **5.4** Provide certification support services for high-potential technologies **5.5** Support on-site certification and pre-certification trial projects **5.6** Explore a stepped certification acceptance of the European CE Mark as equivalent to a CSA mark
Support the introduction of already certified technologies	**5.7** Establish a comprehensive suite of measures to reduce some of the cost and risk borne by industry when introducing new technologies **5.8** Establish a building electrification Centre of Excellence
Accelerate the adoption of low GWP technologies	**5.9** Advocate to the Federal Government to accelerate the phasing out of high GWP refrigerants **5.10** Explore adding minimum GWP refrigerant requirements in the Energy Efficiency Standards Regulation **5.11** Add GWP refrigerant climate impacts to provincial climate modeling
Expand the market in North America for building electrification	**5.12** Coordinate closely with other leading jurisdictions

Appendix C: Logic Maps for Building Electrification

The Building Electrification Road Map for Existing Buildings 2021-2035



The Building Electrification Road Map for New Construction 2021-2028

SHORT-TERM ACTIONS (2021-2023)

Awareness Campaign
- 1.4 Launch major public campaign to promote benefits of electrification

Improve cost competitiveness of building electrification
- 2.4 Continue carbon pricing on fossil fuels

Reduce transactional costs associated with fuel switching
- 2.12 Improve response time for electrical service connections and upgrades

Expand electrification sales force
- 1.1/4.1 Provide clear and strong market signals

★ **1.1 Provincial policy announcements**
- 1.5. Commitment and timeline to regulate GHGs for new and existing buildings
- 1.3 Confirm BC Hydro's mandate to promote and expand building electrification market

Regulatory Changes
- 1.3 Utilities directed to drive/enable electrification with effort consistent with provincial GHG targets
- 1.5 Standards and timeline for new construction energy, GHG and climate resilience enacted

Improve long-term cost competitiveness of building electrification
- 2.2/2.3 Review & update BC Hydro "electrification" rates & establish standards for supportive metering
- 2.5 Phase out fossil fuel incentives
- 2.6 Review & update BC Hydro's fee structure for connections and electrification-ready system upgrades
- 2.7/2.8 Improve building electrification integrated design methodologies and practices

Address systemic barriers
- 3.1 Reflect high-efficiency features more accurately in property appraisals
- 3.4 Ensure buildings connected to gas district energy systems can decarbonize
- 3.5 Improve access to capital
- 3.6 Create clear guidelines for common applications and streamline permitting accordingly

Improve industry building electrification awareness, coordination and advocacy
- 4.4/4.5 Develop communications plan & work with key stakeholders (e.g, realtors, contractors etc)
- 4.6 Form Building Electrification Coalition & knowledge hub

Build industry knowledge, experience, and competence
- 4.7/4.9/4.10 Work with industry to design and offer training & identify and promote best practices
- 4.8 Support demonstration projects and develop case studies
- 4.11 Establish a Refrigerant Management Program to minimize risk of high GWP refrigerants
- 4.12 Implement consumer awareness campaign about quality installation and permitting
- 4.13 Increase industry awareness and use of the existing heat pump best practices guideline (Part 9)
- 4.14 Regulate minimum energy efficiency performance standards for space heating systems (Part 9)
- 4.15 Develop and require a trade designation/certification for HVAC training & experience (Part 9)

Recruitment & Formal Training
- 4.16 Outreach to high school students about career opportunities in electrification related trades
- 4.17 Work with trade schools to increase capacity for electrification related training & qualifications
- 4.18 Support the reskilling of contractors switching from the fossil fuel space and water heating sector

Reduce the time it takes to have new technologies certified and introduce to the BC market
- 5.1/5/2 Support the work of development of building and equipment standards
- 5.3/5.4/5.5/5.6 Accelerate the certification of promising new technologies
- 5.7/5.8 Support the introduction of certified technologies
- 5.9/5.10/5.11 Accelerate the adoption of technologies with low GWP refrigerants

Expand the influence of the North American building electrification market
- 5.12 Coordinate closely with other leading jurisdictions

Short-term actions: lead to more immediate market uptake but with limited impact on long-term market conditions

Long-term actions: More gradual to implement but lead to bigger and more self-sustained long-term market impacts

SHORT-TERM OUTCOMES (2021-2023)

Market demand (Phase 1)
- Recognized need for low-carbon space and water heating solutions.
- Increasing market awareness & demand for high-efficiency electric space and water heating options, driven by shorter-term measures, public sector leadership and local government requirements

Province-wide requirements
- 1.2 Energy, GHG, and climate resilient requirements for all new public sector buildings

Local Government Leadership
- Local governments being to opt-in to lower steps of GHG performance requirements for new construction

Carbon tax
- 2.4 Continue to increase carbon tax

Improved long-term cost competiveness
- 2.2/2.3/2.6 New BC Hydro rate structure for electrification & hook up fees

Growing, electrification sales force & trades pool
- Growing electrification sales force
- Improved quality installation
- Expanded knowledge base
- Supply of qualified building professionals and trades keeping up with market demand

Knowledge library
- Extensive online collection of detailed electrification case studies

Quality Assurance & Control
- Mechanical System Guidelines and Permitting
- 4.15 HVAC Trade designation certification

Low refrigerant GWP technologies
- 5.10 Low GWP refrigerant standards established
- 5.11 GWP of refrigerants included in provincial climate modelling

Expanded available technologies
- Increased availability of higher-efficiency and lower-cost technologies in the BC market

Key market fundamentals established, further strengthened & driving demand

MID-TERM OUTCOMES & ADDITIONAL ACTIONS (2024-2027)

Market demand (Phase 2)
- Market fundamentals favour zero-emissions space and water heating
- High-efficiency electric solutions for space and water heating applications are widely understood and desired

Province-wide requirements
- 1.5 Minimum energy, GHG, and climate resilience requirements for all new construction

Local Government Leadership (Opt-in)
- 1.5/1.6 Zero-emissions performance requirements and climate resilience requirements begin to come into effect for certain existing building types

Low-Carbon Public Sector
- 1.2 Public sector is leading the marketplace in building electrification

District Energy Systems Decarbonization
- 1.5/ New GHG requirements are putting pressure on DE systems to decarbonize

LONG-TERM OUTCOMES & ADDITIONAL ACTIONS (2028)

Province-wide requirements
- 1.5 Zero-emissions and climate resilient requirements for most new buildings by 2028

Market demand (Phase 3)
- Zero-emissions and climate resilient buildings are standard across most parts of the province
- High-efficiency electric options for space and water heating applications are the widely acknowledged technology of choice

Equipment Standards
- 1.8 Federal and Provincial space and water heating equipment standards of COP > 1 (by 2035)

NEW CONSTRUCTION

Colour Key:

- Create market demand
- Improve cost competitiveness
- Address systemic barriers
- Expand industry capacity
- Increase available technologies
- ★ Key initial action

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