BC Heat Pump Technology Attraction Strategy

VANCOUVER ECONOMIC COMMISSION

B2E Building to Electrification Coalition

This report was commissioned by the Vancouver Economic Commission (VEC), working on the unceded territory of the xʷməθkʷəy̓əm (Musqueam), Skwx̱wú7mesh (Squamish), and səl̓ilw̓ətaʔɬ (Tsleil-Waututh) Nations. These Nations have cared for the lands and waters of “Vancouver” since time immemorial, sustaining strong economies while thriving in balance with the natural world.

Vancouver is a City of Reconciliation, and VEC – an agency of the City – commits to forming long-lasting relationships of mutual respect and understanding with host First Nations and other local urban Indigenous communities.

VEC pledges to better understand the full breadth of truth and reconciliation and to work alongside local Indigenous communities to support and collaborate on building economic prosperity for all.

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Who We Are

VANCOUVER ECONOMIC COMMISSION

Our Purpose

The Vancouver Economic Commission's (VEC) purpose is to build a prosperous, inclusive, zero-carbon and resilient local economy, competitively positioned in the global market.

Pledge to Vancouver

As our world reopens following the COVID-19 pandemic, and as the world commits to a net zero future, we must reflect on the new realities of how people work – and how we measure prosperity across a wider social, economic and environmental framework.

It is within this context that VEC delivers on its mandate to support the long-term resilience and values of our local economy.

Our pledge to Vancouver is further shaped by our corporate values, which guide how we prioritize the highest and best use of our resources.

B2E Building to Electrification Coalition

Building to Electrification Coalition

B2E is a BC-based member-driven coalition whose purpose is to create opportunities for multiple stakeholders to work collaboratively to identify and address barriers to electrification and take actions that contribute to a meaningful market shift to low carbon building electrification. B2E is a convener and knowledge hub of building electrification best practices.

The creation of B2E was identified as a key strategy in the BC Building Electrification Road Map to support a rapid transition to building electrification.

B2E and the BC Building to Electrification Road Map were sponsored by cofounders BC Hydro, the City of Vancouver, and the BC Ministry of Energy, Mines, and Low Carbon Innovation. The B2E Coalition now contains numerous members from across industry, local government, nonprofits, and environmental organizations.

Executive Summary

The BC Building to Electrification Coalition (B2E) and Vancouver Economic Commission (VEC) partnered to develop and implement a BC Heat Pump Technology Attraction Strategy. The resulting strategy, delivered by Dunsky Energy + Climate Advisors and FRESCo Building Efficiency, identifies the needs, availability, gaps and opportunities in heat pump supply in BC; explores barriers to addressing these gaps; and proposes a series of actions and implementation steps to overcome barriers.

Heat pump technologies and products are a critical component of meeting BC's building electrification, climate action, and economic development goals. Strategies focused on increasing market demand via regulations and incentives are important; however, the BC market also needs tactics to catalyze and attract new technology, thereby ramping up the volume and diversity of heat pumps supplied by global manufacturers.

The use of fossil gas in buildings accounts for 34% (12.2Mt) of British Columbia's greenhouse gas emissions (excluding the oil and gas sector; in urban centres, such as Vancouver, they represent 54% of total emissions). Almost all of these emissions result from heating water and spaces. Heat pumps will help decarbonize space and water heating, and create greater resilience via their cooling capacities, as well.

Strategy Goal

Ensure that British Columbians have access to an affordable supply of high-performance heat pumps, which is critical to achieving local government and provincial decarbonization goals, especially those envisioned in the BC Building Electrification Road Map and the City of Vancouver's Climate Emergency Action Plan.

Availability and Gaps

Interviews with local suppliers of heat pumps in the BC market found that:

1. **Most of BC's heat pump needs are being met by currently available technologies, especially for single family homes and new construction.**
2. **Some technology availability gaps remain in key segments,** including lower global warming potential (GWP) refrigerant options for space heating systems, high temperature (>180°F/82°C) air-to-water space heating units, very low capacity 120V in-room units for low heating demand applications, and in-room units that integrate ventilation.
3. **Increasing the number of available models and manufacturers can help improve awareness and reassure the market** that heat pump technology is ready for the scale of the challenge represented by electrifying BC's building stock.

The following table provides a summary of gaps and product availability in the BC heat pump market:

Widely Available	Gaps
Air-to-air heat pumps • Cold-climate and standard • Ducted and ductless • Residential and commercial models	• Low GHGs (low GWP refrigerants) • 120V "Plug-in" units • Cold-climate performance (all-in-ones and HP water heaters) • Lower capacities (< 9kBtu/h) • Integrated ventilation • Higher temperature air-to-water units
Heat pump water heaters • Split and in-room models	

Barriers and Solutions

With the objective of increasing the supply and diversity of heat pump products in the BC market in mind, the project team conducted interviews with global heat pump manufacturers to identify any barriers and potential solutions. Interviewees generally agreed on three main barriers, and the interviews also yielded insights into promising solutions and tactics:

Barriers	Solutions for B2E Coalition and VEC
Market Size	• Collaborate with leading jurisdictions and industry partners • Collaboration between markets • Bulk procurement • Canadian assembly and manufacturing • Streamline certification processes
Workforce Capacity	• Training programs • BC Centre for Demonstration and Training
Safety and Performance Standards	• Review refrigerant regulations • Accelerate cold climate standards

Market Size

The most significant barrier is the cost and complexity of bringing a new heat pump technology into the market, particularly considered alongside anticipated demand for the product. To sell a new heat pump product in BC, global manufacturers must complete an extensive certification process to meet performance and safety standards, as well as undertake any necessary equipment modifications (e.g., voltage and frequency).

Solutions to this barrier include:

1. **Collaborate with leading jurisdictions and industry partners that have similar heat pump technology needs.** Demonstrate to global manufacturers that demand is larger than currently perceived by partnering with North American jurisdictions facing similar heat pump availability challenges.

2. **Undertake bulk procurement of products "missing" from the market.** Bulk procurement can offer a streamlined pathway to quickly address market needs and encourage innovation through the development of new products.

3. **Ramp up Canadian manufacturing with a focus on domestic market need.** Heat pumps that are manufactured and/or assembled in Canada are more likely to be tailored to suit domestic market needs and do not need to undergo equipment modifications.

4. **Streamline the certification process.** Pumps that are manufactured and/or assembled in Canada are more likely to meet local context, including a step-by-step comparison of how the certification process corresponds to European and other global standards.

Workforce Capacity

Another significant barrier is the lack of a qualified workforce or adequate labour capacity to design and install heat pumps. Systems that are poorly designed, installed or serviced can pose a reputational risk to manufacturers. While product-specific training programs are in place, manufacturers are concerned about lack of basic knowledge/skills of participants.

Solutions to this barrier include:

5. **Invest in workforce training programs.** BC should expand programs to increase quality and capacity of the local workforce. These programs should be tailored to prepare contractors for manufacturer training programs currently in the market. This could also include an initiative to develop a Red Seal trade (an adaptation of the existing refrigeration trade) focused on residential systems, as has been done in other provinces.

6. **Establish a BC heat pump centre for research, demonstration, and training.** This could provide hands-on opportunities to train the local workforce and provide product demonstrations.

Safety and Performance Standards

Manufacturers had two concerns related to safety and performance standards. The first is a current incompatibility with North American regulations and existing products by global manufacturers despite high performance. Some of these products have high potential, but would require significant revision to meet North American safety standards.

The second concern is related to the prevalence of energy efficiency performance standards that do not capture the overall performance (e.g., heating and cooling) or value of products by global manufacturers. Solutions to address this barrier include:

7. **Review standards to enable low-GWP refrigerants.** Exploring updates to regulations to enable different refrigerants would help diversify the market while addressing safety concerns.

8. **Explore opportunities to increase use of cold-climate performance metrics.** To increase the supply of cold-climate all-in-one units and heat pump water heaters, BC should assess options to better differentiate products that can meet local climate needs.

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1. Introduction

Building electrification is one of the most straightforward paths to rapidly decrease overall greenhouse gas (GHG) emissions in our communities and the province. Currently, buildings in BC represent 10.7% of the province's total emissions. At a regional level, community emissions from buildings account for 42% of GHG emissions in the Lower Mainland.

Building electrification replaces fossil fuel-based building operating systems (such as heating, domestic hot water, and cooking) with electric-powered systems. Fully electrified buildings significantly benefit from a clean electric grid. Ninety-eight percent of the electricity in BC is generated from renewable energy, which is more than 16 times cleaner from a GHG emissions perspective than fossil gas, and nearly 23 times cleaner than heating oil.

Increasing the availability of heat pumps is critical to meet BC's building electrification, climate action, and economic development goals. While strategies focused on increasing market demand will be critical, strengthening supply chains via investment attraction, capacity building, and industrial and manufacturing policy are also needed to ramp up the volume and diversity of heat pumps supplied to the BC market by global manufacturers.

The BC Building to Electrification Coalition (B2E) and the Vancouver Economic Commission (VEC) have partnered, leveraging the services, research, and insights of Dunsky Energy + Climate Advisors and FRESCo Building Efficiency, to develop an actionable BC Heat Pump Technology Attraction Strategy. The objective is to identify the needs, availability, gaps, and opportunities related to heat pump supply in BC, understand barriers to addressing these gaps, and develop a series of corresponding actions and implementation steps.

The project was overseen by a steering committee consisting of staff from VEC, BC Hydro, the BC Government, and relevant industry organizations.

Strategy Goal

Ensure that British Columbians have an affordable and accessible supply of high-performance heat pumps that are critical to achieving local government and provincial decarbonization goals, especially those envisioned in the BC Building Electrification Road Map and Vancouver’s Zero Emissions Economic Transition Action Plan.

Why heat pumps?

Heat pumps are the most efficient building-scale technology for electrification. Newer buildings designed with high-efficiency envelope and heat recovery systems directly benefit from emissions reduction through space heating and cooling with heat pumps. However, to electrify existing, more energy-intensive buildings, heat pumps require complementary support through heat recovery and/or envelope upgrades to achieve a holistic approach to decarbonization.

In addition to their environmental benefits in reducing building-related GHG emissions, heat pumps also improve occupancy comfort and climate resilience and adaptation. In the coming decades, it is projected that our regions will experience longer, hotter, drier summers with increasing frequency of extreme heat events. This, in turn, it fuels the likelihood of larger and more frequent wildfires that impact outdoor air quality.

Heat pumps' ability to both heat and cool a space allows buildings to be resilient during extreme heat and poor air quality events. The devastation caused by the heat dome in 2021 shows the critical need for buildings to maintain thermal comfort without relying entirely on passive measures such as operable windows. Although one might argue that conventional air conditioning systems can have similar functions, heat pumps operate at a comparable, if not improved, cost benefit and significantly lower carbon footprint. In comparison to fossil gas counterparts, heat pumps are up to 300% more energy efficient.

Why BC and why Vancouver?

Markets for technologies do not respect political boundaries, and nowhere is this truer than buildings and construction. As VEC learned from work completed in 2019 to attract heat pump manufacturers and others green building technology developers to invest in Vancouver, the small size of our market, both at a local and provincial scale, is a significant barrier to obtaining high quality products at an appropriate scale. This is why VEC and B2E are partnering to deliver the Heat Pump Strategy: to overcome these market size barriers for the benefit of everyone across Vancouver and BC.

The Strategy also benefits from the integrated way in which BC's efforts to decarbonize buildings have already begun. The City of Vancouver and other local governments have worked in partnership with the Province of BC since the creation of the BC Energy Step Code; now, B2E allows for an even wider array of collaborators from industry and communities to accelerate electrified, resilient buildings.

Milestones

Table 1. BC Building Decarbonization Milestones

2008	• Government of BC introduces comprehensive energy efficiency requirements into BC Building Code
2014	• Government of BC identifies local government guidelines for energy-efficient new construction
2016	• City of Vancouver releases Zero Emissions Building Plan
2017	• BC Energy Step Code Council formed and implementation begins
2019	• VEC forecasts $3.3B demand for building products from regional Step Code implementation
2020	• Multi-stakeholder BC Building Electrification Road Map (BERM) developed
2021	• VEC identifies strategic need to develop BC Heat Pump Technology Attraction Strategy in alignment with BERM and CEAP • Government of BC releases the CleanBC Roadmap to 2030
2022	• VEC releases Zero Emissions Economic Transition Action Plan (ZEETAP), with recommendation to deliver and support implementation of BC Heat Pump Technology Attraction Strategy

Why this strategy?

The need for work to address supply chain gaps was identified in BC's Building Electrification Road Map in Action 5.3, which states:

> *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 identify and assess the market readiness of high potential technologies that are in use elsewhere but not currently available in BC.*

Adding to the building decarbonization goals in CEAP, VEC's Zero Emissions Economic Transition Action Plan identifies a need to:

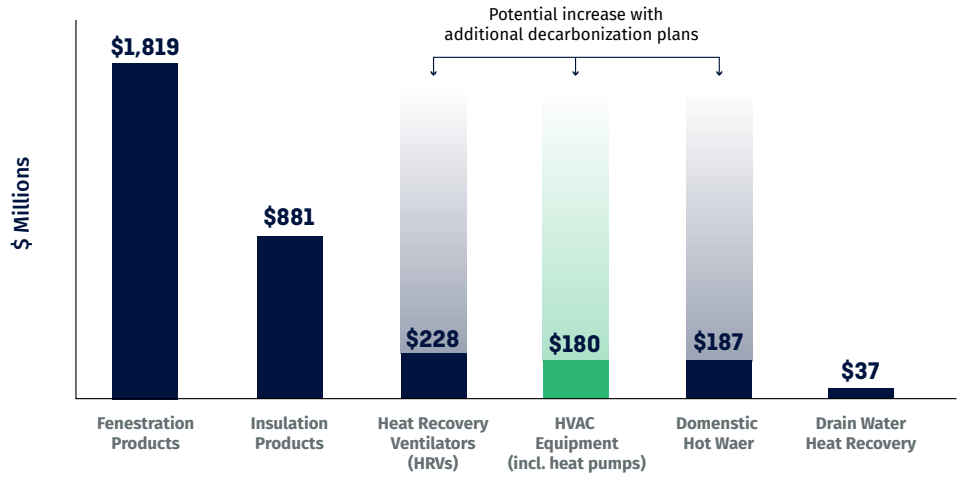
> *Develop plans and activities to close supply chain gaps, including technology "attraction strategies" for key decarbonization technologies [and to] finalize the development of the BC Heat Pump Technology Attraction Strategy and work with B2E to implement the activities therein between 2022-2025.*

Out of these recommendations, VEC, BC Hydro, and the Ministry of Energy, Mines, and Low Carbon Innovation developed the intention for a heat pump specific strategy as both a proof of concept for work on other technologies, and to ensure that the most important building electrification technology had a strong foundation for success in BC. Ultimately, the goal of this strategy is to ensure British Columbians have access to an affordable supply of high-performance heat pumps, which are critical to our climate goals. By doing so, we can develop meaningful economic opportunities along the way.

Economic Benefits of Green Buildings

Constructing high-performance buildings to meet Vancouver and BC's zero emissions and net-zero energy-ready building policies is driving a $3.3 billion market for green building products and technologies in Metro Vancouver alone. Combined with retrofit projects, which make up between 25-50% of all construction activities, and increased retrofit and renovation projects could double the demand for this market.

Demand for Building Products
Metro Vancouver, New construction, 2019-2032 Forecast (cumulative)



Source: Green Building Market Forecast, VEC

In addition, the future BC Retrofit Code could generate more than 4,400 direct jobs and close to 6,000 indirect jobs between 2019 and 2039 (net impact, full-time equivalent jobs) and contribute over $8.3 billion to BC's GDP.

1.1 Methodology

This project utilized three modes of analysis:

• **Background availability research**
The initial phase of the project identified the needs, availability, gaps, and opportunities in heat pump supply in BC. To achieve this, the team conducted desktop research of existing resources, interviewed five local heat pump suppliers/distributors, and leveraged internal industry expertise in heat pump technology and understanding of the BC market.

• **Company identification and evaluation**
This phase of the project involved identifying relevant global manufacturers that are well positioned to help supply BC's market needs. The project team developed a shortlist of global manufacturers with potential to help meet BC's market needs, identifying each company's interest, fit, and ease of access to the market.

• **Identification of barriers and solutions**
Interviews were conducted with manufacturers to understand the barriers they face entering the BC market, and developing products to meet BC's specific market needs. Manufacturers were interviewed based on the evaluation process outlined above and based on availability within project timelines.

2.0 Heat Pump Needs, Availability and Gaps

This section presents an overview of needs, availability, and gaps in the BC heat pump market.

Key findings include:

• **Most of BC's heat pump needs are being met by currently available technologies, especially for single family homes and new construction**. This was not the case a few years ago, but increased demand driven by tightening municipal building codes, incentives and the rapidly increasing carbon tax has resulted in new technologies filling key gaps. Note that although products may be available, not all suppliers are familiar with existing products, while some contractors refrain from promoting heat pump products to avoid their increased complexity, contributing to a perception of limited availability for some technologies.

• **Some technology availability gaps remain in key segments**, including lower global warming potential (GWP) refrigerant options for space heating systems, high temperature (>180°F/82°C) air-to-water space heating units, very low capacity 120V in-room units for low heating demand applications, and in-room units that integrate ventilation. The identified gaps represent a significant part of the building stock, including retrofits, multi-unit residential buildings (MURB), and commercial buildings. Given the high percentage of MURB buildings in BC, the demand for 120V plug-in and low-capacity units is high.

• **Increasing the number of available models and manufacturers would help improve awareness and reassure the market** that heat pump technology is ready for the scale of the challenge that electrifying BC's building stock represents.

Table 2. Summary of heat pump availability and gaps in BC

Widely Available	Gaps
Air-to-air heat pumps • Cold-climate and standard • Ducted and ductless • Residential and commercial models	• Low GHGs (low-GWP refrigerants) • 120V "Plug-in" units • Cold-climate performance (all-in-ones and HP water heaters) • Lower capacities (< 9kBtu/h) • Integrated ventilation • Higher temperature air-to-water units
Heat pump water heaters • Split and in-room models	

2.1 BC Heat Pump Needs

To achieve decarbonization goals, BC needs heat pumps that are compatible with the building stock, work with (or affordably replace) the building's existing distribution system, match the building's heating and cooling demand, work with existing electric service, work in the local climate, and comply with permitting regulations. To maximise GHG savings, heat pumps must have low GWP refrigerants and/or low refrigerant leakage. Heat pumps are needed for both space heating and cooling and domestic hot water.

Table 3. BC heat pump market needs

Building types	• Single-family • Multi-family • Small/medium commercial and institutional • Large commercial and institutional
Compatibility with existing building stock	• Matches or replaces distribution system • Required voltages and capacities
Climate zones	Zones 4, 5, 6, 7, and 8 with some marine (temperate humid) areas
Refrigerants	Low-GWP refrigerants
Additional end-uses integrated	Space heating • Space cooling • Ventilation • Domestic hot water Water heating • Space cooling • Ventilation

2.2 Availability and Gaps

An analysis of building heating requirements revealed that, in general, heat pump technologies are available for integration into most building heating contexts; however, a few notable gaps remain:

- **Low-GWP refrigerants** for some heat pump configurations.

- **The range of available low-capacity units** suited to smaller apartments and homes. To serve apartments and individual rooms, more models and options for low-capacity (< 9kBtu/h) standard-voltage heat pumps, and low voltage (120V plug in) in-room heat pumps are needed.

- **Cold-climate air-to-water (hydronic) heat pumps** necessary to serve the interior region, including Kamloops and Prince George, are currently limited, with no mid-to low-GWP options available.

The table below summarizes the availability of various heat pump technologies for space heating and how well they fulfill BC market needs.

Table 4. Summary of space heating technology availability and gaps

BC Market Needs		Heat Pump Technology							
		Ducted			In-room			Hydronic	
		Air-to-air	Ground source water-to-air	Rooftop	All-in-one (PTHP)	Ductless mini split	VRF	Air-to-water	Ground source water-to-water
Building types	Single-family	✓	✓		✓	✓		✓	✓
	Multi-family				✓	✓	✓	✓	✓
	Small/medium C&I			✓	✓	✓	✓	✓	✓
	Large C&I			✓			✓	✓	✓
Compatibility	Matches/ replaces distribution system	●	●	●	●	●	●	◒	◒
	Required voltages and capacities	●	●	●	◒	◒	●	●	●
Climate	Cold-climate compatible	●	●	●	○	●	●	◒	●
Refrigerants	Low GWP	○	◒	◒	◒	○	○	◒	◒
Additional end-uses integrated	Space cooling	●	●	●	●	●	●	◒	●
	Ventilation (fresh air requirements)	○	○	●	○	○	○	○	○
	Domestic hot water	○	●	○	○	○	○	◒	●

Legend: ● Need fully covered by multiple models, ◒ Need only partially covered or covered by few models, ○ No models available

The table below summarizes the availability of various heat pump water heater technologies and how well they fulfill the needs identified in section 2.1 of this report. While most needs are covered, the market is dependent on a few key products. Remaining gaps include low-GWP 120V systems for residential retrofits, 600V systems for large commercial applications, and low-GWP refrigerant packaged systems.

Table 5. Summary of water heating technology availability and gaps

BC Market Needs		Heat Pump Technology	
		Split heat pump water heater	**Packaged heat pump water heater**
Building types	Single-family	✓	✓
	Multi-family	✓	✓
	Small/medium C&I	✓	✓
	Large C&I	✓	
Compatibility with existing buildings	Required voltages and capacities	◒	◒
Climate	Cold-climate compatible	◒	○
Refrigerants	Low GWP	◒	○
Additional end-uses integrated	Space cooling	◒	◒
	Ventilation (fresh air requirements)	○	○
	Space heating	◒	○

Legend: ● Need fully covered by multiple models, ◒ Need only partially covered or covered by few models, ○ No models available

2.2.1 Building Types

Different building types have different distribution systems, including forced air, hydronic, and in-room. Heat pumps need to work with each of these systems.

Heat pumps that work with ducts are referred to as "-to-air" systems, and those that work with hydronic distribution are referred to as "-to-water" systems. The water temperature in hydronic distribution systems varies significantly across the different heat distribution equipment types (radiators, baseboards, under-floor heating, fan-coils). At the low temperature end, underfloor heating can run at 85°F (30°C). At the high end, baseboards in existing buildings will often run at 190°F (88°C) or higher. In the case of -to-water systems, products need to meet the wide range of distribution water temperatures.

Where working with the existing distribution system is too challenging, or where the existing distribution system cannot provide the service required (e.g., radiators cannot provide cooling), heat pumps can be installed to circumvent the distribution system.

Table 6. Summary of BC building types and distribution systems

Building Type	Distribution System
Ground-oriented residential buildings	Typically have forced air distribution, although some do have hydronic systems.
Apartments	Majority are central hydronic systems, but a significant proportion have electric baseboards. Majority of older stock have no air conditioning, except Okanagan zone where window AC is prevalent.
Commercial buildings	Typically have forced air distribution for ventilation air and hydronic distribution for envelope heating.

Availability and Gaps:

• **Ground-oriented residential buildings,** such as single family and row homes, have a variety of available space heating heat pumps to choose from, including ducted, in-room, and low-medium temperature hydronic options.

• **For small/medium commercial buildings,** there is also good space heating availability

• **Hydronic systems**, which are used to replace boilers across the whole range of building segments, are limited with only a few models. High temperature (> 180°F/82°C) models compatible with existing hydronic baseboard distribution systems are not available. Available hydronic systems are typically not suitable to meet the heating loads in very cold climates such as Kamloops and Prince George, and must rely on electric resistance back-up.

• **For small apartment buildings,** limited options are available for 120V or low capacity (< 9kBtu/h) heat pumps. The need in this area is crucial as apartment buildings remain a larger portion of BC's existing building stock.

• **Water heating** needs are met for all building types; however, they are represented by very few models. Options are particularly limited for packaged heat pump water heaters. 240V systems and conventional refrigerant (R-134a and R-410a) systems are widely available, however, 120V systems are not. This is a key gap in retrofit situations as 120V systems would make it much easier to install heat pump water heaters by avoiding panel upgrades.

2.2.2 Compatibility with existing building stock

Heat pump technologies need to **match (or replace) the existing distribution system.** In new construction, engineers have the flexibility to design the distribution system to optimize heat pump performance. In retrofit applications, however, replacing the existing distribution system is not normally an option. Heat pump technology must therefore work with the existing distribution systems or circumvent it.

Heat pumps are also needed that **match building voltages and electrical capacity.** Specifically, in retrofit applications, heat pumps need to match the capacity of the building's main electrical service and/or space on the electric panel. For example, in residential and small commercial buildings, installing 240V equipment in suites may require wiring upgrades, whereas 120V equipment avoids the cost and complication associated with these upgrades. Most multi-unit residential buildings have 208/120V 3 phase services available for central heat pumps, and 120V/208 single phase available in suites. Large commercial buildings in Canada use 600V 3 phase service.

In addition, heat pumps must be properly sized to buildings' demand. Oversizing tends to reduce efficiency and shorten the life of the equipment because the compressor cycles on and off frequently. Heat pumps also cost more per unit of capacity than fossil-fuel fired systems, so oversizing them is expensive. It is therefore important that a **full range of heat pump capacities** are available to meet different buildings' needs, from low-capacity units for well-insulated apartments, to high-capacity units for large commercial buildings.

Availability and Gaps:

• **Ducted air-to-air and ground source systems** are widely available for use in the residential sector.

• **Rooftop heat pumps** are available to meet the needs of small/medium commercial buildings.

• **For Hydronics**, which represent a large portion of BC's building stock, product availability is improving, but the choice of models is limited given how big the need is. Available models can work at supply temperatures up to 175°F (80°C) and can therefore cover new construction and some retrofit applicants. To retrofit buildings with high temperature hydronic systems without modifying the distribution system, systems would require even higher distribution temperatures (~180°F/82°C). This is a case where changing or modifying the distribution system may be the solution, rather than looking for heat pumps that can supply such hot water. An additional problem that NRCan does not have a test standard for this category of products (W2W GSHPs).

• **Water heating** needs are filled by a few niche, but critical products. One key modular product offers good cold-climate performance with a low-GWP refrigerant (CO_2) and can provide space heating for low load buildings. This product is often used in multiples to serve higher capacity applications. Commercial-sized CO_2-based products are also available. These CO_2 systems can provide the very hot water temperatures (175°F/80°C) needed in healthcare applications. They can also provide some cooling by using heat from the cooling loop.

A major gap in the water heating end-use is the lack of 120V systems, which would make it much easier to retrofit heat pump water heaters in ground-oriented and apartment buildings without additional wiring upgrades. A minor gap is that 600V systems are not currently available for large commercial applications, so 480V units must be used instead, which adds cost and complexity.

2.2.3 Climate Zones

A different heat pump technology is required to cover buildings' heating and cooling loads across BC's climate zones (4, 5, 6, 7, and 8) – ranging from marine (temperate humid) to very cold areas.

The efficiency and capacity of air source heat pumps decrease as outdoor air temperature falls. An increasing number of cold-climate air source heat pump models are available that can maintain a reasonable capacity and efficiency at very low outdoor air temperatures (down to -25°C). While this is not necessarily a need in BC's Lower Mainland and Vancouver Island, which experience milder climates, cold-climate performance is important for BC's colder regions. In particularly cold regions, or where cost or electric service constraints make it impossible to size the heat pump at the local design temperature, auxiliary heat in the form of electric resistance or fossil fuel-fired heat can be used to complement or supplement heat pump operation. In this case there is a need for control systems that allow the two systems to operate optimally together.

Availability and Gaps:

• **For space heating,** aspecifically ducted and ductless mini-split systems that are adequate for cold climates, availability has greatly improved in recent years.

• **There are limited cold-climate all-in-one (PTHPs) models** (available models only work down to -20°C) and low-GWP/mid-GWP refrigerant models (although mid-GWP models may soon be available), which are particularly useful in apartment buildings. Available air-to-water heat can be used to cover the full heating load in relatively cold climates such as Kelowna. However, they are not suitable for covering the full heating load in colder climates such as Kamloops and Prince George; however, hybrid systems can fill this gap and are available.

• **Minimal cold-climate heat pump water heaters are available** in the BC market. There are no low- or mid-GWP cold-climate packaged heat pumps and there is only one key split heat pump water heater product that offers good cold-climate performance with a low-GWP refrigerant (CO_2).

2.2.4 Refrigerants

Heat pumps provide significant GHG emissions reductions relative to fossil fuel equipment[1] even when accounting for refrigerant leakage, so concerns about refrigerants should not slow efforts to electrify.

Refrigerant leakage is nonetheless a significant source of emissions which, if left unabated, will become increasingly significant as other emissions fall. The impact of refrigerant leakage can be decreased by reducing leakage and/or by reducing the GWP of the refrigerant used.

In terms of the refrigerants themselves, today's Hydroflourocarbon (HFC) refrigerants have GWPs of the order of 2000 times greater than carbon. One of the most commonly used refrigerants today is R410A, which is considered a high-GWP refrigerant (GWP=2090). International accords and laws mean that global manufacturers are now starting to use lower GWP refrigerants. These fall into two categories:

- Mid-GWP refrigerants (150-750) such as R32 and R513A
- Low-GWP refrigerants (< 150) such as R744 (CO_2), R290 (Propane), and R-1234-yf

[1] In British Columbia where the electric grid is clean and low-emitting, this remains true however, this may not apply to all jurisdictions where electricity is produced via fossil fuels.

Refrigerants are classed based on their flammability. There are four flammability classes (1, 2L, 2, and 3), with a higher rating equal to higher flammability. Traditional high-GWP refrigerants like R410A are class 1. Some of the lower GWP synthetic refrigerants, including R32, are 2L. Propane is a class 3 refrigerant.

Availability and Gaps:

• **Mid-GWP refrigerant models in the space heating category are becoming increasingly available.** Recent/ongoing updates to the regulation on A2L refrigerants such as R32 (GWP=677) mean that some of the more innovative manufacturers have brought in mid-GWP refrigerant systems or are planning to do so in the near future.

• **There is a lack of low-GWP products in BC across all heat pump technologies.** However, there is one key CO_2 based water heating product[2] which meets a critical need in low-load residential buildings, in addition to some commercial-sized CO_2 products.

• **For ducted air-to-air heat pumps, low-GWP options represent a key gap.** Building regulations prohibit propane (R290) charges higher than 150g[3] , and CO_2 needs a big temperature drop through the distribution system, which is hard to design for. The split nature of these heat pumps means the refrigerant cannot be in a factory-sealed component, so leaks are much more likely. There is also more refrigerant than in a packaged system. These factors mean that the GWP of the refrigerant is particularly important for split systems.

2.2.5 Additional end-uses integrated

Across the entire space and water heating sectors, there is limited to no availability of ventilation integrated options. Very few of the space heating units available can integrate domestic hot water.

Currently, only ground source water-to-air heat pumps can meet some of the water heating load (pre-heating via desuperheater). Additionally, some DHW CO_2 refrigerant-based units can be used to provide space and water heating in very low heating demand applications; however, the options are limited.

Most space and water heating units can also provide space cooling. However, water heating units have limited functionality when it comes to supplying space heating, where once again a single key product can meet this added function.

[2] $SANCO_2$ heat pump water heater by Eco2Systems. https://www.eco2waterheater.com/
[3] The International Electrotechnical Commission (IEC) now allows R290 charges up to 500g, so R290 heat pumps are widely available in Europe.

3.0 The Strategy

The BC Building Electrification Road Map and the Vancouver Economic Commission's Zero Emissions Economic Transition Action Plan require supply chain gaps to be addressed to advance climate action and building decarbonization. The strategy that follows directly responds to the needs and priority actions of both. It will be implemented collaboratively with members from the entire B2E Coalition.

BC Building Electrification Road Map	Zero Emissions Economic Transition Action Plan
Electrification is recognized by all levels of government as a critical strategy for decarbonizing BC's building sector. The Building Electrification Road Map is a tool through which a set of tactical actions for building electrification have been identified, including the right sequence and steps to ensure BC's building sector reaps the benefits of a clear and coordinated market transformation for both the existing building and new construction sectors.	As directed through the City of Vancouver's Climate Emergency Action Plan (CEAP), the Vancouver Economic Commission's (VEC) new Zero Emissions Economic Transition Action Plan (ZEETAP) aims to address barriers and challenges on the path to a just and equitable zero-carbon future. The plan is oriented around six directional statements that contain 25 actions to be implemented by VEC and partners over the next three years. Direction three (Accessible Climate Solutions) action four directs VEC and partners specifically to develop the BC Heat Pump Technology Attraction Strategy as a part of strengthening key technology supply chains.

3.1 Challenge Mapping

To support the development of a strategy that addresses supply chain gaps in heat pumps, the project team interviewed a variety of international heat pump manufacturers, who identified challenges and barriers preventing their ability to penetrate the BC market.

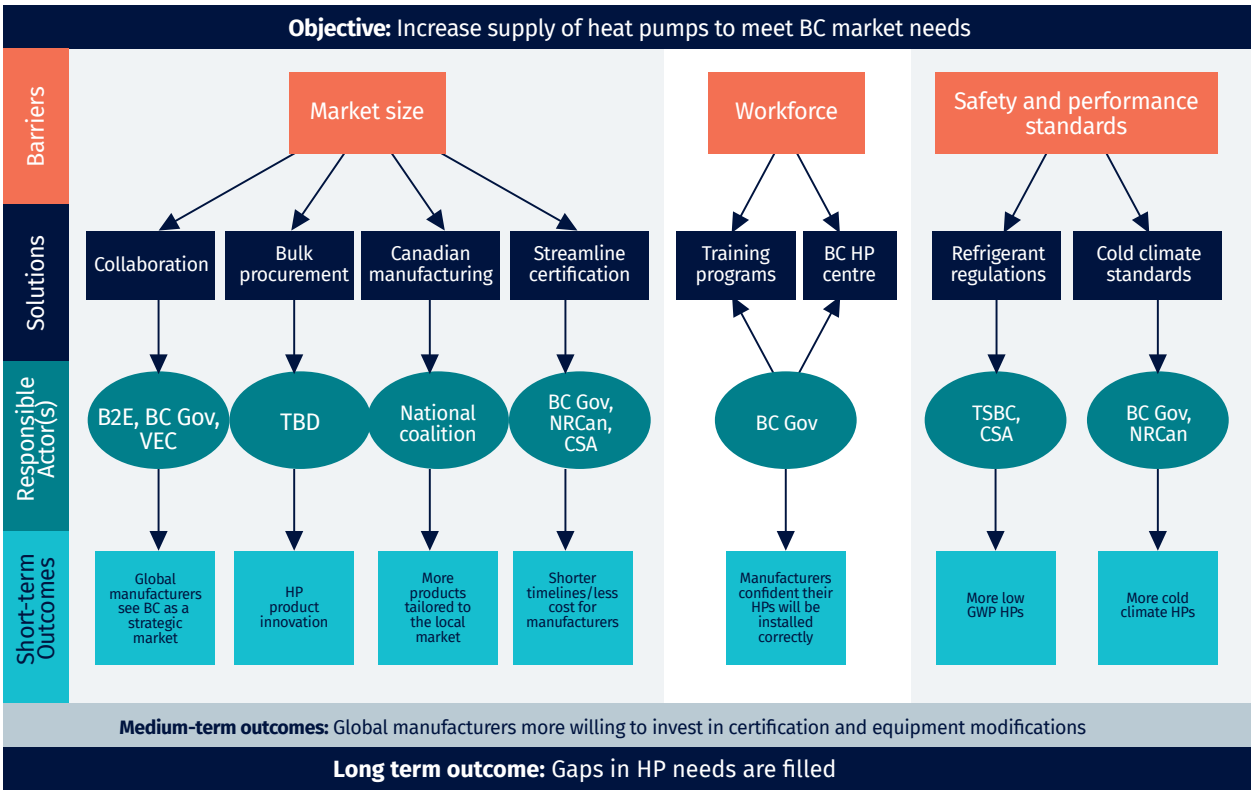
The extent to which the identified challenges and barriers deter different manufacturers depends on a variety of factors, including company size and maturity, diversity/applicability of product line, manufacturing presence, size of market, etc. In many cases, these barriers may not be mutually exclusive, and the implication/severity of one may make additional barriers more (or less) manageable. For example, where perceived market size is too small to overcome the costs of re-engineering and/or certification, the combined effect is that the product is delayed or does not make it to market.

Table 7: Summary of barriers and solutions

Barriers	Solutions
Market Size	• Collaborate with other markets • Bulk procurement • Canadian manufacturing • Streamline certification processes
Workforce Capacity	• Training programs • BC Centre for Demonstration and Training
Safety and Performance Standards	• Review refrigerant regulations • Accelerate cold climate standards

3.2 Strategy Overview

Figure 1: Summary of barriers, solutions, actions and outcomes



3.3 Market Size

The most significant barrier identified by manufacturers was the cost and complexity of bringing a new heat pump technology into the market relative to the anticipated demand.

To sell a new heat pump product in the BC market, global manufacturers must complete an extensive certification process to meet performance and safety standards, as well as undertake any necessary equipment modifications (e.g., voltage and frequency). While some standards are harmonized across North America, there are also requirements specific to each jurisdiction, and North American standards differ from international/European standards. Specific issues raised by manufacturers include:

- The need for every component to be certified, which adds cost and limits the number of available components.
- The need for full certification to bring a product over solely for testing, which makes it hard to de-risk the introduction of a new product into the market.
- Frequent, short-notice changes in requirements, which are particularly hard on smaller manufacturers with limited engineering resources.
- Despite support from federal and provincial regulators, certification know-how is a barrier for first-time importers. Multiple global manufacturers mentioned that differences between the European and North American certification systems made it harder for them to understand how to get their products certified in North America.
- Differences in regulations among various jurisdictions (e.g., among provinces, between Canada and the USA, between NA and the EU) add cost and complexity for manufacturers.

Findings from interviews with manufacturers highlighted that, because the North American market for air-to-air products is large and mature, certification processes and equipment modifications are well worth the cost and effort.

However, for other products that are needed in BC, but not seen by manufacturers to have a large demand in North America, (such as air-to-water heat pumps, cold-climate all-in-ones, and 575V heat pump water heaters), the small size of the market is not enough of an incentive to go through the certification process and equipment modifications. In addition, the large European heat pump market demand means there is strong competition for supply, and manufacturers have less need to find new markets for their products.

Solutions to addressing this barrier include:

- Form a trade coalition with jurisdictions with similar heat pump technology needs.
- Bulk procurement of "missing" products in the market.
- Ramp up Canadian manufacturing with a focus on domestic market needs.
- Streamline the certification process.

3.3.1 Collaborate with leading jurisdictions and industry partners

Outcome: Demonstrate to global manufacturers that BC is a strategic market by:

1. Reducing market barriers through harmonizing safety and performance requirements across jurisdictions
2. Presenting assessments of combined market demand for similar heat pump product needs

One opportunity to help reduce the barrier presented by the small size of the BC market is to demonstrate to global manufacturers that the demand for the "missing" products is larger than perceived, by partnering with other North American jurisdictions facing similar heat pump availability challenges. By either forming new (e.g., trade coalitions), or enhancing existing (e.g., the Advanced Heat Pump Coalition, the Pacific Coast Collaborative) with jurisdictions with similar technology needs, BC could demonstrate to global manufacturers that anticipated market demand justifies going through North American certification processes, and/or equipment modifications.

To reduce market barriers, collaborations should also work to harmonize safety and performance requirements across these jurisdictions to ensure products can enter the market more easily. It could also engage with regulatory bodies, such as NRCan and the CSA Group, to advocate for standards to be further aligned with those applied in Europe.

These collaborations or coalitions should include relevant jurisdictions with similar heat pump needs (e.g., California for 120V appliances, and New York on cold-climate products) as well as leading-edge policy environments that are likely to contribute to strong growth in heat pump market demand. These efforts could develop an assessment of combined market demand for similar heat pump product needs, making the investment of time and hassle required to modify and certify products more worthwhile for global manufacturers. Quantifying the impact of strong building decarbonization policies, such as building codes and standards, on the future demand for heat pumps can play a critical role in making markets more attractive for manufacturers. More visible presence at trade shows and exhibitions could also play a role.

Implementation steps include:

• Initial engagement with manufacturers to explore pathways enabling them to ramp up their supply of heat pumps to the BC and Canadian market(s) and showcase the growing heat pump market demand driven by innovative building policies. These manufacturers might have large and innovative product lines, products available in other jurisdictions that are needed in BC, and/or an active presence in the BC market (e.g. Mitsubishi, Innova, or Ephoca, Daikin, Gradient).

• Quantify the size of the BC and Canadian heat pump market(s), including heat pump technology needs and the impact of policies on market size.

• Explore partnership and collaboration models with leading jurisdictions with similar heat pump needs and leading climate policies. For example, start with Canadian cities and provinces (e.g., Quebec), then expand to US cities and states. These collaborations could undertake work to:

- Perform cross-jurisdictional analysis to compare and quantify market needs.
- Harmonize requirements across different jurisdictions, as applicable (e.g., safety standards and energy efficiency and GHG performance requirements).[4]
- Engage with NRCan and CSA Group to explore harmonization with EU/ international standards.
- Conduct broader engagement with global manufacturers through trade missions, trade shows etc. (focusing on manufacturers likely to be interested in the Canadian market).

[4] For example, BC requires that split system heat pumps models manufactured in 2020 or later to have a Heating Seasonal Performance Factor (HSPF) ≥ 7.39, which is higher than that of the federal standards applied in other provinces (≥ 7.1).
Source: https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/14_2015

Key actors responsible for implementing this solution include:

Lead Actors

- B2E Coalition
- Advanced Heat Pump Coalition
- BC Ministry of Energy, Mines and Low Carbon Innovation
- Natural Resources Canada (NRCan)
- Vancouver Economic Commission (VEC)
- BC Hydro

Supporting Actors

- Other Canadian cities (Toronto, Montreal, etc.)
- Pacific Coast Collaborative
- New York, California, and other states
- Canadian Standards Association (CSA) Group

3.3.2 Bulk procurement of heat pump technologies missing from the market

Outcome: Encourage development of new innovative products to fill a specific heat pump market need.

Bulk procurement of heat pump technologies that are currently "missing" from the market is another strategy to fill gaps in heat pump supplies. Bulk procurement can offer a streamlined pathway to quickly address market needs and encourage innovation by encouraging the development of new products. The New York Clean Heat for All Challenge is a recent example of a bulk procurement initiative to fill a specific heat pump market need. However, for this strategy to be effective, the heat pump technology would need to be already certified in the North American market; global manufacturers are unlikely to be willing to go through the certification process for a single procurement initiative.

Implementation steps include:

- Engage with industry associations and building owners to assess strategic opportunities to fill specific technology gaps.
- Assess existing innovation programs that could be leveraged (e.g. Project Greenlight clean tech commercialization program).
- Identify lead actor/organization best positioned to lead delivery (e.g. VEC, ZEIC, BC Hydro, BC Housing)

Key actors responsible for implementing this solution include:

Lead Actors

- Vancouver Economic Commission (VEC)
- Metro Vancouver Zero Emissions Innovation Centre (ZEIC)
- BC Housing
- BC Government

Supporting Actors

- Heating Refrigeration and Air Conditioning Institute of Canada (HRAI) HRAI and other industry associations

Case Study: NYCHA, NYPA, and NYSERDA joint Clean Heat for All Challenge

Bulk procurement of heat pump technologies that are currently 'missing' from the market is another strategy to fill in gaps in heat pump supplies. Bulk procurement can offer a streamlined pathway to quickly address market needs and encourage innovation by encouraging the development of new products. The New York Clean Heat for All Challenge is a recent example of a bulk procurement initiative to fill a specific heat pump market need. However, for this strategy to be effective, the heat pump technology would need to be already certified in the North American market: global manufacturers are unlikely to be willing to go through the certification process for a single procurement initiative.

3.3.3 Ramp up Canadian assembly and manufacturing

Outcome: Increase products tailored to local market needs without modifications or certification processes.

The cost and complexity of entering a new market can be reduced by increasing the supply of Canadian heat pump manufacturing and assembly. Heat pumps that are manufactured and/or assembled in Canada are more likely to be tailored to suite domestic market needs and do not need to undergo equipment modifications. Domestic manufacturers do not face the challenge of having to undergo multiple certification processes (e.g., North American and European).

Implementation steps include:

- Review and synthesize related industrial policy and commitments (e.g., Superclusters policies, Natural Resources Canada Market Transformation Roadmap, etc.).
- Explore potential niche product manufacturers with the Building Innovation Fund and/or other innovation programs.
- Engage with existing Canadian manufacturers and HVAC-oriented industry associations, Natural Resources Canada, utilities, academics, and other organizations (e.g., the Transition Accelerator). Work with these organizations to:
  - Assess needs and opportunities (e.g., local assembly of components, local customizations for use and climate).
  - Develop a roadmap for how the industry can be expanded/supported to increase the supply of heat pumps, such as:
    - Identify and understand key priorities for market success.
    - Create strategies targeting specific areas of the heat pump supply chain, including but not limited to, access to materials, manufacturing, components (controls etc.), production and assembly.
    - Strengthen local leadership and awareness through increased support, education, and R&D.
    - Support existing HVAC manufacturers to transition into heat pumps (e.g. provide guidance and resources, facilitate partnerships with suppliers).

Key actors responsible for implementing this solution include:

Lead Actors	Supporting Actors
• Transition Accelerator • HRAI • NRCan • Vancouver Economic Commission	• BC Government • BC Hydro

Case Study: WaterDrop Project by Small Planet Supply

The WaterDrop product offered by Small Planet Supply is a central DHW heat pump for large, commercial buildings utilizing the SanCO2 heat pump technology by Eco2Systems. This product combines multiple SanCO2's in a packaged array with a proprietary controls system (designed by Small Planet Supply, Eco2Systems, and Culler LLC) that includes staging, optional M&V, and load shift potential to ensure maximum performance. This project was awarded grant funding from CleanBC to be manufactured within the province and is "North America's first market-ready large building CO_2-based central water solutions heating solution" – filling a critical gap for large scale DHW and low-GWP products.

3.3.4 Develop guidance materials to streamline certification processes

Outcome: Decrease time and cost for manufacturers to enter the BC market.

To reduce the complexity of entering the market, BC should work with industry associations and regulators to develop additional guidance materials on the certification process, including a step-by-step comparison of how it corresponds to European and other global standards. These guidance materials could be offered to manufacturers along with an information package with general information on market size, policy environment, and specific heat pump technology needs and opportunities.

Implementation steps include:

- Map current certification process and key players, including performance and safety testing for certification (Performance = AHRI/CSA & EXP-07 and Safety = UL/CSA).
- Engage with CSA and other regulators to explore opportunities for them to advance / support climate initiatives (e.g. more streamlined processes for approval of key technologies).
- Develop guidance materials for manufacturers, including local, provincial and federal/North American requirements and how they align with EU/international requirements.

Lead Actors
• Vancouver Economic Commission/trade coalition • BC Government • CSA
Supporting Actors
• NRCan • BC Hydro

3.4 Workforce capacity

The second most significant barrier identified by manufacturers to increasing the supply of heat pumps to the BC market was the lack of a qualified workforce to design and install heat pumps.

Lack of a qualified workforce and capacity was seen to pose a reputational risk to manufacturers if systems are poorly designed, installed, or serviced. While product-specific training programs are in place, manufacturers were concerned about the lack of basic knowledge/skills of participants.

Even with packaged systems, heat pumps are less forgiving of poor design and installation than combustion equipment. In addition, installing split systems requires knowledge of how to charge refrigerant piping. Local refrigeration technicians are already in very high demand, and the required skillset for installing air-to-water systems bridges electricians, plumbers, and refrigeration technicians. Additional challenges may arise as new, low-GWP refrigerants are introduced to the market. One such example is CO_2, where very few technicians are trained to maintain the necessary high pressure to correctly service these products.

Solutions to this barrier include:

- Investing in workforce training programs.
- Establishing a BC Heat Pump Centre for demonstration and training.

3.4.1 Invest in workforce training programs

Outcome: Improve manufacturer confidence in the local workforce by increasing qualified heat pump installers.

To address this barrier, BC should expand programs to increase the quality and capacity of the local workforce.

These programs should be specifically tailored to prepare contractors for manufacturer training programs currently in the market. This could also include an initiative to develop a Red Seal trade (an adaptation of the existing refrigeration trade) focused on residential systems, as has been done in other provinces. Contractor certification programs can be used by utilities and government incentive programs to increase the number of heat pumps installed by "accredited" or "registered installers.

Implementation steps include:

- Review findings of the Energy Step Code Industry Capacity Study and work to implement/build on the recommendations for HVAC professionals[5].
- Leverage existing initiatives (for example, from the Advanced Heat Pump Coalition) and review current heat pump workforce training programs in BC to assess whether the scope/capacity aligns with future BC workforce needs. Efforts to integrate include:
    - The B2E Coalition's Expanding Industry Capacity Sub-Committee's efforts on training and skills-building[6]; and
    - The Quality First™ training program designed by the City of Vancouver and TECA (Thermal Environmental Comfort Association) to develop training to up-skill the existing installer base on requirements of heat pump installations[7].
- Engage with educational institutions, industry and professional organizations, and unions to review demand, gaps and opportunities and inform the overall development of the StrongerBC Skills and Training Plan.
- Engage and partner with programs and initiatives to increase diversity and inclusion in buildings-related trades, such as the BC Centre for Women in the Trades (BCCWITT), to increase the overall supply of labour for heat pump installations and design.

[5] BC Energy Step Code Capacity Study. SCIUS Advisory and Delphi Group. July 2021. Accessed at: https://energystepcode.ca/app/uploads/sites/257/2021/09/BCESC-Capacity-Study-Presentation-07_07_21-1.pdf
[6] Quality First™ Training Courses: Setting Minimum Standards for the Heating, Ventilating and Cooling Trade in British Columbia. Accessed at: https://www.teca.ca/quality-first-training-courses.php
[7] Ibid

- Engage with BC Ministry of Advanced Education and Skills Training to identify/co-create educational opportunities and programs.
- Engage with manufacturers to assess alignment opportunities with product-specific training programs.
- Identify lead actor/organization and funding opportunities.

Key actors responsible for implementing this solution include:

Lead Actors	Supporting Actors
• BC Government • BCIT and other educational institutions • ZEIC • B2E • Advanced Heat Pump Coalition • Home Performance Contractor Network • VEC/Just Transition Coalition	• City of Vancouver • HRAI

Case Study: Home Performance Contractor Network (HPCN)

The Home Performance Stakeholder Council (HPSC) is working to develop the HPCN, which will be a network of "skilled and knowledgeable contractors installing energy efficient, lower-carbon home performance solutions for HVAC" and more in BC. The program has a required list of courses which qualifying HVAC contractors must complete in order to join. Currently, qualifying companies must complete four mandatory courses, including two by HPSC and two by either TECA or HRAI. This program replaced the Program Registered Contractor (PRC) network by BC Hydro and FortisBC in 2021 as a central database of qualified retrofit contractors in the province.

3.4.2 Establish a BC Heat Pump Centre for demonstration and training

Outcome: Improve manufacturer confidence in the local workforce by consolidating training resources.

Another solution to help address workforce challenges is to establish a BC Heat Pump Centre for research, demonstration, and training. This could be a multipurpose facility, or a smaller series of distributed centres, that provide opportunities to educate and train the local workforce and provide product demonstrations. Although the centre could collaborate and align with similar initiatives across Canada, a local, physical presence to conduct demonstrations and training is key to its success.

This kind of hub could provide hands-on opportunities to educate and train the local workforce and provide product demonstrations to allow engineers, architects, regulators, suppliers and prospective purchasers an opportunity to view products in action in a range of outdoor weather conditions at any time of year, which could overcome fears about cold weather and sound. It could help attract heat pump manufacturers by further demonstrating that the market is serious and encourage suppliers to stock product. If co-located with a refrigeration school, hands-on teaching functions such as flare connections, refrigerant capture, weigh-in, and maintenance diagnosis could be combined.

Implementation steps include:

- Conduct a scoping study to determine needs, opportunities, costs and potential host organizations.
- Leverage findings from workforce studies.
- Ensure training and resources are available/ transferrable to regions outside Metro Vancouver.
- Engage with other testing and research centres (e.g. Canmet) to ensure alignment.
- Identify lead actors/organizations and funding opportunities.

Key actors responsible for implementing this solution include:

Lead Actors
• BC Government • Industry Associations (HRAI, TECA, VRCA, Etc)
Supporting Actors
• Canmet ENERGY • NRCan • BCIT, or other similar educational institution • BC Hydro

3.5 Safety and Performance Standards

Two main barriers were identified by manufacturers related to safety and performance standards and increasing the supply of certain products to the BC market:

• **Refrigerant regulations:** Manufacturers identified a regulatory barrier that limits the supply of low-GWP heat pumps in the market. Propane (R290) is an example of a high-performance refrigerant with a very low GWP (3); however, it is also highly flammable (class 3). Recent modifications to the International Electrotechnical Commission (IEC) standard increased the limit of A3 (flammable) refrigerants (e.g. R290) up to 988 grams in single-split air-to-air AC/HP systems, providing additional safety measures (increased airflow, leak detectors, and safety shut-off valves). The charge limit was also increased for outdoor systems using A3 refrigerants and for multi-split air-to-air systems using A2L (mildly flammable, e.g., R32) refrigerants. While air-to-water heat pumps using R290 are widely available in Europe, North American refrigerant regulations hinder their commercialization in Canada. These products would be particularly pertinent to the BC market due to the relatively high penetration of hydronic systems in residential buildings compared to the rest of North America. Beyond the specific and possibly timely case of R290, other low-GWP refrigerants, particularly those with a GWP below 750 (as California and others seem to be regulating towards), must be regulated and coordination sought – particularly between with Quebec and California, which are two of the leading jurisdictions.

• **Energy efficient performance standards:** The current ENERGY STAR standard for heat pumps means that many programs champion only certain metrics (cooling performance). The adoption of the NEEP cold-climate heat pump specifications and product list has helped, but high-end manufacturers still feel that the real-world cold-climate performance of their products is not sufficiently valued relative to the competition.

Solutions to addressing this barrier include:

- Review standards to enable low-GWP refrigerants.
- Explore opportunities to increase use of cold-climate performance metrics.

3.5.1 Review standards to enable low-GWP refrigerants

Outcome: Increase low-GWP heat pumps by updating flammability regulations.

One strategy for increasing the supply of low-GWP refrigerant heat pumps to meet BC market needs is to review and explore updates to regulations to enable refrigerants, such as propane (R290) and other non-traditional com, similar to Europe.

However, BC does not set its own standard in this case. Flammability regulations are defined as part of the CSA standard No. 60335-2-40, which is a bi-national standard with UL in the US.[8] CSA standards were recently updated, but not enough to match international/EU standards.[9]

Recognizing that BC does not have the jurisdiction to set its own standard, the province could collaborate with other jurisdictions that have higher penetration of hydronic systems and need for low-GWP heat pump options and engage with CSA to explore whether flammability and other regulations can be updated to allow these products to enter the market. However, since the CSA recently completed a review of flammability regulations and decided not to align with international/European standards, this is a longer-term strategy.

[8] see Standard for Household And Similar Electrical Appliances - Safety - Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers.
[9] What is new? Expansion of scope to include new "slightly flammable" refrigerants (class 2L) to be used in AC/HP system – should be part of updated standard effective in 1.5 years (January 2024). Use of climate control with smart leak detection systems will be mandatory. IEC is on 7th edition of the 2-40 standard, with ~500g of A3 (e.g., propane) refrigerant allowed. The 4th edition of the CSA/UL 2-40 standard to be published end of 2022 will allow ~150g of A3 in appliances.

Implementation steps include:

- Identify other jurisdictions that have need for high performance air-to-water products that use low-GWP refrigerants, such as R290.
- Review and engage with industry standards, such as ASHRAE 15.2-2022, that focus on mitigating the impact of high-GWP refrigerants.
- Engage with CSA in collaboration with other jurisdictions, to explore whether standards can be further updated.
- Utilize trade coalitions and other partnerships to help push more progressive standards for refrigerants in line with EU/international requirements.
- Assess implications of the refrigerant transition on technicians and the need for upgrade training.
- Engage with initiatives to promote local manufacturing to ensure the use of next-generation refrigerants for any and all made-in-Canada heat pumps.

Key actors responsible for implementing this solution include:

Lead Actors	Supporting Actors
• BC Hydro • Technical Safety BC • Canadian Standards Association (CSA) Group	• BC Government • Natural Resources Canada (NRCan) • Vancouver Economic Commission (VEC)

3.5.2 Explore opportunities to increase use of cold-climate performance standards

Outcome: Increase cold climate heat pumps by updating performance standards.

To increase the supply of cold-climate all-in-one units and heat pump water heaters, BC could assess options to better differentiate products that meet its climate needs.

The CSA recently developed a load-based testing standard (CSA EXP-07) designed to better represent the real-world performance of heat pumps in different climates. NRCan has decided this will be a voluntary standard used as a basis for incentive programs. Manufacturers were split on this ruling. Some considered this standard a key opportunity to differentiate their products based on real-world performance in the Canadian climate. Others felt it wasn't yet sufficiently developed and its use would hinder the development of products applicable to awide range of markets.

BC could incorporate requirements in incentive programs that heat pumps achieve a level of performance under EXP07 in order to encourage and recognize the higher performance of cold-climate heat pump models. However, if BC were the only market to move forward with this approach, this could create a significant new burden on manufacturers that they do not face in other jurisdictions, and create a disincentive to enter the market.

Alternatively, BC could collaborate with other jurisdictions that have comparable climates to explore options to incorporate cold climate ratings by working within the system (e.g. NEEP and ENERGY STAR). The US Department of Energy has just updated their performance standards and pre-empts all US states from adopting different metrics. NRCan has just published a regulatory proposal to adopt the new US DOE metrics (HSPF2, SEER2) with slight modifications for Canadian climates (making the voluntary -15°C test a requirement).

Implementation steps include:

- Work with NRCan to explore opportunities to set performance requirements under EXP07 and/or expedite the proposed update (and alignment to the US) of energy efficiency regulations, including a mandatory -15°C test point.[10]
- Work with BC Government and BC Hydro to explore incorporating cold climate standards (such as EXP07 standards or the proposed amendment to energy efficiency regulations mentioned above) into BC regulations, programs, and incentives.
- Work with the City of Vancouver, Metro Vancouver, and others to explore pilot or other projects and other demonstration opportunities to ease concerns about particular models.
- Engage with other cold-climate jurisdictions to explore alignment and work with industry to ensure it does not create a new market barrier.
- Set a timeline for the introduction of requirements in BC as part of regulations and/or incentives programs.

Key actors responsible for implementing this solution include:

Lead Actors	Supporting Actors
• BC Government • NRCan • Technical Safety BC	• BC Hydro • Vancouver Economic Commission/trade coalition • Pacific Coast Collaborative

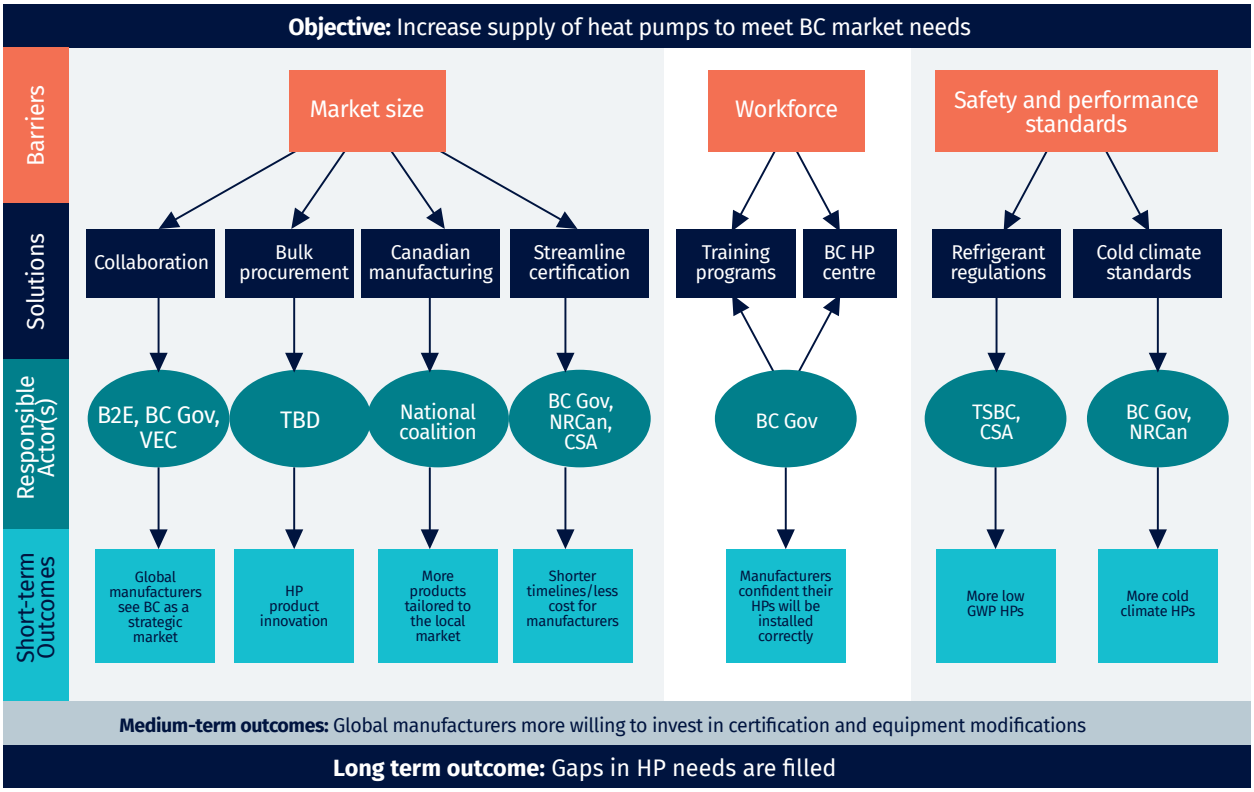
[10] Canada Gazette, Part I, Volume 156, Number 14: Regulations Amending the Energy Efficiency Regulations, 2016 (Amendment 17). Accessed at: https://gazette.gc.ca/rp-pr/p1/2022/2022-04-02/html/reg5-eng.html

4.0 Implementation and Next Steps

Developing a strong, resilient, and sustainable supply chain for heat pumps and other building decarbonization technologies will not be an overnight process.

As envisioned in both the BC Building Electrification Road Map and the Zero Emissions Economic Transition Action Plan, now is the time to start making investments for the long term – in training, infrastructure, and local manufacturing – to meet our long-term climate, building-related comfort and safety, and economic development goals. The BC Heat Pump Technology Attraction Strategy lays out a pathway to meet these objectives in an integrated way. By addressing market size, workforce, and performance standard barriers (and opportunities) in an effective sequence across business and government, BC could position itself further as a leading climate action jurisdiction and build well-paying and resilient jobs in our province.

Figure 2: Summary of barriers, solutions, actions and outcomes



4.1 Implementation

The Heat Pump Strategy includes a multitude of actions and opportunities that cannot be actioned all at once. Through the work of the Steering Committee for the development of this strategy, as well as direct input from business and government, the first actions of this work have been prioritized and will take shape in 2023 and 2024. After that, B2E, the BC Government and VEC will need to decide on next steps – particularly with an eye towards the Government of Canada's forthcoming Green Buildings Strategy.

All of the activities within the strategy will be actioned by constituent groups of B2E, or within the work and mandates of individual organizations. A Heat Pump Strategy working group will be convened by VEC under the auspices of the B2E Coalition.

Prioritized activities within the strategy for 2023-2024 include:

- **3.1.1** – Coordinate with other jurisdictions and markets outside of BC to understand their plans regarding heat pump supply chains and identify immediate coordination opportunities, particularly, opportunities to create forecasts or other information on market size to share with manufacturers.
- **3.1.3** – Begin assessments of relevant industrial policies and industry initiatives to promote and coordinate around local manufacturing and assembly of heat pump components; identify next steps to promote a "made in Canada heat pump agenda."
- **3.1.4** – Begin development of informational materials related to certifications and standards to help both local and international manufacturers more quickly bring products to market.
- **3.2.1** – Liaise with, and where necessary provide support, to B2E members' efforts on workforce training, with a particular focus on those doing workforce development focused on creating opportunities in equity-deserving communities and increasing the overall supply of labour.
- **3.2.2** – Conduct initial research to understand the needed components, scope, structure, and partners for a potential BC Heat Pump Centre.

Opportunities to expand or otherwise amplify the activities in the strategy will be iteratively sought, and impacts captured, in other B2E and ZEETAP-related initiatives.

Related projects and research

Plan

ZEETAP: Zero Emissions Economic Transition Action Plan

Designed to help businesses and workers transition to a zero-carbon economy

Download

Market Research

Green Buildings Market Forecast

Demand for Building Products, Metro Vancouver 2019-2032

Download

VANCOUVER ECONOMIC COMMISSION

BC Heat Pump Technology Attraction Strategy

Making heating and cooling cleaner, more affordable, and more resilient.

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To learn more about heat pump opportunities in Vancouver, speak to one of our team members:

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VEC respectfully acknowledges that it is located on the traditional, ancestral and unceded territory of the Sḵwx̱wú7mesh (Squamish), Səl̓ílwətaʔ/Selilwitulh (Tsleil-Waututh) and xʷməθkʷəy̓əm (Musqueam) Nations.