BC Energy Step Code Supply Chain & Economic Opportunities Study

FINAL REPORT

Prepared for:

Vancouver Economic Commission

December 1, 2018

DelphiGroup

Environmental Strategies. Business Solutions.

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VANCOUVER
ECONOMIC COMMISSION

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In Partnership with:

Brantwood consulting
real estate • construction • infrastructure

Acknowledgements

This report was prepared with funding support from the Discovery Foundation and BC Housing. The Delphi Group would also like to thank the following companies, government agencies, and industry organizations. These key stakeholders and industry leaders provided important resources, insights and / or data to support this study.

BC Housing
BC Hydro
BCIT
Brantwood Consulting
Building Officials' Association of BC (BOABC)
Canada Green Building Council
Canada Mortgage & Housing Corporation (CMHC)
Canadian Home Builders Association of BC (CHBA BC)
Cascadia Windows & Doors
Centra Windows
City of Richmond
City of Surrey
City of Vancouver
Concert Properties
CORE
Core Two
Ecolighten
FortisBC
Home Performance Stakeholder Council
Integral Group
Ledcor
Morrison Hershfield
PassiveHouse Canada
Peak Group
Pembina Institute
Perkins+Will
RDH
Red Door Energy Advisors
Rockwool International
Roger Bayley Inc.
SHARC Energy Systems
Small Planet Supply
Wood Works BC
Zero Emissions Building Exchange (ZEBx)

With funding support from:

Discovery Foundation BC HOUSING

Preface

The Delphi Group, in partnership with Brantwood Consulting, and with financial and in-kind support from BC Housing, the Discovery Foundation, and a broader group of industry stakeholders, undertook this study to better understand the potential economic and supply chain impacts from the adoption of the BC Energy Step Code in British Columbia. Research activities for this project included:

- Extensive secondary research and data analysis around the technologies and building components as they relate to the BC Energy Step Code;
- Undertaking a supply chain gap analysis to understand where BC's strengths and weaknesses lie; and
- In-depth interviews with industry stakeholders, including product manufacturers and suppliers, engineering, consulting and architecture firms, construction firms, energy utilities, non-profits, and local governments.[1]

Outputs from this project included:

- The development of a BC Energy Step Code Product Demand Forecasting Model[2]; and
- A final report on how to stimulate economic development in BC's high-performance and green building sector through the BC Energy Step Code.

The final outcomes of this initiative are intended to bring more clarity to developers, builders, manufacturers, local governments, and others across the supply chain with respect to the projected demand for key products and equipment in line with BC Energy Step Code adoption rates. It is hoped that this work will trigger greater dialogue that will drive the development of strategies and actions by key stakeholders in order to maximize the economic development opportunities and potential benefits while minimizing any potential negative impacts and risks from the adoption of the BC Energy Step Code.

[1] For more on this study's research methodology, refer to Appendix A.
[2] For more on the BC Energy Step Code Product Demand Forecasting Model and its functionality, key inputs, assumptions, and outputs, refer to Appendix A.

List of Acronyms & Abbreviations

AFUE	Annualized Fuel Utilization Efficiency
BCIT	BC Institute of Technology
CaGBC	Canada Green Building Council
CEA	Certified Energy Advisor
cfm	Cubic Feet per Minute
CHBA BC	Canadian Home Builders Association of BC
CLT	Cross-laminated Timber
DHW	Domestic Hot Water
DLT	Dowel-laminated Timber
DWHR	Drainwater Heat Recovery
FENBC	Fenestration Association of BC
GHG	Greenhouse Gas
HPSC	Home Performance Stakeholder Council
HRAI	Heating, Refrigeration and Air Conditioning Institute of Canada
HRV	Heat Recovery Ventilator
HVAC	Heating, Ventilation, and Air Conditioning
mbh	Thousand BTUs per Minute
MURB	Multi-unit Residential Building
NAFS	North American Fenestration Standards
NAICS	North American Industry Classification System
NLT	Nail-laminated Timber
PI/PU/PS	Polyisocyanurate, Polyurethane, and Polystyrene
RD&D	Research, Development, and Deployment
SHGC	Solar Heat Gain Co-efficient
TECA	Thermal Environmental Comfort Association
UBC	University of British Columbia
VBBL	Vancouver Building Bylaw
VEC	Vancouver Economic Commission
W/m2.K	Watts per Meter Squared Kelvin
WWR	Window-to-Wall ratio

Executive Summary

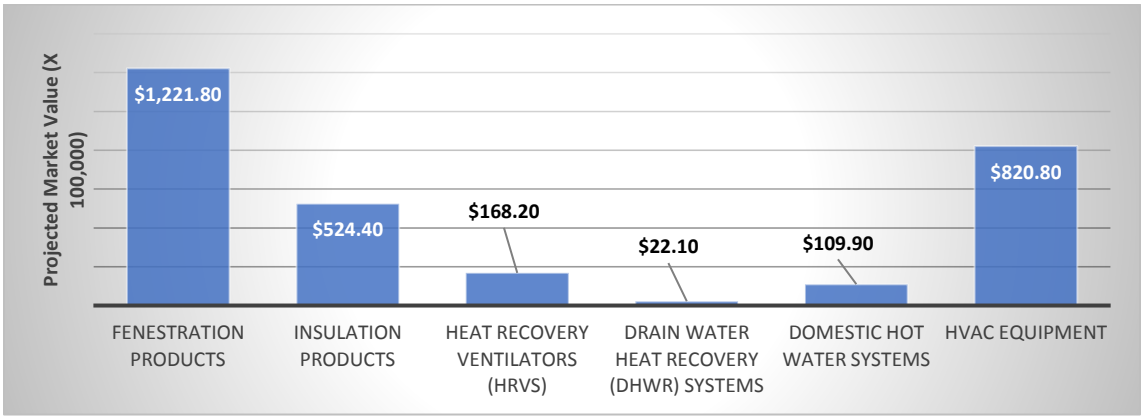
The BC Energy Step Code presents a new pathway for local governments in BC to raise the bar with respect to the construction of energy efficient, high-performance buildings in British Columbia. It also provides an opportunity to diversify the economy, attract investment, and create jobs.

This project investigated the supply chain and economic development opportunities based on the growing market demand for high-performance products from the adoption of the BC Energy Step Code. The research for this project included insights gathered through more than 30 key informant interviews and an extensive supply chain analysis looking at the products and services most relevant to the BC Energy Step Code, including building envelope products (fenestration and insulation) and mechanical systems and equipment (space heating, cooling, ventilation, and hot water technologies).

In order to get a better understanding for how the BC Energy Step Code may impact on the demand for high-performance building products over the next decade, a "Product Demand Forecasting Model" (i.e., "the Model") was developed. The Model estimates the quantity of products and materials required for meeting the energy performance goals of the BC Energy Step Code for different building typologies across Metro Vancouver. The Model considers the most likely combination of products based on lowest cost and highest net present value scenarios, as well as BC Energy Step Code adoption rates, and new construction growth projections across Metro Vancouver from 2019 to 2028.

Market Value for Green Building Products

Results from the Model suggest that the market value for high-performance products, materials, and equipment (not including their installation) related to the BC Energy Step Code will be worth more than $2.9 billion across Metro Vancouver over the next decade (see Figure ES1).



Source: Product Demand Forecasting Model

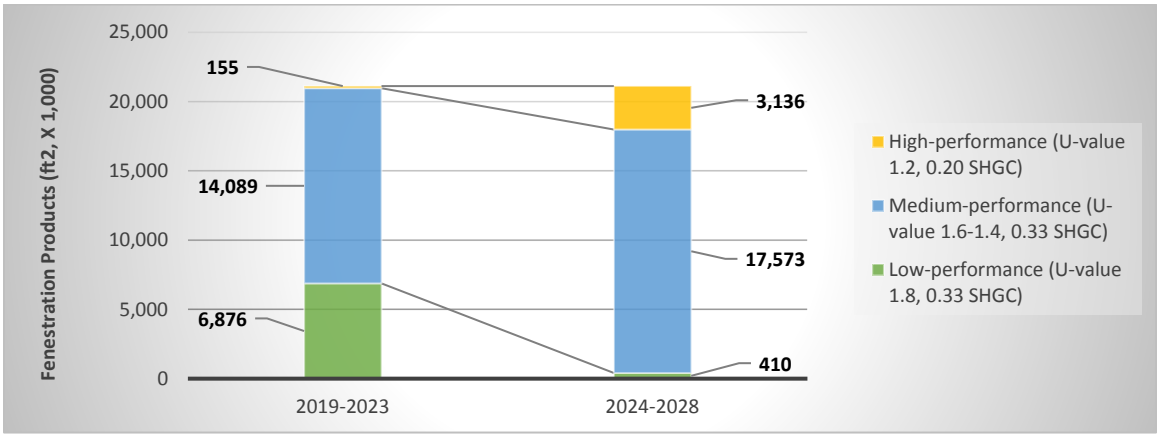
Figure ES1: Projected value (in Canadian dollars) based on market demand for relevant product and equipment across Metro Vancouver's new construction market from 2019 to 2028 based on the modelled scenario.

The demand for fenestration products (i.e., windows, doors, and skylights) is highest overall, estimated to be worth more than $1.2 billion. Despite lower forecasted demand for new construction across Metro Vancouver over the next decade (particularly for the single-family market), a shift from lower-value, low efficiency double-glazed products to higher value, more energy efficient triple-glazed products is expected. The market demand for high-performance heating, ventilation, and cooling (HVAC) equipment is expected to be worth $820 million between 2019 and 2028, with significant growth projected for heat recovery ventilator (HRV) units (equivalent to an additional $168 million). Insulation products will also see a growing demand as the BC Energy Step Code requires better and thicker wall construction to meet Upper Steps, with a market value estimated at $524 million over the next decade.

Building Envelope Products

The results of the Model developed for this project reinforce the "envelope first" design approach encapsulated within the BC Energy Step Code. The Model's results show the largest demand for products across the Metro Vancouver region over the next decade will be primarily for medium performance, double-glazed fenestration products (U-value of 1.6-1.4, 0.33 SHGC), equal to approximately 31.7 million square feet (2.95 million m^2) of product (see Figure ES2).

BC has a well-established fenestration sector with leading players that have experience adapting their product lines to code changes. Larger, local fenestration manufacturers anticipate that they will be able to meet the projected increase in demand for higher performing products over the next decade. However, there will be a need to work with some companies, particularly small and medium-sized manufacturers, who risk being squeezed out of the local market due to a lack of resources to invest in R&D, product testing, and the required infrastructure upgrades for retooling their production lines in order to remain competitive.



Source: Product Demand Forecasting Model

Figure ES2: Projected demand for fenestration products across Metro Vancouver's new construction market from 2019 to 2028 based on the modelled scenarios.

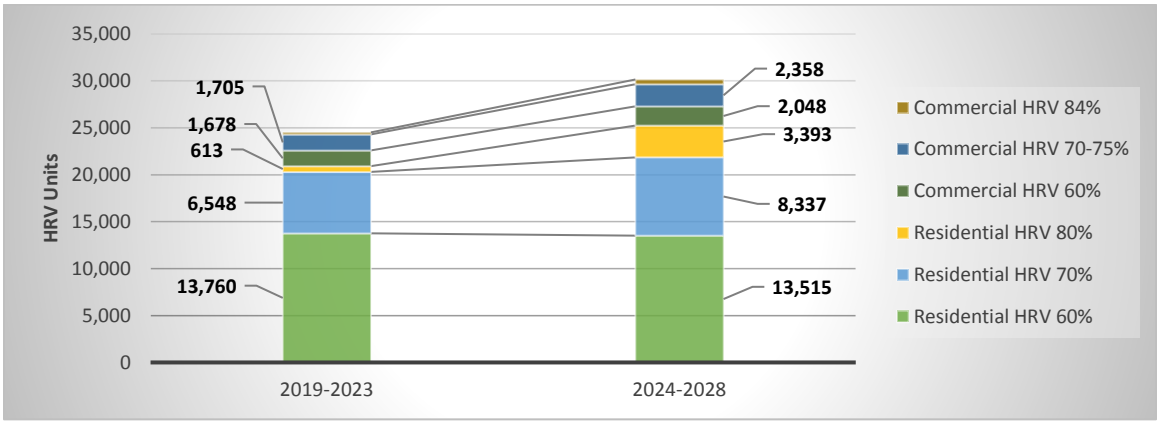
In addition, more than 507.7 million square feet (47.2 million m2) of insulation products (i.e., batt, blown-in, and rigid foam / polystyrene products) will be in demand in order to support the thicker, more insulated walls, roofs, and foundations required to meet the higher energy performance requirements for Upper Steps of the BC Energy Step Code and the proposed BCBC updates.

For insulation products, international firms supplying fibreglass batt and PI/PU/PS[3] foam (spray and board) products will continue to meet demand. The province's leading forest products and pre-fabrication sectors could leverage established supply chains for cellulose insulation (commonly used for blown-in applications) to look to create production lines for high-performance wood fibre insulation boards and wall assemblies, creating local jobs and diverting resources currently spent on importing these products from international producers.

Mechanical Systems & Equipment

The "envelope first" approach entrenched in the BC Energy Step Code pathways is expected to result in the demand for mechanical equipment shifting to systems that are generally smaller, more efficient, and less complex in nature.

As local governments adopt Upper Steps of the BC Energy Step Code and proposed updates to the BCBC take affect, the most significant growth in demand of all the mechanical equipment segments over the current state today is expected for heat recovery ventilators (HRVs). Demand is expected for products ranging in efficiency from 60%-80%, as well as a variety of sizes, from approximately 100-150 cubic feet per minute (cfm) units suitable for in-suite applications and single-family homes through to larger-scale commercial units in the size range of 600 cfm (see Figure ES3).



Source: Product Demand Forecasting Model

Figure ES3: Demand for HRV systems across the Metro Vancouver new construction market from 2019 to 2028 based on the modelled scenarios.

[3] Polyisocyanurate, polyurethane and polystyrene.

Under the Model's current assumptions for the Metro Vancouver region, the largest demand for heating equipment is expected to be for electric baseboard heaters given current technology pricing. With respect to air source heat pumps, the estimated market value over the next decade to 2028 is approximately $778 million for the Metro Vancouver region under current pricing estimates. Heat pumps for space heating and cooling purposes are expected to see some increased demand, although not significantly compared to current annual demand within the Part 9 residential market over the next five years given current the low prices for natural gas in BC and the fact that heat pump systems cost more up front than natural gas furnaces on average.

In the second half of the next decade, more growth in demand for heat pumps is anticipated as system sizing requirements come down along with costs, making them more affordable, particularly in that they offer both cooling and heating for homes. This scenario could be further accelerated if GHG emission intensity requirements are included in future local government building bylaw updates.

Results from the Model also show an expected increase in demand for drain water heat recovery (DWHR) technology in the single-family residential market, as well as more efficient gas and electric domestic hot water (DHW) systems and boilers, across the Metro Vancouver region between 2019 and 2028.

The capacity to meet the increased demand in BC for higher-performing mechanical equipment is largely met at present by local suppliers who source from North American and international manufacturers. Opportunities may exist to develop relationships with leading Canadian and global HVAC manufacturers, as well as HRV innovators (such as Lifebreath, Swegon, Venmar, Ventacity, and Zehnder) to explore partnerships and/or licensing agreements and, potentially, develop local assembly hubs for high-performance systems and equipment over the next decade in order to serve Western Canada and the United States in line with growing demand.

Construction & Professional Services

The supply chain for construction and professional services required to deliver better performing buildings related to the BC Energy Step Code is extensive. Many BC-based architecture and design firms are recognized for having strong expertise related to the BC Energy Step Code, including in areas such as air-tightness, building envelope design, and building science.

One of the largest areas of growth in terms of key services related to the BC Energy Step Code is expected to be for Certified Energy Advisors (CEAs), who will need to work with builders and developers to ensure plans are meeting the energy performance requirements of given Steps.

In Conclusion

The BC Energy Step Code is expected to drive significant change within BC's construction market over the coming decade. The success for all stakeholders will rely on the responsiveness and capacity of the local supply chain to deliver and install the relevant building products at affordable prices, particularly for Upper Steps of the BC Energy Step Code.

The Model provides some clarity for industry (i.e., developers, builders, manufacturers, and suppliers) on the potential future demand for high-performance building products and services, and also serves as a tool for local governments and other stakeholders to better understand the economic development and investment attraction opportunities from the adoption of the BC Energy Step Code.

Results from this study suggest that the greatest opportunities for new investment and economic development from the adoption of the BC Energy Step Code relate to fenestration products and pre-fabrication, where particularly strong expertise and local capacity already exists. Future projected growth in demand for other high-performance products and equipment, including innovative insulation products, wall panel assemblies, and potentially HRVs and HVAC equipment (e.g., commercial hot water heat pumps and CO_2 heat pumps), warrants further investigation.

Combined with BC's well-established brand as a green building leader, the accelerated adoption of the BC Energy Step Code by local governments could result in expanded domestic manufacturing in BC where it makes sense. Local manufacturing is important as it provides an institutional foundation for learning and developing process skills and capabilities that are increasingly inter-twined with R&D, innovation, intellectual property development, and long-term sector competitiveness.

Expansion of the domestic manufacturing base in BC may be achieved through product licensing and partnerships with established international players. However, it is important to keep in mind that business success is not in manufacturing the equipment or components alone but how they are managed as a whole system.

Before these economic development opportunities can be fully realized, however, clear messaging from local governments is required to better define prevailing uncertainties around the rate of adoption of the BC Energy Step Code, allowing for a better understanding of the potential market demand for relevant products.

Contents

1. Introduction

Background on the BC Energy Step Code

The BC Energy Step Code seeks to improve the consistency of building regulations across the province by replacing the patchwork of different energy-related building standards that have characterized local governments in the past. The BC Energy Step Code was designed as a voluntary compliance pathway within the BC Building Code (BCBC) that local governments can use to require or incentivize incremental and consistent energy efficiency requirements in new construction, with the overall goal of having all new construction in British Columbia (BC) be "net zero energy ready" by 2032.[4] Builders can voluntarily use the BC Energy Step Code as a pathway to meet energy-efficiency requirements of the BCBC. The BC Energy Step Code is fuel-neutral, which allows for designers and builders to select natural gas, electricity, or other energy sources.

The BC Energy Step Code emerged as formal policy in April 2017 in response to the need for consistency within the Building Act in BC.[5] However, some see it as a potential pathway to reducing greenhouse gas (GHG) emissions from buildings in support of the Province of BC's climate targets.[6] As of October 15, 2018, 32 local governments in British Columbia (including 10 in the Metro Vancouver region) had submitted their initial notification form, indicating that they had started consulting with industry on the BC Energy Step Code. Approximately half of these now reference the BC Energy Step Code in a policy, program, or bylaw.[7]

The BC Energy Step Code employs a performance-based approach as opposed to a prescriptive approach, providing energy efficiency targets that vary through a series of progressive Steps. Local governments in BC can either incentivize or require developers and builders to meet the various Steps over time, in line with the BCBC or as part of accelerated timelines within their building bylaw regulations.

All the Steps apply to two categories of buildings:

> **Part 9 Buildings** – Houses and small buildings that are three storeys or less and have a building area no more than 600 square meters (i.e., single-family homes, duplexes, townhomes, small apartment buildings up to four storeys, and offices).
>
> **Part 3 Buildings** – Large and complex buildings that are four storeys and taller and greater than 600 square meters in building area (e.g., condos, low and high-rise residential buildings, shopping malls, and commercial office buildings).

For Part 9 buildings, Steps range from 1 to 5 (see Figure 1). Larger buildings under Part 3 of the BCBC have fewer Steps: low- and high-rise multi-unit residential buildings (MURBs) have four Steps while commercial office buildings have three Steps.

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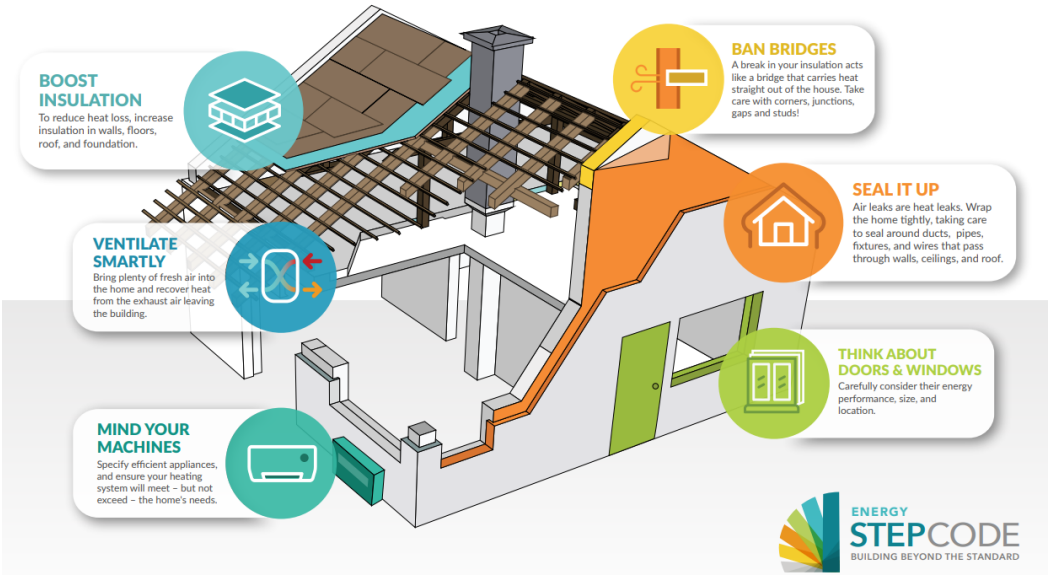
[4] See: BC Energy Step Code – Building Beyond the Standard – Background https://energystepcode.ca/
[5] See: BC Building Act Consistency https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/building-act/consistency
[6] See BC Strategy needed to reduction carbon pollution at home: http://www.pembina.org/op-ed/bc-existing-buildings-letter
[7] See: Local Governments Referencing the BC Energy Step Code https://energystepcode.ca/implementation_updates/

Source: EnergyStepCode.ca

Figure 1: The BC Energy Step Code pathway to net zero energy ready buildings for Part 9 and Part 3 new construction.

The purpose of Step 1 is to familiarize builders with a new way of measuring energy efficiency and an increased focus on careful air sealing practices to achieve energy efficiency targets. As builders move to the Upper Steps, it demands the adoption of a more integrated approach to building design. From a design perspective, the BC Energy Step Code takes a "building envelope first" approach, which puts the emphasis on specific aspects of a building's performance. Figure 2, for example, illustrates six strategies designed to achieve the best energy performance for a new home under BC Energy Step Code building best practices, five of which relate to the building envelope and air flow.



Source: EnergyStepCode.ca

Figure 2: Six strategies to boosting energy-efficiency performance and minimizing additional costs for new home construction in line with the BC Energy Step Code pathways.

Building to Upper Steps of the BC Energy Step Code may increase costs for some new home construction, particularly in BC's colder climate zones. However, over the longer-term and with the right-sized mechanical and ventilation systems, a more energy efficient building envelope should reduce the dependence on larger heating and cooling systems, which should translate into both operational cost and maintenance savings.

While reaching higher levels of the BC Energy Step Code may require a shift in construction processes and certain products / materials by builders, case study evidence is growing across BC showing that building to the Lower Steps of the BC Energy Step Code for Part 9 buildings (i.e., Steps 1 to 3) can be done with relatively low additional upfront construction costs (i.e., increases from 0-2%).[8] In addition, while case studies in colder climate zones in BC do see cost increases closer to 4% for Upper Steps, the savings in heating costs are recouped at a greater rate than those in milder climates.[9]

About this Supply Chain Study

This project set out to answer four questions through secondary research, industry consultation, and economic analysis related to the adoption of the BC Energy Step Code:

1. What is the economic potential and market demand for high performance products from the adoption of the BC Energy Step Code?
2. What does the product, equipment, and construction supply chain look like related to higher levels of the BC Energy Step Code?
3. What approaches could be used to address gaps in local production and supply?
4. What approaches could be used to ensure industry competitiveness and affordability for builders / homeowners in BC?

The supply chain for delivering buildings that comply with the BC Energy Step Code is extensive, as illustrated in Figure 3. The supply chain with respect to products, materials, equipment, and services relevant to the BC Energy Step Code includes more than a dozen industries (at the four-digit NAICS code level), primarily in the areas of building envelope, mechanical systems, energy efficient lighting and control systems (for Part 3 buildings), as well as a range of construction trades and professional services.

This supply chain analysis more specifically reviewed a subset of the key products and services important and relevant to the various Steps of the BC Energy Step Code, with a focus on:

- Building envelope technologies, in particular fenestration and insulation products;
- Mechanical systems, in particular heating, cooling, ventilation, and hot water systems; and
- Construction and professional services.

[8] See: BC Energy Step Code – Case Studies https://energystepcode.ca/case-studies/
[9] See: Inside the Step 3 Home – Case Study: Westside Park Residence, Invermere http://energystepcode.ca/app/uploads/sites/257/2018/09/STEP_CaseStudies_Invermere_FINAL.pdf

Part 3 ICI	Part 3 MURBS	Part 9
• Commercial developers • Public and private owners; purchasers • Architects & spec. writers • Mechanical engineers • Electrical engineers • Structural engineers • Building scientists • Energy modellers • General contractors • Trade contractors (HVAC; electricians; steel stud & drywall; roofing; insulators) • Suppliers (windows, doors, HVAC, etc.) • Building officials (building inspectors, plan checkers)	• Residential developers • Architects & spec writers • Mechanical engineers • Electrical engineers • Energy modellers • Structural engineers • Building scientists • General contractors • Trade contractors (HVAC; electricians; steel stud & drywall; roofing; insulators) • Suppliers (windows, doors, HVAC, etc.) • Building officials (building inspectors, plan checkers)	• Residential developers • Home builders • Architects and home designers • Energy advisors • Trade contractors (plumbers & HVAC, electricians, carpenters & framers, roofing, insulators) • Suppliers (windows, doors, HVAC, etc.) • Building officials (building inspectors, plan checkers)

Source: BC Energy Step Code Training and Capacity Report[10]

Figure 3: Supply chain participants involved with delivering buildings that comply with the BC Energy Step Code.

Project Methodology

Product Demand Forecasting

To get a better understanding for how the BC Energy Step Code may impact on the demand for high-performance building products and equipment in BC, this project developed a "Product Demand Forecasting Model" (i.e., "the Model"). The Model was designed as a responsive, Excel-based tool for estimating the economic development and investment potential in line with the demand for relevant high-performance building products and equipment in the Metro Vancouver region coming from the adoption of the BC Energy Step Code by local governments, as well as updates to the BCBC, over the next decade.

Key variables and assumptions in the Model include:[11]

- **Building Typologies:** Five building typologies and corresponding Steps related to the BC Energy Step Code were included in the Model (including single family, multi-unit residential, and commercial office buildings). These archetypes were based on the information and assumptions originally published in the September 2017 Metrics Research study (and updated in 2018).

[10] MODUS Planning and Brantwood Consulting (2017), "Energy Step Code Training and Capacity Project Summary Report". See: http://energystepcode.ca/app/uploads/sites/257/2018/07/BC-Energy-Step-Code-Training-and-Capacity-Report-Final.pdf

[11] For more information on the BC Energy Step Code Product Demand Forecasting Model, its design, and the data inputs / assumptions, see Appendix A.

- **Projected Construction Growth Rates:** The projected growth of new construction for each of the five building typologies from 2018 to 2028.[12] It should be noted that the projected demand for products and equipment compared to current baselines is somewhat tempered by the assumption that residential new construction in Metro Vancouver (particularly for Part 9 single-family dwellings) is expected to be lower over the coming decade compared to historic trends.[13]
- **Energy Step Code Adoption Timelines:** The adoption timelines of the BC Energy Step Code by local governments in Metro Vancouver.[14] As no local governments in Metro Vancouver have publicly stated their plans to reach Step 5 (for Part 9 buildings) prior to 2028, the Model assumes that Step 5 will be reached after the 2028 timeframe. That being said, the City of Vancouver anticipates reaching the equivalent of Step 5 for Part 9 buildings as per proposed updates to the Vancouver Building Bylaw (VBBL) by approximately 2025.
- **Product / Material Quantities & Costs:** The underlying inputs and assumptions related to product quantities were developed for the five building archetypes based on current product costing estimates[15], sourced from the information originally published in the September 2017 Metrics Research study[16] and updated in 2018, along with additional input from the project's Advisory Committee.

Two "time period" scenarios were examined through the Model in order to estimate market demand for products and equipment across the Metro Vancouver region: 2019 to 2023 (short-term scenario) and 2024 to 2028 (medium-term scenario).[17] The results for these two scenarios provide insights on the demand for both building envelope products (i.e., fenestration and insulation) and mechanical systems (i.e., space heating and cooling, heat recovery ventilation, drain water heat recovery, and domestic hot water systems).

Key Informant Interviews

The Delphi Group undertook 30 key informant interviews with leading subject-matter experts with proven knowledge of the high-performance / energy efficient building sector and the related supply chain in BC. The list included building product manufacturers; construction companies and trades; engineering, architecture, and consulting firms; energy utilities; industry associations; and training institutions. Interview questions explored factors such as the supply of products and equipment in BC, as well as local manufacturing capabilities versus imported products and technologies and potential product pricing and affordability issues.

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[12] New construction projections were based on Metro Vancouver's 2040 Regional Growth Strategy (broken out by municipality and building type using historical BC Housing registration data) for the residential sector and Avison Young's commercial real estate forecasts for Metro Vancouver (see Model Methodology section in Appendix A for more details).

[13] Residential new construction estimates built into the current Model are based on the 2040 Regional Growth Strategy estimates published by Metro Vancouver (updated in July 2017). See: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf

[14] See Table A2 in Appendix A for adoption rate assumptions by local government.

[15] Product combinations were estimated using a blend of both lowest incremental cost and net present value for each building archetype. See Appendix A for more details.

[16] See: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/reports/bc_energy_step_code_metrics_research_report_summary.pdf

[17] The **short-term scenario** provides a reasonable level of certainty with respect to the projected volumes of incremental products and equipment in demand across the Metro Vancouver region from those municipalities that have published their intentions to adopt the BC Energy Step Code and updates to the BCB. Under the **medium-term scenario**, the results are somewhat less certain given potential variances related to the real estate growth assumptions; changes over time to the performance of specific technologies and their costs which may impact on their demand; as well as impacts on the demand for relevant products and equipment from additional municipalities that may choose to adopt the BC Energy Step Code. As such, the Model's input data and assumptions should be updated regularly in order to ensure the outputs and information are as accurate as possible.

About this Report

This report was developed primarily for local governments and other stakeholders to better understand the economic development and investment attraction opportunities from the adoption of the BC Energy Step Code, as well as provide an overview of BC's current supply chain for key products and services. It also helps provide industry (i.e., developers, builders, manufacturers, and suppliers) with clarity on the potential future demand for products and services in line with the BC Energy Step Code and BCBC updates.

The report is broken out into the following chapters:

- **Chapter 2**: Provides an overview of the projected market demand for **building envelope products** (i.e., fenestration and insulation) across the Metro Vancouver region over the next decade, the current state of supply for these products, and potential supply chain risks and growth opportunities for consideration.
- **Chapter 3**: Provides an overview of the projected market demand for **mechanical systems and equipment** (i.e., space heating and cooling, heat recovery ventilation, drain water heat recovery, and domestic hot water systems) across the Metro Vancouver region over the next decade, the current state of supply for these products, and potential supply chain risks and growth opportunities for consideration.
- **Chapter 4**: Provides an overview of the current state of the supply chain and related opportunities for key **construction and professional services**.
- **Chapter 5**: Describes the **key take-aways and conclusions** based on the research, consultation, and the Product Demand Forecasting Model results.

In addition, appendices provide more information on the methodology and modelling inputs and data assumptions, key outputs from the Model, as well as shortlists of international manufacturers and suppliers of products relevant to the Upper Steps of the BC Energy Step Code which may be potential targets for partnership and/or investment attraction efforts going forward.

2. Building Envelope Products

With the BC Energy Step Code's performance-based, "envelope first" approach, evolving building practices will necessitate thicker, more air-tight walls, more insulation, and higher performing fenestration products (i.e., windows, doors, and curtain walls).

The Product Demand Forecasting Model projects that the largest demand for building envelope products within the residential construction sector between 2019 and 2028 will be for medium-performance, double-paned fenestration products (i.e., in the range of U-value 1.6 to 1.4 W/m^{2}K and SHGC 0.33)[18], as well as wall and roof related insulation products (i.e., batt and/or blown-in).

There is strong local capacity in the supply and installation of energy efficient windows in BC, with an opportunity to leverage BC's wood products and manufacturing sectors to develop increased local capacity in areas including wood fibre insulation, integrated wall panels, wall assemblies, and thermal breaking products.

More details on the projected market demand and current supply chain risks and opportunities for both the fenestration and wall / insulation sectors are presented below.

Fenestration

Market Demand

Fenestration products included in the Model are outlined in the table below. The approximate market value for fenestration products as projected by the Model is $1.22 billion for the Metro Vancouver region between 2019 and 2028.[19]

Product	Description
Low Performance Glazing	Double-pane fenestration product with U-value 1.8 (W/m2.K) and 0.33 SHGC
Low-medium Performance Glazing	Double-pane fenestration product with U-value 1.6 (W/m2.K) and 0.33 SHGC
Medium-high Performance Glazing	Double-pane fenestration product with U-value 1.4 (W/m2.K) and 0.33 SHGC
High Performance Glazing	Triple-pane fenestration product with U-value 1.2 (W/m2.K) and 0.2 SHGC

The slower forecasted demand for new construction as per Metro Vancouver's 2040 Regional Growth Strategy[20], particularly for Part 9 single-family homes, suggests that demand for fenestration products over the next decade will be lower overall than the average over the last 10-years for the region. In addition, despite historical trends toward larger window-to-wall (WWR) ratios[21], Upper Steps of the BC Energy Step Code and advancements to the BCBC will likely require decreases in the WWR ratio over time to meet energy performance requirements.

[18] W/m^{2}K = Watts per Meter Squared Kelvin / SHGC = Solar Heat Gain Co-efficient.
[19] See Appendix C for estimated market size calculations.
[20] See Metro Vancouver 2014 Regional Growth Strategy, Appendix A: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf
[21] See: Windows and Doors: Canada. Freedonia Focus Reports. December 2017.

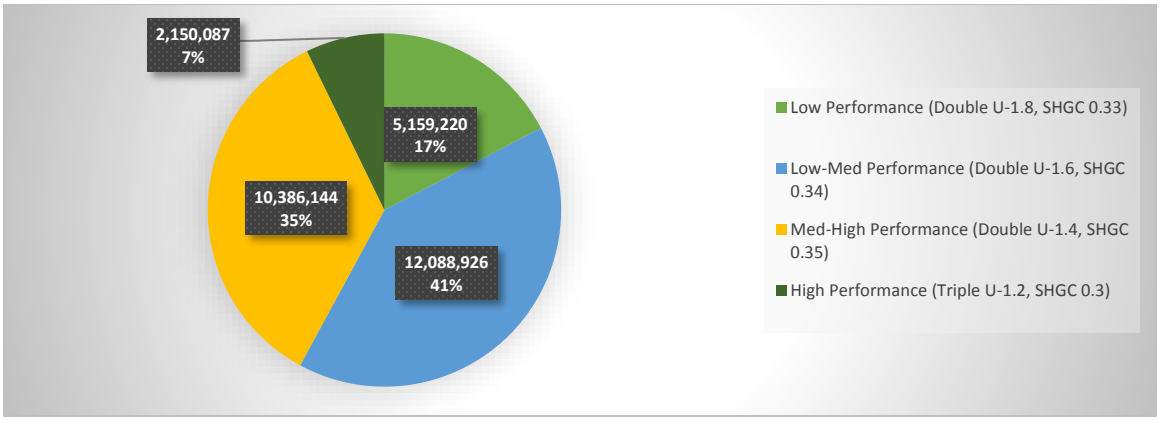
That being said, the BC Energy Step Code and the evolution of the BCBC will result in a shift from lower performing windows to higher performing double-glazed and, in some jurisdictions triple-glazed products, particularly between from 2024 onwards. Within the second half of the next decade, fenestration products with U-values of 1.8 W/m^{2}K are expected to be more or less entirely phased out.

Results from the modelling as it relates to fenestration products is further described below, broken out by: (1) the Part 9 residential market; and, (2) the Part 3 multi-unit residential building (MURB) and commercial office building markets.

Part 9 Residential Market

Results from the Model show that approximately 29.8 million square feet (ft2) or 2.8 million square meters (m^2) of fenestration products (i.e., windows, doors, and skylights) will be in demand for the Part 9 residential market between 2019 and 2028 across the Metro Vancouver region (see Figure 4). Based on the assumed current BC Energy Step Code adoption rates across Metro Vancovuer and the proposed timelines for BCBC updates, approximately three-quarters (76%) of this demand will be for medium performing fenestration products with a U-value ranging from 1.6 to 1.4 watts per square meter Kelvin (W/m^{2}K) and a solar heat gain co-efficient (SHGC) of 0.33.

The demand for the highest-performing, triple-glazed fenestration products (i.e., windows, doors, and skylights at a U-value of 1.2 W/m^{2}K or lower and a SHGC in the range of 0.30) is estimated at approximately 2.15 million ft^2 by 2028 for the Part 9 residential market, with demand largely starting in 2025. This demand will increase as more progressive local governments in the region look to adopt the Upper Steps of the BC Energy Step Code and the BCBC moves closer to requiring net zero energy ready construction.

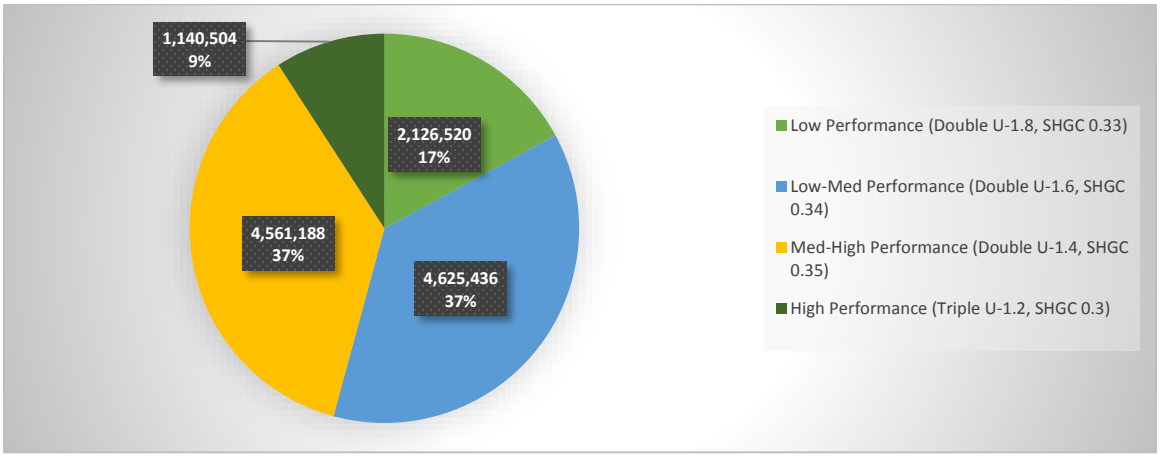


Source: Product Demand Forecasting Model

Figure 4: Demand for fenestration products in the Part 9 residential market across Metro Vancouver (square feet), 2019 to 2028.

Part 3 MURB & Commercial Office Building Markets

Results from the Model show that approximately 12.5 million ft2 or 1.2 million m^2 of fenestration products will be in demand for the Part 3 MURB and commercial office building markets between 2019 and 2028 across the Metro Vancouver region (see Figure 5). In addition, it is estimated that approximate 1.14 million ft2 (0.11 million m^2) of high-performance, triple-glazed fenestration products (i.e., at a U-value of 1.2 W/m^2K or lower and a SHGC in the range of 0.3) will be in demand, the largest portion of demand (i.e., 60%) coming between 2024 and 2028, largely from the high-rise MURB segment as Upper Steps are adopted.



Source: Product Demand Forecasting Model

Figure 5: Demand for fenestration products in the Part 3 multi-unit residential and commercial office building market across Metro Vancouver (square feet), 2019 to 2028.

Supply Chain Insights

The features, functionality, and performance of fenestration products can vary widely, from wood and vinyl framed windows and patio doors for houses through to structural glazing and curtain wall systems for high-rise buildings. As glazing is typically the area of greatest heat loss (or gain) in a building, many features and technologies have been incorporated into windows and frames to make them more energy efficient and improve the durability, aesthetics, and functionality.

Overall the fenestration industry in Canada has become increasingly international in scope over the past several decades. High degrees of customization and generally low barriers to entry support the participation of numerous small and mid-sized producers. However, stronger barriers to entry exist for more advanced products.[22]

[22] See: Windows and Doors in Canada – Freedonia Focus Reports (December 2017) and "Market Transformation Strategies for Energy Using Equipment in the Building Sector (Energy and Mines Ministers' Conference, August 2017). https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Market-Transformation-Strategies_en.pdf

The demand for fenestration products in Canada is being met by approximately 15 large manufacturers and approximately 1,400 small-to-medium manufacturers that supply regional or local markets. Collectively these companies in Canada make up an estimated 12 million square meters of factory-built fenestration products shipped annually for the new and retrofit construction market, totalling an estimated $4 billion in market demand in 2016 nation-wide.[23] The new construction segment alone is estimated to be worth $2.4 billion annually by 2021, 75% of which is projected to come from the residential market.[24]

The demand for high-performance fenestration products has also been steadily increasing alongside policies that regulate the energy performance of windows.[25] BC's fenestration industry has a history of adapting to these evolving standards and regulations. The ENERGY STAR program has had one of the largest impacts on raising consumer awareness and creating a market for energy efficient windows in BC, particularly as some incentive and rebate programs were historically linked to this certification.[26]

Sample of BC-based Window & Door Manufacturers

- A1 Windows
- Cascadia Windows
- Centra Windows
- Euroline
- Fenstur
- Inland Glass
- Innotech
- Milgard Windows
- Oasis Windows
- Starline
- Thermoproof
- Van Isle Windows
- Vinyltek
- Vitrium
- West Coast Windows
- Westeck

ENERGY STAR was also revised to more stringent standards in 2010, which was partially done in response to aligning with BC's move to ensure that 100% of BC's windows, glazing assemblies, and doors were energy efficient under BC's Energy Efficiency Act (EEA).[27] Targets within EEA regulations prompted manufacturers to apply upgrades to their window products by applying low-e coatings, filling with argon gas, and using vinyl frames in order to meet the minimum U-value standards, as well as apply alternate frame materials.[28]

In addition, the North American Fenestration Standard (NAFS) came into effect across Canada in 2010 and in BC in 2013[29] which resulted in additional specification requirements. In 2014, another regulatory update was introduced as part of the Vancouver Building Bylaw, which prompted another round of upgrades to glass technology and frame profiles for companies serving the Vancouver market to ensure Part 9 windows met the U-value of 1.4.[30] The updated regulation was also taken by some companies as a signal to begin looking at triple-glazed products as a more efficient way of achieving better U-values.[31]

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[23] See: Windows and Doors in Canada – Freedonia Focus Reports (December 2017) and "Market Transformation Strategies for Energy Using Equipment in the Building Sector (Energy and Mines Ministers' Conference, August 2017). https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Market-Transformation-Strategies_en.pdf
[24] See: Windows and Doors in Canada – Freedonia Focus Reports (December 2017).
[25] See: Market Transformation strategies for energy using equipment in the building sector. Energy and Mines Ministers' Conference. August 2017. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Market-Transformation-Strategies_en.pdf
[26] See: Transforming the Window and Glazing Markets in BC through Energy Efficiency Standards and Regulations. (2011). http://www.ashrae.bc.ca/vi/images/stories/Codes_and_Standards_for_Glazing_in_BC_Final_Revised_Final.pdf
[27] Ibid.
[28] Ibid.
[29] See: What you need to know about NAFS in Canada. Al Jaugelis, RDH. https://www.rdh.com/nafs/nafs_in_canada_intro/
[30] See: Window makers say Vancouver's green building bylaw is clouding their future. Frank O'Brien. Business in Vancouver. https://biv.com/article/2014/11/window-makers-say-vancouvers-green-building-bylaw-
[31] Ibid.

The 2017 BC Energy Step Code[32] pushes manufacturers once again to undertake testing and development to offer better performing double and, in some cases, triple-glazed window / fenestration products, which may require a redesign of the window frame itself when getting into the Upper Steps and triple paned fenestration products.[33]

BC's greatest capacity for high-performance building product manufacturing resides in its residential fenestration sector.

Of all the high-performance building product supply chain sub-sectors, BC's greatest strength lies in the manufacturing of energy efficient fenestration products, particularly for the residential sector. At present, there are over 100 companies of varying sizes that serve the BC market, including local, national, and international fenestration manufacturers.[34] Table 1 below illustrates the approximate number of establishments with employees across BC from industries relevant to the window and door manufacturing sector (including wood windows, plastic / vinyl, and metal frames). Many of the more than 50 ENERGY STAR-certified window manufacturers in BC are located in the Lower Mainland region, with the balance coming from the Southern and Central Interiors and Southern Vancouver Island.[35]

Some of the larger BC-based manufacturers include Centra Windows, Starline, Westeck, Vinyltek, Van Isle Windows, Euroline, and Cascadia Windows (see sidebar).[36] Other Canadian and international companies who add to the supply of products available to BC builders and developers including All Weather Windows, Fibertec, Inline Fiberglass, Atrium, Jeld-Wen, Masonite International, Pella, Aluprof Windows, Kawneer, and RAICO Curtain Wall.[37]

Table 1: Establishments with employees in BC from select industries relevant to building envelope product manufacturing (by development region).[38]

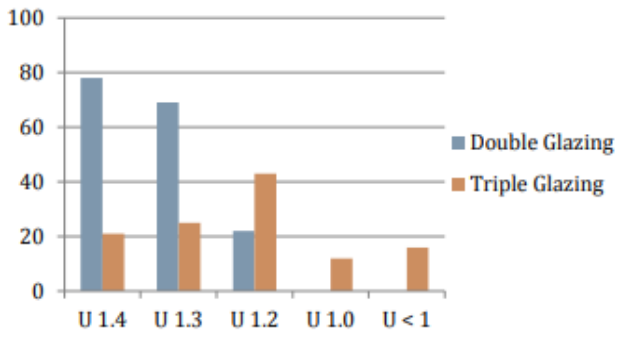
NAICS – Industry	Cariboo	Kootenay	Mainland/ Southwest	Nechako	North Coast	Northeast	Thompson/ Okanagan	Vancouver Island/Coast	TOTAL
321911 - Wood window and door manufacturing	1	0	49	0	0	0	14	13	77
326196 - Plastic window and door manufacturing	2	0	22	0	0	0	4	1	29
332321 - Metal window and door manufacturing	0	0	36	0	0	0	1	5	42

Source: Statistics Canada, Business Registry (December 2016 data)

[32] See: Fenestration Energy Performance: Requirements for Residential Buildings in British Columbia, BC Housing. https://www.bchousing.org/research-centre/library/builder-insight/builder-insight-09&sortType=sortByDate
[33] Interview with BC window manufacturer.
[34] Number of companies based on secondary research, industry consultation and industry association member lists and NRCAN ENERGY STAR window manufacturing companies.
[35] See: Windows, doors, and skylights manufacturers – ENERGY STAR Canada Participants https://www.nrcan.gc.ca/energy/products/energystar/participants/manufacturers/13512
[36] List of large local companies based on secondary research validated through key informant interviews.
[37] Companies identified through secondary research and consultation with BC fenestration companies and Freedonia's Windows & Doors Canada Market Report (December 2017).
[38] Note the definition of 'establishments' by Statistics Canada refers to unique business locations and not necessarily unique companies (i.e., the same company with multiple business addresses may appear more than once in the table).

Collectively, between the local capacity of BC's fenestration manufacturers, as well as suppliers who source fenestration products from other Canadian and international manufacturers, a comprehensive supply chain exists for meeting all levels of the BC Energy Step Code.

That being said, data provided through Natural Resources Canada (NRCan) on the number of fenestration products available in BC shows a decline in the number of models as the U-value decreases across double and triple-glazed products (see Figure 6).[39]



Source: Industry Survey conducted through City of Vancouver – UBC Greenest City Scholar Program

Figure 6: Number of window models at each U-value being produced by BC manufacturers.

While BC is not experiencing a gap in high-performance fenestration products at present, there is a gap in the supply of affordable, locally-produced triple-glazed fenestration at a cost that is competitive with larger, international players (out of Asia, Europe, or elsewhere in North America).[40]

In terms of being able to meet the incoming market shift towards higher performing windows, larger manufacturers consulted as part of this study have indicated capacity to upgrade their technology and manufacturing capabilities (i.e., those with a U-value of 1.4 or lower) if given sufficient clarity on timelines for increased demand.[41] This was also reflected in a 2018 survey of window manufacturers in BC, conducted by the City of Vancouver's Greenest City Scholar program, where respondents from BC's fenestration industry suggested that they had sufficient capacity to produce windows at a U-value of 1.2.[42]

However, concerns were raised that smaller and medium-sized manufacturers in BC may be challenged in terms of their ability to fund the costs for R&D, testing, and infrastructure upgrades required for producing higher-performing products in line with Upper Steps of the BC Energy Step Code and advances of the BCBC.[43]

It is also worth noting a gap in the fenestration sector supply chain related to the proper installation and inspection of high-performance windows. There are concerns in the industry, as flagged by the Home Performance Stakeholder Council's (HPSC) Fenestration Sector Council, around sufficient capacity for skilled trades and quality workmanship in the practice and installation of high-performance products.[44] As the industry begins to respond to greater demand for high-performance windows, the HPSC recommends that BC-specific standards or credentials should be required via training and certification programs to improve the knowledge and understanding of home performance and house-as-a system best practices across the industry.[45]

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[39] Note: Data from NRCAN is not updated as regularly and may not provide a fully accurate snapshot of current industry status.
[40] Key informant interviews with BC fenestration companies and engineering firm.
[41] Key informant interviews with fenestration companies.
[42] See: "Local High-Performance Building Supply for New Low-Rise Homes". Arash Shadkam, UBC Greenest City Scholar Program, City of Vancouver (August 2018). https://sustain.ubc.ca/sites/sustain.ubc.ca/files/GCS/2018_GCS/Reports/2018-50%20Research%20Local%20High-Performance%20Building%20Supply%20for%20New%20Low-Rise%20Homes%20_Shadkam.pdf
[43] Key informant interviews.
[44] See: Home Performance Stakeholder Council Fenestration Sector Working Roadmap. January 2018.
[45] Ibid.

Profile Box: Cascadia Windows

www.cascadiawindows.com

Based out of Langley, BC, since 2008, Cascadia Windows and Doors is a leading, award-winning manufacturer of high-performance fiberglass windows, including double and triple glazed windows and curtain wall vent adaptor, in North America. The company's technology and expertise have produced the first commercially available all-fiberglass Passive House Certified window and door system, as well as the Cascadia Clip, an innovative solution that reduces thermal bridging and improves the overall performance of exterior walls.

Within BC's fenestration space, the company represents a valuable source of innovation whose industry networks and technology can inform the shift among other local window manufacturers who will begin to move toward the production of high performance windows and doors. Through projects such as the award-winning Union Street ECO Heritage project in Vancouver, BC, Cascadia is continually recognized for the innovation that it applies both internationally and in BC.

Text provided by Cascadia Windows.

Walls & Insulation

Market Demand

The estimated market value for insulation products between 2019 and 2028 is approximately $524 million for the Metro Vancouver region (products included in the Model are outlined in the table below).[46] The market demand for insulation products is expected to grow significantly over the next decade, particularly for the Part 9 residential building market, nearly doubling between Lower Steps (i.e., Steps 1 and 2) and Step 5, which comes into play for some jurisdictions from 2025 onwards.

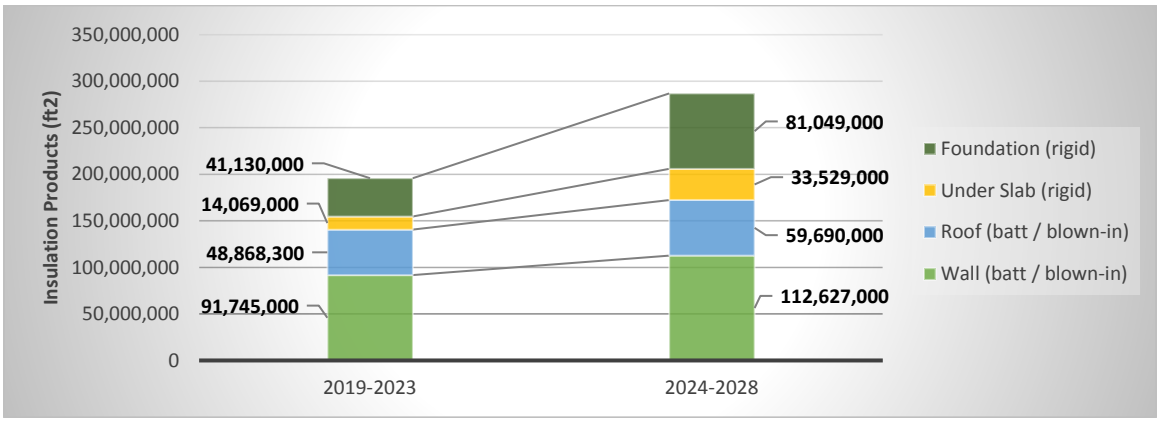
Product	Description
Wall Insulation	Equivalent to 6" batt or blown insulation
Roof Insulation	Equivalent to 12" batt or blown insulation
Under Slab Insulation	Equivalent to 4" rigid, polyisocyanurate, polyurethane, and/or polystyrene insulation
Foundation Wall Insulation	Equivalent to 2" rigid, polyisocyanurate, polyurethane, and/or polystyrene insulation

Results from the modelling as it relates to these insulation products are further described below, broken out by: (1) the Part 9 residential market; and, (2) the Part 3 multi-unit residential building and commercial office building markets.

[46] See Appendix C for estimated market size calculations.

Part 9 Residential Market

Results from the Model show that approximately 312.9 million ft^2 (29 million m^2) of wall and roof insulation (batt and/or blown-in) will be in demand across the Metro Vancouver region, as well as approximately 169.8 million ft^2 (15.8 million m^2) of under slab and foundation wall insulation (i.e., rigid foam and/or polystyrene), based on current BC Energy Step Code adoption rates and planned updates to the VBBL and BCBC over the next decade (see Figure 7).



Source: Product Demand Forecasting Model

Figure 7: Demand for insulation products in the Part 9 residential market across Metro Vancouver (square feet), 2019 to 2023 and 2024 to 2028 time periods.

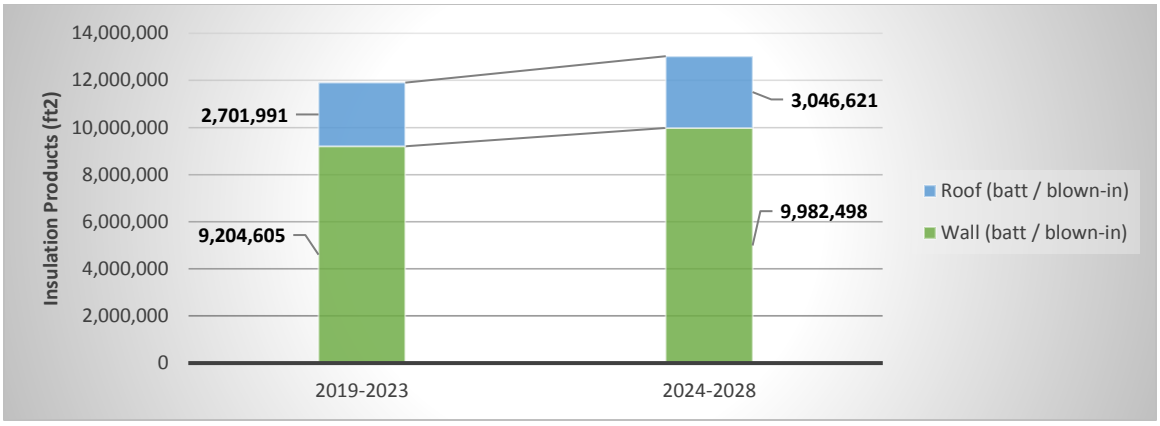
Increased demand comes largely in the 2024 to 2028 time period, particularly from the cities of Vancouver, Surrey, Richmond, and Burnaby, based on Metro Vancouver's Regional Growth Strategy construction forecasts, proposed VBBL and BCBC updates, and BC Energy Step Code adoption plans.

Part 3 MURB & Commercial Office Building Markets

Results from the Model show that approximately 24.9 million ft2 (2.3 million m^2) of wall and roof insulation (batt and/or blow-in) will be in demand within the Part 3 MURB and commercial office building segments between 2019 and 2028, based on current adoption rates for the BC Energy Step Code in Metro Vancouver combined with planned updates to the VBBL and the BCBC (see Figure 8).

Growth in demand for insulation products in the Part 3 market is not as significant as for the Part 9 segment given that these buildings are primarily built with concrete and have more inherent insulating factors. In addition, larger buildings are not expected to generate demand for either foundation or under slab insulation.[47]

[47] Based on Morrison Hershfield's assumptions from BC Housing's 2017 Metrics Study.



Source: Product Demand Forecasting Model

Figure 8: Demand for insulation products in the Part 3 MURB and commercial office building markets across Metro Vancouver (square feet), 2019 to 2023 and 2024 to 2028 time periods.

Supply Chain Insights

Creating an energy efficient, air tight building envelope is an important pathway to the Upper Steps of the BC Energy Step Code and will drive the demand for insulation, vapour barrier and air barrier membranes, air sealing tapes, and caulking. Improved performance may be achieved via the adoption of either better quality or different products, or greater quantities of traditional products (particularly for insulation).

An emphasis on wall and roof assemblies, as well as related products and components such as wood framing and locally-made insulation products, will likely result in some net positive economic impacts for BC manufacturers, suppliers, and product installers.

Insulation Products

Currently, BC has a few local manufacturers of spray foam and polystyrene insulation (e.g., Beaver Plastics in Chilliwack, Masonville Plastics Group and HAL Industries in Surrey), as well as a large manufacturing facility for stone wool insulation in Grand Forks owned by Rockwool International (see Profile Box).

The lack of local supply of high-performance insulation (with the exception of Rockwool in Grand Forks and a few smaller local operations) presents a gap in BC's high-performance building products manufacturing supply chain. As such, builders tend to look to suppliers such as PacWest Systems, Pinnacle West, and Pro-line who source from major manufacturers such as Knauf (fiberglass), DuPont (foamed plastic), BASF (foamed plastic), Owens Corning (fiberglass, foamed plastic, mineral wool), Johns Manville (fiberglass, foamed plastic), Quick-therm (based in Winnipeg, Manitoba), and a range of others providing cellulose and mineral wool products.[48]

[48] Freedonia, Residential Insulation Market Report, May 2018

Air Barriers and Vapour Sealing

Though this study did not model the demand for air barrier and vapour sealing products (e.g., tapes, caulking, etc.), it is worth highlighting that these products are important for creating air tight building envelope enclosure for walls and roofs and, as such, demand for these products is expected to grow. Brands such as Johns Manville, CertainTeed, SOPREMA, and Owens Corning supply some of the commonly used products for sealing gaps around windows, as well as mechanical, electrical, and plumbing related building envelope penetrations.[49] These products are supplied in BC directly or through networks of distributors and wholesalers, as well as through retailers such as Rona, Lowe's, and Home Depot.[50] From interviews with builders who are aiming for higher performing projects, internationally-sourced air barrier and vapour sealing products from brands such as SIGA, HANNO, or Pro Clima, are sourced locally through specialist wholesalers such as Small Planet Supply and 475 High Performance Building Supply.[51]

Wood Products and Materials

Another fundamental component of wall structures, wood is considered a green building material due to its renewable nature and ability to sequester carbon, allowing it to score positively from a life cycle assessment (LCA) perspective. Engineered wood products, such as cross-laminated timber (CLT), dowel-laminated timber (DLT), nail-laminated timber (NLT), and glulam, are highly relevant in the building of better walls and roofs and can leverage the existing equipment and structures applied by BC's prefabricated building industry to efficiently deliver building envelope components.

Profile Box: Rockwool International

www.rockwool.com

As the world's largest producer of stone wool, ROCKWOOL products are diverse and all contribute to shaping a circular economy, enhancing resource efficiency, and contributing to greater sustainability in the built environment. ROCKWOOL has been operating in North America for 30 years, with five production facilities and over 1,000 employees. It is a leading provider of stone wool insulation to the residential & commercial building sectors as well as to the industrial, offshore and marine sectors. ROCKWOOL stone wool products are made from natural basalt rock and recycled slag that is melted and spun into a dense, high-performing insulation. ROCKWOOL products are sought after for their fire- and moisture-resistance, excellent thermal properties and ability to absorb sound, creating safer, quieter and more comfortable environments.

In British Columbia, ROCKWOOL's Grand Forks facility is a staple of the community, contributing approximately $3 million to the local economy each year and employing nearly 200 people. In recent years, the Grand Forks facility invested $6 million in upgrades to achieve a more sustainable production process in keeping with the company's overall sustainability commitment. ROCKWOOL products, operations, programs and policies support 9 of the 17 United Nations Sustainable Development Goals. ROCKWOOL leverages its global expertise, technology and research and development to advance its purpose: to release the natural power of stone to enhance modern living. ROCKWOOL is a strong contributor to the local economy, providing innovative products and demonstrating leadership through forward-thinking practices, processes and solutions.

Text provided by ROCKWOOL INTERNATIONAL.

[49] See: Home Performance Stakeholder Council Insulation Sector Working Roadmap. January 2018.
[50] See: Ibid.
[51] Key informant interviews.

Currently, CLT is being produced in BC by Okanagan-based Structurlam and BC Passive House in Pemberton. In addition, StructureCraft in Abbotsford recently launched its DLT products.[52] Although BC does have local capabilities in mass-timber and engineered wood products such as CLT, DLT, and NLT, there is a gap in the number and variety of companies that offer similar high-quality products – particularly for CLT. Most recently, Katerra, a large player in the CLT space, opened a 250,000 square foot plant in Spokane, Washington, to help ease supply chain issues around CLT.[53]

While it is favourable to use local products and capacity is growing, importing mass timber products and panels can be cost effective. Some builders look to Quebec, the United States, and Europe for certain products.[54]

Key Take-aways

A key overarching message coming from interview participants for this study is that builders can achieve the Lower Steps of the BC Energy Step Code by taking on modest increases in the cost of construction, some or all of which may be absorbed through improved efficiencies (e.g., pre-fabrication).[55] At the Upper Steps and in colder climates, overall exterior wall thicknesses are likely to increase. While this is good for insulation suppliers, there may be additional costs that will be passed on to consumers.

There was general agreement amongst interviewees for this study that envelopes performing to the Lower Steps of the BC Energy Step Code are largely achieved through attention to detail and taking greater care with how wall assemblies are put together.[56] Only when Upper Steps are attempted are new products and/or approaches required, and the learning curve becomes steeper. That said, there were some industry stakeholders that voiced concern about the possible time required to adapt to new approaches to building, and that there is a risk that this learning curve may introduce temporary cost increases.[57]

While some builders are already investing in the training and equipment necessary to build high-performance building envelopes (e.g., BC has more Passive House certified gross floor area than any other province[58] and the BC Institute of Technology's building envelope training courses have been oversubscribed for the last couple of years) [59], the learning curve will become steeper while the broader industry adapts to the Upper Steps.

[52] https://structurecraft.com/materials/mass-timber/nail-laminated-timber
[53] https://katerra.com/en/about-katerra/our-factories.html
[54] Comment from wood industry expert.
[55] Key informant interviews with local construction and building consulting firms.
[56] Key informant interview with local builder.
[57] Ibid.
[58] Comment from Rob Bernhardt, CEO of Passive House Canada
[59] Comment from BCIT course instructor.

3. Mechanical Systems & Equipment

Efficient space heating and cooling relies not only on the air tightness of the building envelope, but on the efficiency of the equipment that comprise the heating, ventilation, and air conditioning / cooling (HVAC) system. HVAC systems in buildings across BC can include furnaces, electric baseboard heaters, air source heat pumps, boilers, ducts, and heat / energy recovery ventilators (HRVs or ERVs), depending on the building size and typology.[60]

The "envelope first" approach entrenched in the BC Energy Step Code pathways is expected to result in the demand for mechanical equipment shifting to systems that are generally smaller, more efficient, and less complex in nature. Mechanical equipment and systems are described in more detail below, including HVAC, hot water systems, and heat recovery technology.

Space Heating, Cooling & Ventilation Systems

Market Demand

Heating, cooling, and ventilation system products and equipment included in the Model are outlined in the table below.

Product	Market	Description
Electric baseboard heater	Part 9 Residential	Equivalent to a 1 kW residential electric baseboard heater unit.
Natural gas furnace (95% AFUE)	Part 9 Residential	Equivalent to a 60 mbh natural gas furnace at 95% AFUE.
Cold climate air source heat pump	Part 9 Residential	Equivalent to a 25 mbh cold climate, central / ducted air source heat pump.
Heat recovery ventilator (various efficiencies)	Part 9 Residential	Equivalent to a 100 cfm unit with efficiencies ranging from 60%-75%.
Cold climate air source heat pump	Part 3 MURB / Commercial	Equivalent to a 720 mbh large commercial, central / ducted air source heat pump.
Heat pump	Part 3 MURB / Commercial	Equivalent to a 60 mbh split-type commercial heat pump.
Natural gas combination unit	Part 3 MURB / Commercial	Equivalent to a 60 mbh natural gas fired combination heat and hot water commercial boiler and roof top unit.
Fan coil	Part 3 MURB / Commercial	Equivalent to a 1000 cfm commercial, 4-pipe connection fan coil system.
Heat recovery ventilator (various efficiencies)	Part 3 MURB / Commercial	Equivalent to a 600 cfm unit with efficiencies ranging from 60%-84%.

[60] See: Building Science BPCA Mechanical Basics. https://buildingscience.com/sites/default/files/2009-11-05-BPCA-Mechanical_Basics.pdf

Under the Model's current assumptions for the Metro Vancouver region, the largest demand for mechanical systems related to heating equipment is expected to be for electric baseboard heaters, with an estimated market value for baseboard heating products of approximately $24 million for the Metro Vancouver region between 2019 and 2028.[61]

In addition, heat pumps for space heating and cooling purposes are expected to see some increased demand. This increase, however, is not expected to be significant compared to current annual demand within the Part 9 market over the next five years given current the low prices for natural gas in BC and the fact that heat pump systems cost more up front than natural gas furnaces in general.

Between 2024 and 2028, more growth in demand for heat pumps is anticipated as costs come down along with system sizing requirements, making them more affordable. This scenario could be further accelerated if GHG emission intensity requirements are included in future local government building bylaw updates. As such, the estimated market value for air source heat pump products between 2019 and 2028 is approximately $778 million for the Metro Vancouver region.[62]

The region is also expected to see a significant increase in demand for HRVs, particularly for products ranging in efficiency from 60%-80% and in size from approximately 100 cubic feet per minute (cfm) (suitable for in-suite applications and small homes) to over 600 cfm (suitable for larger buildings). The estimated market value for HRVs units is approximately $168 million for the Metro Vancouver region between 2019 and 2028.[63]

The results from the modelling as it relates to HVAC systems are described in more detail below, broken out by: (1) the Part 3 residential market; and, (2) the Part 3 MURB and commercial office building markets.

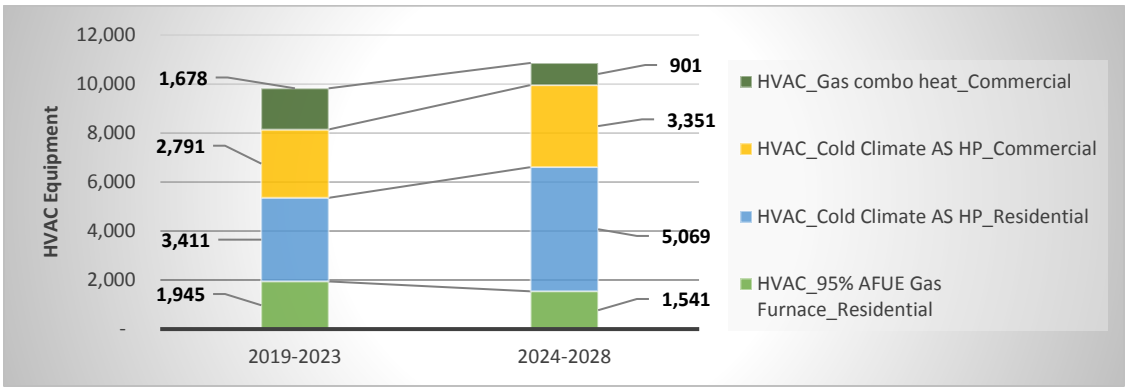
Part 9 Residential Market

Heating and Cooling

Given the expected improvement of building envelope systems, electric baseboard heaters will continue to dominate the single-detached market in terms of demand for space heating – with more than 480,000 1kw units in demand. These units are relatively inexpensive to install, and the decreased space heating demand means that they will continue to be economically viable for owners and rate payers. These are followed by high-efficiency natural gas furnaces that are 95% Annualized Fuel Utilization Efficiency (AFUE) and higher, as well as residential and small commercial air source heat pumps (see Figure 10).[64]

It should be noted that as heating requirements decrease over time as building envelope construction improves through the BC Energy Step Code, the sizing requirements for furnaces and heat pump units is expected to decrease, although the Model does not account for these factors at present.

[61] See Appendix C for estimated market size calculations.
[62] See Appendix C for estimated market size calculations.
[63] See Appendix C for estimated market size calculations.
[64] See Appendix A for more detailed product descriptions.

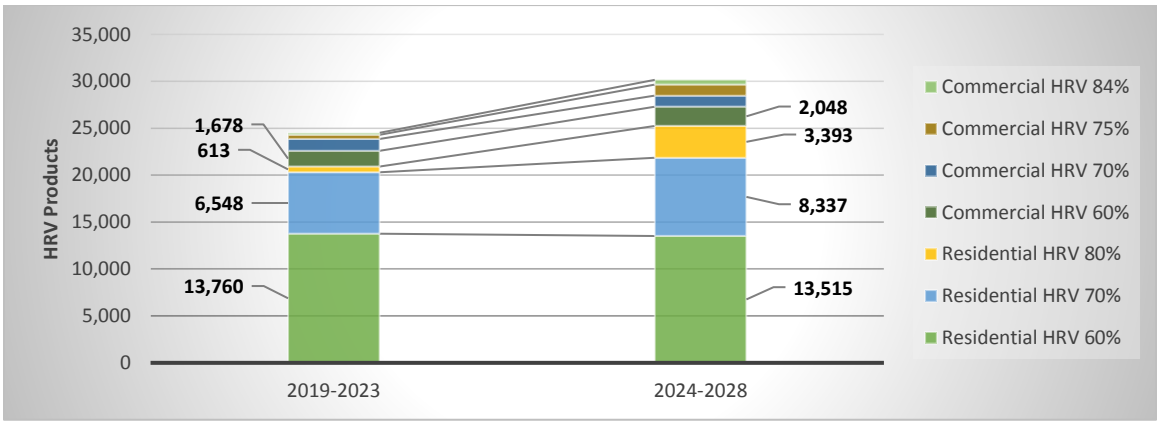


Source: Product Demand Forecasting Model

Figure 10: Demand for higher-performance HVAC systems in the Part 9 residential market across Metro Vancouver, 2019 to 2023 and 2024 to 2028 time periods.

HRVs

In addition, results from the Model show that approximately 46,000 in-suite HRVs (ranging from 60%-80% efficiency and – with a capacity of between 100-200 cfm) will be in demand across the Metro Vancouver region's single-detached residential market between 2019 and 2028 (see Figure 11). In addition, it is estimated that approximately 8,500 larger, commercial (centralized) HRV units (in the 400-600 cfm size range) will be in demand to serve the Part 9 MURB market. The bulk of the demand for high-performing HRV units (>75% efficiency) is anticipated from 2025 onwards.

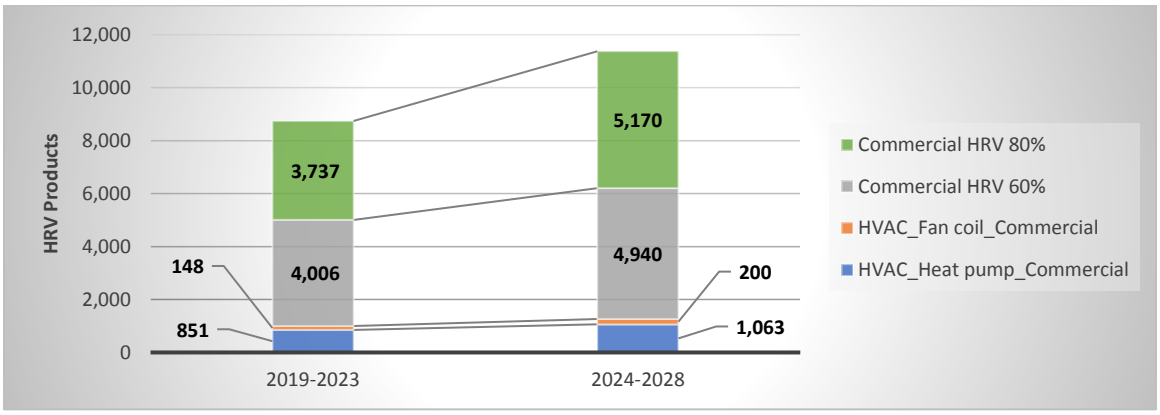


Source: Product Demand Forecasting Model

Figure 11: Demand for HRV systems in the Part 9 residential market across Metro Vancouver, 2019 to 2023 and 2024 to 2028 time periods.

Part 3 MURB & Commercial Office Markets

Results from the Model show that approximately 17,800 commercial scale HRVs (ranging from 60%-84% efficiency and with a size of >400 cfm) will be in demand for the Part 3 MURB and commercial office markets across the Metro Vancouver region between 2019 and 2028 (see Figure 12).[65] In addition, 1,900 larger, centralized air source heat pumps (of a scale equivalent to approximately a 700 thousand BTUs per minute commercial system) are projected to be in demand.



Source: Product Demand Forecasting Model

Figure 12: Demand for incremental HVAC equipment and HRV units (i.e., above baseline) in the Part 3 MURB and commercial office building markets across Metro Vancouver, 2019 to 2023 and 2024 to 2028 time periods.

Supply Chain Insights

The HVAC equipment industry is dominated by a number of very large multi-national firms, although smaller players participate in the industry in a number of product segments, as well as through the supply of components. Nortek is the largest Canadian-based manufacturer, taking an 8% market share with six manufacturing locations (mainly in Quebec) and offering brands including Broan, NuTone, Venmar, and Zephyr.[66] The current supply chain includes a complex network coordinated among wholesalers, retailers, contractors, and agents who are directly connected to the leading manufacturers.[67]

Builders and project developers tend to purchase complete HVAC systems and related components from the established national and international manufacturers and suppliers (see list of global HVAC manufacturers in sidebar).[68]

[65] It should be noted that the market for HRVs in large, complex buildings such as high-rise MURBs and multi-tenant commercial buildings is evolving quickly. There are a wide range of design solutions that range from the use of small individual in-suite systems through to large commercial systems that are integrated into the building's overall HVAC design.
[66] IBIS World, Heating & Air Condition Equipment Manufacturing in Canada report, December 2017 and Home Performance Stakeholder Council HVAC Sector Working Roadmap. January 2018
[67] See: Home Performance Stakeholder Council HVAC Sector Working Roadmap. January 2018
[68] See: IBIS World Industry Report HVAC Manufacturing in Canada. December 2017.

For products such as furnaces, electric baseboard heaters, heat pumps, HRV / ERVs, and boilers, local developers and builders rely on suppliers and wholesalers who deliver products that are manufactured by the dominant HVAC companies.[69]

While there are no major HVAC manufacturers local to BC, a few niche players do exist. Table 2 below illustrates the approximate number of establishments with employees in regions across BC from industries relevant to mechanical system product and equipment manufacturing (at the 6-digit NAICS code level).

BC firms that are producing niche products are competing with global equipment manufacturers and may eventually be forced out of the market. Barriers to entry into the HVAC equipment industry are substantial, due to the large economies of scale needed to compete in highly price conscious markets.[70] The quality and price point that these companies can offer local builders and developers are rooted in well-established, advanced global supply chains, based largely in Asia, Europe, and the United States, with economies of scale and R&D budgets that make it difficult for others to compete.[71]

This highlights an important challenge that BC manufacturers face in this subsector, which is the high capital investment that is required to open manufacturing facilities across the province to serve the local heating and cooling market, as well as high real estate / land values and labour costs. Most BC firms also lack the necessary resources to invest in marketing, testing, product modelling.[72]

Boilers

BC has a small number of boiler manufacturers, including IBC Technologies and Allied Engineering Company.[73] However, most products are imported from leading international manufacturers and suppliers.

HVAC Product Suppliers / Wholesalers

- Axton Incorporated
- Bay Industrial
- Accuwest Controls
- Kemp Agencies
- Olympic International
- Ellett Industries
- Small Planet Supply

Major HVAC Manufacturers serving the Canadian Market

- Midea
- Gree Electric
- Carrier (United Technologies)
- American Standard
- York
- Goodman
- Rheem
- Dettson
- Granby
- Napoleon
- Lennox
- Trane (Ingersoll-Rand)
- Bosch
- Viessmann
- Johnson Controls
- LG Electronics
- Fujitsu
- Mitsubishi
- Daikin

Source: IBIS World Industry Report 41612CA Plumbing, Heating & Air Conditioning Equipment Wholesaling in Canada, IBIS World Industry Report 33341CA Heating & Air Conditioning Equipment Manufacturing in Canada Freedonia Industry Report, and key informant interviews.

[69] Key informant interview.
[70] Freedonia, Global HVAC Equipment Market Report. August 2018. https://www.freedoniagroup.com/Brochure/FocusReports/bFW75034.pdf
[71] See: IBIS World Industry Report: HVAC Manufacturing in Canada. December 2017.
[72] Key informant interview.
[73] See: Thomas Industry Database https://www.thomasnet.com/profile/10001685/allied-engineering-company.html?cov=BC&what=Boilers&heading=6101307&act=M&cid=10001685&searchpos=5

Table 2: BC-based companies with employees from select industries relevant to mechanical equipment manufacturing.

NAICS - Industry	Cariboo	Kootenay	Mainland/ Southwest	Nechako	North Coast	Northeast	Thompson/ Okanagan	Vancouver Island/Coast
332410 - Power boiler and heat exchanger manufacturing	0	0	3	0	0	0	0	1
333413 - Industrial and commercial fan and blower and air purification equipment manufacturing	1	1	5	0	0	0	1	0
333416 - Heating equipment and commercial refrigeration equipment manufacturing	1	2	33	0	0	0	5	8

Source: Statistics Canada, Business Registry (December 2016 data)

Heat Pumps

In 2015, approximately 11,000 air source heat pump systems were shipped to the province, of which likely half or more were installed in the Metro Vancouver region.[74] BC's supply of air source heat pumps is entirely imported with three brands representing nearly 60% of Metro Vancouver's market.[75]

Many air source heat pumps have lower performance in colder climates (below -25 degrees Celsius). Those that do have better performance in colder climates are more costly which translates into a continued demand for natural gas-fired equipment (i.e., furnaces and boilers), at least in the near-term.[76]

HRVs

Heat recovery ventilator (HRV) technology is largely imported into BC. A gap relevant to higher levels of the BC Energy Step Code is the reduced variety of brands, models, and sizes / capacity of HRVs with higher performance levels (e.g., of the more than 200 models of HRV available in Canada and listed on NRCan's HRV product database, only 16 reach a sensible heat recovery efficiency of >75%).[77]

Generally, the cost of an HRV increases with its efficiency, estimated at approximately 7% more for a unit at 60% efficiency, and up to 43% more for a unit at 80% efficiency (due in large part to lower demand

Highest-performing HRV Brands available in Canada (i.e., >75% efficiency)

- Airflow (Ontario)
- Lifebreath (Ontario)
- Venmar / VanEE (Quebec)
- Broan (Quebec)
- Lennox (United States)
- Aldes (France)
- Fantech (Sweden)
- Panasonic (Japan)

Source: NRCan Office of Energy Efficiency HRV database

[74] See: Heat Pumps (Air Source, Split System) Regulatory Proposal. Energy Efficiency Branch, B.C. Ministry of Energy and Mines. September 2016. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/energy-efficiency/mem_eesr_ris_heat_pumps_air_source_split_system_september_27_2016.pdf
[75] See: "Local High-Performance Building Supply for New Low-Rise Homes". Arash Shadkam, UBC Greenest City Scholar Program, City of Vancouver (August 2018). https://sustain.ubc.ca/sites/sustain.ubc.ca/files/GCS/2018_GCS/Reports/2018-50%20Research%20Local%20High-Performance%20Building%20Supply%20for%20New%20Low-Rise%20Homes%20_Shadkam.pdf
[76] See: Ibid and verified through key informant interview with builder and developer based in interior of BC.
[77] Natural Resources Canada Office of Energy Efficiency HRV database: http://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.search-recherche&appliance=HERV combined with key informant interviews and the "Local High-Performance Building Supply for New Low-Rise Homes", City of Vancouver (August 2018). https://sustain.ubc.ca/sites/sustain.ubc.ca/files/GCS/2018_GCS/Reports/2018-50%20Research%20Local%20High-Performance%20Building%20Supply%20for%20New%20Low-Rise%20Homes%20_Shadkam.pdf

for high-performing products at present resulting in less economies of scale which, in turn, result in higher costs for manufacturers and consumers).[78]

BC does have a niche strength with CORE Energy Recovery Solutions, a company providing components for HRVs/ERVs. Based in Vancouver, CORE designs and produces air-to-air heat exchangers that apply to both residential (including multi-unit buildings) and commercial applications (see Profile Box).[79]

Control Systems

A potential area for growth related to high performance HVAC systems are the controls which allow for optimal operation and monitoring. BC-based manufacturers, such as Delta Controls, ESC Automation, and Reliable Controls, provide integrated control systems that allow building owners or managers to efficiently operate and oversee lighting systems, HVAC, and security. The knowledge and expertise within these companies offers a valuable niche in BC's technology manufacturing sector that could be further targeted for supply chain partnership development.

Workforce Capacity

From a skills and workforce capacity perspective, the trend toward the merging of forced air and hydronics related technologies, where before the two disciplines were relatively segmented, means that trades and installers increasingly need to know how work with both systems. However, gaps exist with respect to the right design and sizing of HVAC equipment and related system components such as ducting.[80]

Profile Box: CORE Energy Recovery Solutions www.core.life

CORE designs and manufacturers air-to-air energy and heat recovery exchangers (ERVs and HRVs) for both residential and commercial buildings. Based out of Vancouver, the company delivers industry leading membrane technology by utilizing state-of-the-art automated manufacturing processes to produce energy recovery exchanger and ventilation components that not only improve the building's energy efficiency, but also provides improve air quality for building inhabitants. Their design does not rely on any moving parts, reducing the costs around operation and maintenance of their systems.

The company's expertise in ERV technology competes with the technology delivered by larger players such as Mitsubishi and represents a niche strength in BC that can evolve into key supplier of high efficiency HRV and ERVs in BC. Projects such as the Vancouver House, a LEED Gold high rise project showcases the 67% efficient in-suite technology that benefits builders with a lower initial capital cost and takes up less flor space for homeowners. By spotlighting the company's current project success in projects across Canada, US, Europe and China such as there is a case to be made for increased investment into the company to increase its production capacity and divert the supply away from larger international players.

Text provided by CORE Energy Recovery Solutions.

[78] See: Ibid.
[79] See: Core Energy Recovery Solutions http://core.life/en/
[80] Key informant interview with industry association representative.

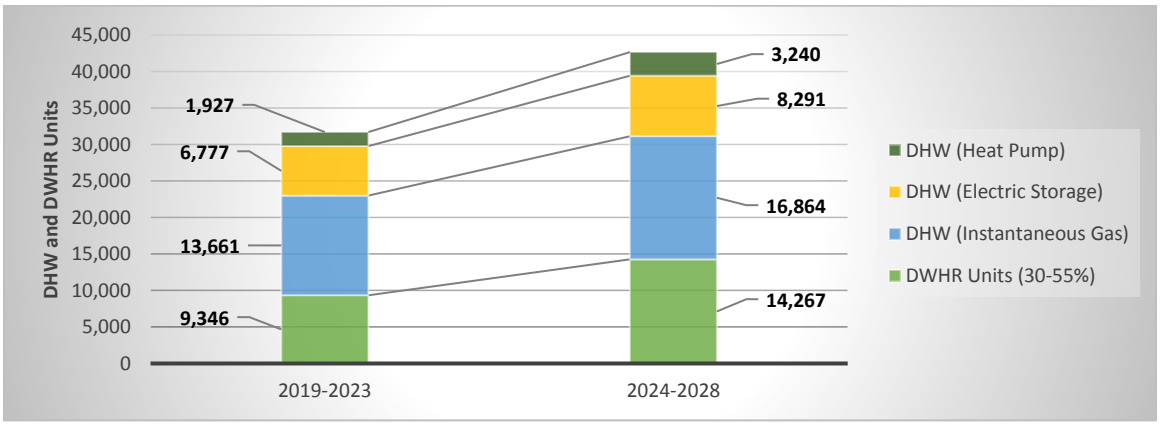
Domestic Hot Water & Drain Water Heat Recovery

Market Demand

Domestic hot water (DHW) and drain water heat recovery (DWHR) technologies included in the Model are outlined in the table below.

Product	Market Segment	Description
Natural gas instantaneous hot water system	Single-family Residential	Equivalent to a 7.5 gallon/minute system manufactured by Rinnai, Navien, or similar.
Electric storage hot water system	Single-family Residential	Equivalent to a 40 gallon system manufactured by Rheem, John Wood, or similar.
Heat pump hot water system	Single-family Residential	Equivalent to a 50 gallon system manufactured by A.O. Smith or similar.
Drain water heat recovery system (various efficiencies)	Single-family Residential	Equivalent to units manufactured by PowerPipe or similar with 30%-55% efficiency.
Natural gas instantaneous hot water system	Multi-unit Residential	Equivalent to a 14.5 gal/min system manufactured by Takagi T-M50 or similar.
Electric storage hot water system	Multi-unit Residential	Equivalent to a 500 mbh system.
Boiler combination system for heating and hot water	Multi-unit Residential	Equivalent to a 400 mbh system.
Heat pump hot water system	Multi-unit Residential	Equivalent to a 963 mbh system.
Condensing hot water boiler system	Multi-unit Residential	Equivalent to a 400 mbh system.
Drain water heat recovery system (various efficiencies)	Multi-unit Residential	Equivalent to an 18 kw unit manufactured by SHARC Energy Systems or similar, ranging from 30%-55% efficiency.

As shown in Figure 13, results from the Model show an expected increase in demand for DWHR technology in the single-family residential market, as well as more efficient gas and electric DHW systems, across the Metro Vancouver region between 2019 and 2028.



Source: Product Demand Forecasting Model

Figure 13: Demand for higher-performance domestic hot water (DHW) and drain water heat recovery (DWHR) systems in the single-detached residential market across Metro Vancouver, 2019 to 2023 and 2024 to 2028.

The combined market value in Metro Vancouver for DWHR technology is estimated at approximately $15 million over the next decade for the single-family residential segment. In total, the Model projects market demand for DWHR technology in the single-family residential segment at approximately 9,300 units over the next five years, growing to 14,300 units over the second half of the decade as energy performance requirements in the BCBC and adoption of Upper Steps of the BC Energy Step Code take effect.

In terms of DHW, the demand for higher performance products in the single-family residential market segment is dominated by high-efficiency natural gas, instantaneous systems or similar, making up approximately 60% of projected demand over the next decade with more than 30,000 units. Electric storage (30%) and heat pump hot water systems (10%) are projected to make up the balance. Combined, the estimated market value for these products is estimated at $64 million over the next decade to 2028 for single-family homes.

For the MURB segment across Metro Vancouver, the Model projects approximately 1,600 commercial DWHR units (ranging from 30% to 55% efficiency) and 3,400 high-performance DHW systems will be in demand (see Appendix B for more details). Combination heating and hot water boiler systems are projected to make up the majority of systems (approximately 53%), followed by electric storage (15%), condensing boilers (13%), heat pump hot water (10%), and instantaneous gas systems respectively (8%).

In terms of the market value, the DHW market for higher-performing commercial products is estimated to be worth approximately $46 million over the next decade (see Appendix C for more details). The Model projects that the total market value for commercial DWHR technology in Metro Vancouver over the next decade will be worth approximately $7.1 million.

Based on the current policy scenarios and adoption plans for the BC Energy Step Code, the Part 3 commercial office building segment is not expected to see any incremental demand for higher performing DHW or DWHR systems beyond current business-as-usual over the next decade to 2028.

Supply Chain Insights

Similar to the space heating and cooling sector, the supply chain for DHW and DWHR systems is supported by larger international manufacturers and a smaller group of local manufacturers of heat pump hot water tanks, heat exchangers, and boilers.

Domestic Hot Water

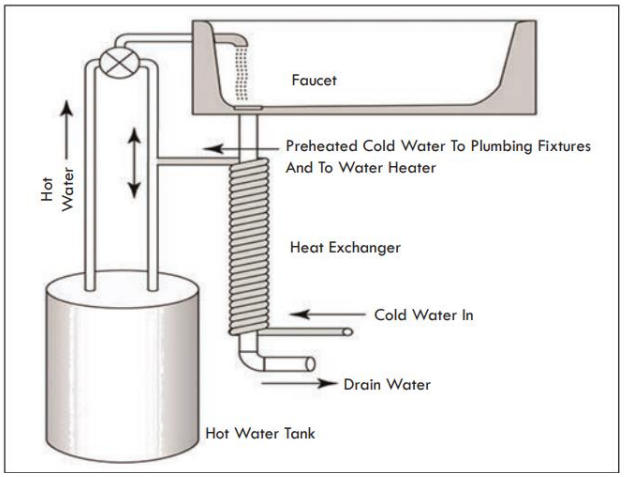
Across Canada, the DHW market is beginning to respond to rising energy prices and the demand for more energy efficient technologies, such as tankless water heaters. Manufacturing capabilities are largely concentrated outside of Canada.

For example, the technology and manufacturing supply chains for tankless water heaters are largely based in Asia and Europe. Key players, such as Sweden-based Electrolux AB, have located some aspects of their manufacturing in the US to supply the North American market.[81]

US-based AO Smith Corporation recently closed its manufacturing plant that was located in the manufacturing hub of Southern Ontario.[82] This shift was largely due to the weakening Canadian dollar and the high cost of labour. Looking forward, this trend is expected to continue.[83]

Drainwater Heat Recovery

DWHR is a proven energy-saving technology, which typically reduces water heating energy consumption by 35% to 50% and total building energy usage by up to 10% (see Figure 14 for example of a standard DWHR technology).[84] Ontario is a market leader in Canada for the manufacture and supply of DWHR technology.



Source: ASHRAE Journal

Figure 14: Drain water heat recovery on-demand unit.

A niche strength in DWHR exists in BC through local manufacture SHARC Energy Systems, the sole DWHR system manufacturer in BC that is currently looking to expand its technology to serve the single-family market[85] (see Profile Box). The company works with a range of local businesses who contribute to the production line of SHARC's DWHR system,[86] and is confident in their ability to ramp up its capacity to meet a greater demand for DWHR systems if given adequate time and accurate projections of growing local demand.

[81] Ibid.
[82] See: IBIS World Industry Report: Major Household Appliance Manufacturing in Canada. April 2018.
[83] Ibid.
[84] Emerging Technologies. ASHRAE Journal. Alissa Cooperman et al. November 2011. http://eddygroup.com/docs/news/Article%20-%20Drain%20Water%20Heat%20Recovery.pdf
[85] See: Business in Vancouver. SHARC takes a bite out of home, business energy costs. https://biv.com/article/2018/06/sharc-takes-bite-out-home-business-energy-costs
[86] Key informant interview.

Profile Box: SHARC Energy Systems

www.sharcenergy.com

The SHARC Energy Systems international headquarters in Port Coquitlam BC, produces an industry leading DWHR technology that harnesses heat from a building's waste water or other waste water supply such as city sewers, lift stations or waste water treatment plants to provide energy efficient heating & cooling. Through their patented SHARC & PIRANHA systems, the company serves Commercial, Industrial and Residential (MURB) space with plans to expand into the single-family residential market within the coming year. In addition to their niche technology offering, the company also works with its clients from the very initial planning design stages through to commissioning and servicing to ensure its system suits the building's needs.

The company's effective and efficient technology has been proven in many local and international projects The two most recent projects are The Southeast False Creek Neighborhood Energy Utility in Vancouver which provides heating and hot water to over 5000 residences and 5 million square feet of heating, and the DC Water Head Quarters in Washington DC, the first office building in the US to provide Heating & Cooling with wastewater. Operating at up to 600% efficient in some projects, the system produces domestic potable hot water and heats buildings through radiant floor heating or air source fan coils and can reduce emissions up to 500kg per person per year on domestic hot water usage.

In 2017, the company's revenue was approximately $1 million; by 2019, the company is projecting revenues of between $20 million and $25 million. The growth is due in part to a major contract in the United Kingdom, and uptake in other markets where GHG emission reductions and energy consumption is a key focus.

The Company's product line can serve to transfer heat energy to and from buildings using wastewater for smaller 50 residential units and up, to very large projects such as district energy systems with multiple buildings. The Piranha, from 25 and up residential units, breweries, hotels, laundry facilities and the SHARC from 400 residential units and up, district energy systems, and commercial/industrial applications. In most cases the company's systems can provide up to 100% of the domestic hot water requirements from the buildings own waste water flow.

Text provided by SHARC Energy Systems

4. Construction & Professional Services

The supply chain for construction and professional services required to deliver better performing buildings related to the BC Energy Step Code is extensive. BC has considerable capacity in terms of the service-oriented firms related the BC Energy Step Code, as exemplified in Table 3 below.

This chapter focuses on a number of service-based industries relevant to the BC Energy Step Code, including (1) builders; (2) architects, designers, and engineers; and (3) energy advisors.

Table 3: Companies with employees in BC from select industries relevant to the construction and professional services supply chain.

NAICS - Industry	Cariboo	Kootenay	Mainland/ Southwest	Nechako	North Coast	Northeast	Thompson/ Okanagan	Vancouver Island/Coast	TOTAL
236110 - Residential building construction	188	213	3,288	42	64	105	774	1,040	**5,714**
236220 - Commercial and institutional building construction	31	24	620	10	9	13	105	142	**954**
238150 - Glass and glazing contractors	3	4	122	0	0	5	17	34	**185**
238170 - Siding contractors	6	3	184	0	1	1	46	36	**277**
238210 - Electrical contractors	75	86	1,212	19	21	73	295	342	**2,123**
238220 – Plumbing and HVAC contractors	79	104	1,301	16	15	54	333	386	**2,288**
238310 - Drywall and insulation contractors	31	17	577	4	3	12	100	97	**841**
541310 – Architectural Services	6	3	425	0	0	0	43	83	**560**
541330 - Engineering services	46	59	1,139	10	13	28	197	269	**1,761**
541340 - Drafting services	4	2	106	0	0	1	19	15	**147**
541350 - Building inspection services	7	3	74	2	2	5	20	24	**137**

Source: Statistics Canada, Business Registry (December 2016 data)

Builders & Trades

Based on 2014 estimates, there are more than 18,000 jobs in BC related to the construction of high-performance and green building projects in British Columbia.[87] Jobs in this segment include contractors and trades engaged in the construction of non-residential and residential buildings certified under a recognized green building standard / certification or an energy efficient building based on mandatory energy code requirements. The Vancouver Economic Commission estimates that in the City of Vancouver alone, more than 4,000 green construction jobs (i.e., builders and trades) existed in 2016.[88]

In the residential space, many BC builders are considered North American leaders in terms of durable home design and construction expertise. Home performance and house-as-a-system construction best practices are becoming more common among leading builders in BC. These efforts are supported by industry organizations such as BC Housing and the Canadian Home Builders' Association (CHBA BC) and its regional chapters, which offer a range of relevant training and continuing professional development options.

In addition, BCIT's High Performance Building Lab[89] provides an excellent example where a collaborative approach has been developed to offer training for builders, trades, and others in the construction sector supply chain relevant to the BC Energy Step Code.

Designers, Architects & Engineers

The professional services segment related to high-performance and green buildings in BC is estimated to have generated approximately 3,500 jobs and $288 billion in GDP in 2014.[90] This segment includes firms active in green building design, architecture, engineering, property management, and related scientific and technical services.

Many BC-based architecture and design firms are recognized for having strong expertise relevant to the BC Energy Step Code, including in areas such as air-tightness, building envelope design, and building science. BC's engineering firms have also demonstrated expertise in designing better lighting as well as HVAC systems, particularly for Part 3 buildings, that are as efficient as possible within the constraints of the building requirements. BC's mechanical and electrical design community has improved the effectiveness of how it sizes and specifies systems in order to improve and achieve performance through design.

On the envelope side, there is strong knowledge of how to specify high-performance glazing and curtain wall systems, optimize insulation levels, and eliminate thermal-bridging (although these activities are not always put into practice based on current market demand).

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[87] Canada Green Building Council and The Delphi Group (2016), "Green Building in Canada: Assessing the Market Impacts and Opportunities" report.
[88] Vancouver Economic Commission (2018), "State of Vancouver's Green Economy 2018". See: http://www.vancouvereconomic.com/wp-content/uploads/2018/06/State_of_Vancouvers_Green_Economy_2018_Report_Vancouver_Economic_Commission.compressed.pdf
[89] See: https://commons.bcit.ca/energy/research/high-performance-building-lab/
[90] Canada Green Building Council and The Delphi Group (2016), "Green Building in Canada: Assessing the Market Impacts and Opportunities" report. https://www.cagbc.org/CAGBC/Advocacy/Green_Building_in_Canada_Assessing_the_Market_Impacts_Opportunities.aspx

The collaborative nature of high-performance building design has also gained momentum, where competition is fierce and even minor efficiencies present an advantage. Emerging integration tools, such as Building Information Modelling (BIM), is helping to improve productivity and coordinate efforts from multiple participants when engaging on a project. BIM software integrates 3D modelling with project management, facilitating the coordination and communication of the design construction-operation teams for a building under one platform.

In addition, the traditional 'design-bid-build' model, where each participant focuses exclusively on their own construction tasks, is increasingly viewed as obsolete when compared to the 'integrated project delivery' (IPD) model, which focuses participant efforts through collaborative incentives. Many architecture and design firms use BIM platforms and IPD models to meet their clients' needs.

BC's architecture, engineering, and construction sectors have worked collaboratively in the design and development of a number of globally recognized high-performance building projects, including tall wood buildings (e.g., Brock Commons at UBC), net zero energy homes, and Passive House certified projects (e.g., the 85-unit, Passive House certified Heights residential building in Vancouver). BC projects have also been the focus for attracting international delegations, who come to learn about specific systems, innovative materials and applications, and unique features developed by BC-based designers, architects, and engineers.

Expertise in developing world-class building projects, as well as archetype buildings, has led to a better understanding of systems-based design in order to optimize performance. Some BC-based leaders in sustainable building and community design are successfully exporting their knowledge and consulting expertise to other jurisdictions such as the United States, Asia, Europe, and Latin America.

Energy Advisors

There are approximately 50 energy modellers in BC that provide services for Part 3 ICI buildings and MURBs.[91] However, the biggest anticipated shift as it relates to the BC Energy Step Code and the energy advisor community will be for the Part 9 sector.

The BC Energy Step Code requires that Part 9 builders work with Certified Energy Advisor (CEAs) to review plans, model energy consumption, conduct air tightness testing, and verify that the plans for new homes meet the energy performance requirements of a given Step of the BC Energy Step Code and to ensure the end result is a healthy, energy-efficient home that will save money over time.

EnerGuide Rating System (ERS) CEAs are third-party consultants who have been registered by Service Organizations that are licensed by Natural Resources Canada (NRCan) to deliver its EnerGuide Rating System, ENERGY STAR for New Homes, and R-2000 initiatives promoting energy-efficient homes. A CEA will use software to complete a whole-building energy model to analyze construction plans and determine the energy efficiency of the building and whether the design will meet the target performance requirements.

[91] MODUS Planning and Brantwood Consulting (2017), "Energy Step Code Training and Capacity Project Summary Report". See: http://energystepcode.ca/app/uploads/sites/257/2018/07/BC-Energy-Step-Code-Training-and-Capacity-Report-Final.pdf

Most service organizations and home energy evaluators work with both new and existing homes.[92] Over the last decade, the home energy evaluation industry in BC has seen a reduction in the number of energy advisors delivering EnerGuide Rating System energy evaluations, although it has seen an increase in the diversity of services provided by the sector.[93] As of April 2018, there were 13 NRCan-licensed Service Organizations providing services for the Part 9 sector across British Columbia.[94]

The BC Energy Step Code is expected to stimulate a dramatic increase in the demand for CEAs for Part 9 building projects given it is a requirement for compliance. To meet the requirements of the BC Energy Step Code, builders and developers will need to work with a CEA to check that their plans meet the energy performance requirements of a given Step. If it does not, the CEA will need to work with the builder or developer to provide upgrade options to increase the energy efficiency of the building until it meets its targets. As such, CEA will act more as consultants in the future to guide builders with the construction of better performing homes.

This will also stimulate the need for additional relevant training. Organizations such as City Green Solutions are actively involved in training CEAs for the new construction market in order to fill the potential gap in numbers of qualified professionals.

Supply Chain Insights

The types of products required in Metro Vancouver to meet Upper Steps of the BC Energy Step Code, as well as future updates to the BCBC, will require a shift by BC's construction sector supply chain. It will require builders, trades, designers, architects, energy advisors, and building inspectors to update their knowledge and understanding of new products, building science, alignment across building and health and safety codes, as well as best practices / standards of excellence that will ensure success at each Step of the BC Energy Step Code.

The latter is a gap that was flagged and emphasized during interviews with several key stakeholders from municipal governments, industry associations, builders, and consultants. The consensus across these stakeholders is that some capacity issues already exist for skilled trades, energy advisors, and building inspectors.[95]

While BC-built homes by leaders in the industry are durable and relatively energy efficient by North American standards, from an energy perspective, European home construction is generally considered to be further ahead in terms of passive design features and based on absolute energy consumption measures. The BC Energy Step Code provides opportunities and a pathway for Canadian companies with expertise in home construction and design to strengthen performance further and, in turn, grow their capacity in this area with the potential for exporting this knowledge.

[92] Home Performance Stakeholder Council Energy Advisor Sector Working Roadmap (February 2018 Draft).
[93] Ibd.
[94] MODUS Planning and Brantwood Consulting (2017), "Energy Step Code Training and Capacity Project Summary Report". See: http://energystepcode.ca/app/uploads/sites/257/2018/07/BC-Energy-Step-Code-Training-and-Capacity-Report-Final.pdf
[95] Key informant interviews with industry associations, consultants and builders operating in BC.

As the adoption of Upper Steps of the BC Energy Step Code takes place, it will become even more critical to implement coordinated training and knowledge and capacity building for trades involved with fenestration, insulation, and HVAC equipment, as well as for energy advisors.[96]

"There is a need for more investment in Energy Advisor training and capacity building. Energy Advisors will need to act as ambassadors for the BC Energy Step Code and must be on the same page in order to avoid industry confusion and resistance."

- BC Engineering Firm

Recommendations put forward in the BC Energy Step Code Training and Capacity report[97] suggest the highest priority gaps to be addressed with respect to construction services relate to:

- Increasing the quality and consistency of energy modeling and airtightness testing for Part 3 MURBs and commercial buildings, as well as increasing access to qualified energy modelers; and
- Ensuring a sufficient number of energy advisors for Pat 9 projects while simultaneously ensuring builders know where and how to integrate CEAs into their building projects.

Energy modellers will need a deeper understanding of building science so that they can play a larger role in the initial building design. While CEA capacity exists in the Metro Vanc ouver region for the most part at present, as local governments look to adopt the Upper Steps of the BC Energy Step Code and future updates to the BCBC take affect, skill levels will also need to evolve accordingly. More advanced training will need to be developed for energy modellers to understand their new role in the integrated design process. CEA capacity outside of the Metro Vancouver region will also need to build up considerably based on input from key stakeholders interviewed for this study.[98]

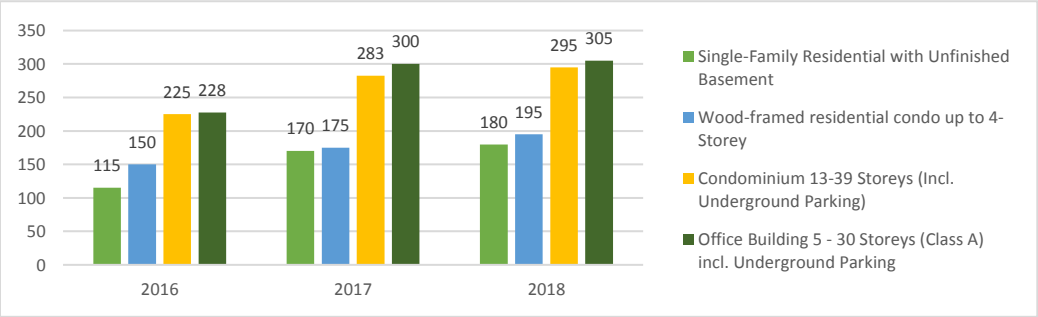
[96] See: Home Performance Stakeholder Council Energy Advisor and Service Organization Sector Working Roadmap. February 2018.
[97] MODUS Planning and Brantwood Consulting (2017), "Energy Step Code Training and Capacity Project Summary Report". See: http://energystepcode.ca/app/uploads/sites/257/2018/07/BC-Energy-Step-Code-Training-and-Capacity-Report-Final.pdf
[98] Insights from CHBA BC and Home Performance Stakeholder Council.

5. Conclusions

The BC Energy Step Code is expected to drive significant change within BC's construction market over the coming decade. As local governments in BC consider their adoption plans for the BC Energy Step Code and industry prepares to respond accordingly, the success for all stakeholders will rely on the responsiveness and capacity of the local supply chain to deliver and install the relevant building products at affordable prices, particularly for higher levels of the BC Energy Step Code.

However, it is important to recognize that the findings presented in this report are set in the context of BC's broader, dynamic construction market which must consider that:

1. Overall, construction prices in BC have been increasing over the past three years (see Figure 15) driven by rising prices for materials and a shortage of skilled labour, which is expected to continue through to 2020.[99] As one example, softwood lumber prices have gone up 39% between January 2016 and July 2018.[100] By comparison, between 2013 and 2017, the average annual growth rate of all construction wages in BC was 1.6%.[101]
2. BC's market for construction products is relatively small, which presents challenges for local manufacturers looking to gain economies of scale in the production of their high-performance offerings.
3. The pricing of particular construction products and materials can be highly variable. Factors such as trade tariffs, order sizes and/or volume discounts, customer loyalty programs, competition for products (e.g., when large projects are tendered), and the tendering process itself can all affect the costs of construction products and materials.
4. Product availability and cost varies throughout BC. Higher performance products that may be available in urban centres may be harder to get and/or more expensive in remote locations.



Source: Altus Group

Figure 15: Construction costs 2016-2018, Vancouver CMA ($/sf), excluding land costs.

[99] Build Force, "Construction & Maintenance Looking Forward, 2018 – 2027" https://www.constructionforecasts.ca/sites/forecast/files/highlights/2018/2018_National_Summary_Constr_Maint_Looking_Forward.pdf
[100] The industrial price index for SPF lumber in BC was 139.2 in Jan 2016 and 193.0 in July 2018. Source, Statistics Canada. Table 18-10-0031-02 Industrial product price index, for selected products, by region, percentage change, monthly. www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810003102
[101] Statistics Canada. See: www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410006401

Given some of the market complexities outlined above, it can be challenging for local governments to pace the adoption of the BC Energy Step Code. Some have concerns that if regulations are too stringent or move too quickly for industry to adapt, it may add costs due to lack of proper industry training and familiarity with certain products, pinch points in supply, and/or temporarily limit the choice for consumers while the market adjusts to new supply chains.

The Product Demand Forecasting model developed as part of this project can help provide some of this clarity for industry and local governments. It provides the flexibility to examine market demand for specific products under various BC Energy Step Code adoption scenarios and timelines.

"We've been trying to encourage curtain wall/fenestration manufacturers from Europe making Passive House certified units to bring their products to Canada and they are looking for hard data and market information on which way the market is going. The Product Demand Forecasting Model provides some of that market data which can be very useful for architects, municipalities, and developers."

- BC Design and Architecture Firm

It can also serve as a tool for providing insights on economic and investment attraction opportunities within BC's high-performance building sector. For example, combined with BC's well-established brand as a green building leader, the accelerated adoption of the BC Energy Step Code by local governments could result in expanded domestic manufacturing in BC where it makes sense.

Local manufacturing is important as it provides an institutional foundation for learning and developing process skills and capabilities that are increasingly inter-twined with R&D, innovation, intellectual property development, and long-term sector competitiveness. Manufacturing underpins wealth creation, high-paying jobs[102] and, through value-added processes, can create economic and employment ripple effects for multiple industries across the local supply chain.

Results from this study suggest that the greatest opportunities for new investment and economic development from the adoption of the BC Energy Step Code relate to fenestration products and pre-fabrication, where particularly strong expertise and local capacity already exists. Future projected growth in demand for other high-performance products and equipment, including innovative insulation products, wall panel assemblies, and potentially HRVs and HVAC equipment (e.g., commercial hot water heat pumps and CO_2 heat pumps), warrants further investigation.

Expansion of the domestic manufacturing base in BC may be achieved through product licensing and partnerships with established international players. For example, Oregon-based HRV manufacturer Ventacity recently partnered with Fujitsu General America to improve the value of their product offering and respond to the demand for energy efficient mechanical systems in that region. Together, the companies developed a joint solution that combined Ventacity's energy efficient HRV and building control technology with Fujitsu's line of

[102] According to Statistics Canada, BC's manufacturing wages in 2017 were higher than the provincial average: $1,099 average weekly earnings versus $947 for all other sectors combined. See: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410020401

variable refrigerant flow (VRF) heating and cooling systems, resulting in a USD 2 million investment into the local economy by Fujitsu.[103]

A number of motivating factors can increase the demand for sourcing local products, including: import tariffs and trade issues; supplier loyalty; a need to see products locally deployed to "kick the tires"; an affordable and streamlined product commercialization and testing process; applicable local standards; and factors such as additional green building certification points (e.g., LEED) from buying local.

> *Cost increases associated with the BC Energy Step Code are almost guaranteed to go towards the local economy because it is decreasing the cost and reliance on mechanical systems that would normally be imported to BC; instead the investment is being put into wall construction which is local material and labour.*
>
> - BC Construction Training Organization

However, it is important to keep in mind that business success is not in manufacturing the equipment or components alone but how they are managed as a whole system; including the processes / economic model around assembly, marketing, real estate costs, and other inputs related to supply chain management, factors that will be considered in detail by any local or global manufacturer looking to BC as a potential expansion opportunity and prior to making investments in capital and infrastructure.

Many builders and suppliers consulted for this study indicated that, in general, they do not have difficulty finding and installing the products, materials, and equipment they need to build high-performance homes and buildings at present (at least under current levels of demand). The exception is with some Passive House certified products relevant only to the highest levels of the BC Energy Step Code.[104] As the demand for higher-performing products grows, however, opportunities may exist for developers, builders, and others to work together to establish coordinated purchasing / procurement efforts to aggregate products with better pricing and/or identify imported components that would save costs and improve overall affordability.

Before these economic development opportunities can be fully realized, however, clear messaging from local governments is required to better define prevailing uncertainties around the rate of adoption of the BC Energy Step Code, allowing for a better understanding of the potential market demand for relevant products. The development of a BC Energy Step Code "Adoption Roadmap" amongst local governments in Metro Vancouver is proposed in order to provide better guidance and clear timelines to industry, leveraging the Model developed as part of this project.

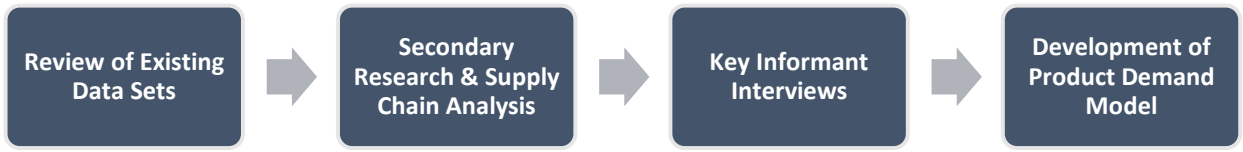
While the first iteration of the Model provides an important basis for understanding the characteristics, scale, and direction of Metro Vancouver's high-performance building product market, the Model needs to be shared with local governments and industry to refine data inputs and assumptions, which will further enhance its accuracy. In addition, to ensure the Model stays relevant, resources will be required to ensure it is maintained and updated on a regular basis and turned into a tool that is easily accessible for industry and local governments to use.

[103] See: Fujitsu, Ventacity Announce Joint Partnerships https://www.achrnews.com/articles/139242-fujitsu-ventacity-announce-joint-partnership
[104] Key informant interviews.

Appendix A: Methodology

Research Activities

The Delphi Group and Brantwood Consulting undertook four primary research and development activities as part of this project, as described below.



1. **Review of Existing Data:** The Delphi Group began by identifying relevant existing data sources. Data sources included BC Housing's BC Energy Step Code 2017 Metrics Research (including the 2018 update); BC Energy Step Code information and related technology costing data from Integral Group, Morrison Hershfield, and Natural Resources Canada (NRCan); floor space (sqm / ft2) estimates by building type, as well as growth projections for new construction over the coming decade, for the various building types relevant to the BC Energy Step Code policy (Part 9 and Part 3) by municipality in Metro Vancouver (Climate Zone 4); and product and equipment information related to the building supply chain available in BC and/or Canada more broadly from NRCan, various industry associations, and a number of product / sector-specific market reports published by firms including IBIS World and Freedonia.
2. **Supply Chain Analysis:** The Delphi Group undertook secondary research and a supply chain analysis to better understand the current supply chain strengths and gaps in BC, as well as potential financial / affordability risks and other issues that may occur through the adoption of the BC Energy Step Code. Based on secondary research results, a review of Canadian and global market reports, and the collection of existing information and data sets, Delphi mapped the existing supply chain capacity in BC (including manufacturers of high-performance products and equipment) and identified the information and data gaps in order to develop a draft recommendations and actions to fill these gaps.

   Delphi also compiled a list of relevant local manufacturers and suppliers of products required to meet higher levels of the BC Energy Step Code (including high-performance fenestration products; air-sealing accessories and air-barriers; thermal bridging solutions; energy efficient heat pumps and other HVAC equipment; and metering and smart controls; and other innovative produces for high-performance construction). This was done through extensive internet searches, the review of relevant industry association databases, the examination of industry and market reports, a review of project case studies and product / equipment listings, and through key informant interviews.

3. **Key Informant Interviews:** The Delphi Group undertook approximately 30 key informant interviews with leading subject-matter experts with proven knowledge of the high-performance / energy efficient building sector and the related supply chain in BC. The list included referrals from the Vancouver Economic Commission and the Advisory Council of knowledgeable experts active in the field. Interviews included the following:

    - 5 high-performance building product manufacturers
    - 5 engineering and architecture firms
    - 2 energy consulting firms
    - 3 construction firms and suppliers
    - 2 energy utilities in BC
    - 3 local governments in Metro Vancouver
    - 3 training institutions and non-profits
    - 7 industry associations

    Delphi conducted the interviews by phone or in person, allowing for contact with respondents in geographically dispersed locations (although it should be noted that the primary focus was on the Metro Vancouver region for this particular study). Interview questions explored factors such as:

    - The supply of products and equipment in BC, as well as local manufacturing capabilities versus imported products and technologies;
    - Options for deeper integration with importers such as licensing or technology transfer;
    - Opportunities for potential export markets;
    - Rural-urban considerations within BC; and
    - Potential product pricing and affordability issues.

4. **Development of a Product Demand Forecasting Model:** The Delphi Group developed a "Product Demand" Forecasting Model (i.e., "The Model") as an interactive, scalable Excel-based tool allowing various data points to be inputted and aggregated in order to estimate the market demand and economic potential for various high-performance building products and equipment from the adoption of the BC Energy Step Code. More detailed description of the Model, its inputs, outputs, and assumptions, is provided below.

Product Demand Forecasting Model

The BC Energy Step Code Product Demand Forecasting Model was designed as a responsive, Excel-based tool for estimating the economic development potential and high-level demand for relevant high-performance building products and equipment resulting from the adoption of the BC Energy Step Code. The Model was designed primarily for industry (i.e., developers, builders, manufacturers, and suppliers) in order to provide clarity on the potential future demand for products and services in line with the BC Energy Step Code. It can also serve as a tool for local governments and other stakeholders to better understand the economic development and investment attraction opportunities from the adoption of the BC Energy Step Code.

As summarized in Figure A1, variables in the Model include:

- BC's geographic regions and climate zones;
- The various levels of the BC Energy Step Code by building typology;
- The projected growth of new construction by building type and floorspace from 2018-2032;
- The adoption timelines of the BC Energy Step Code by municipality; and
- The estimated quantities of products / equipment and market size for reaching the different levels of the BC Energy Step Code for the various building typologies over various time periods.

These variables can be rolled up within the Model under different scenarios in order to show the estimated market size and economic development potential from the adoption of the BC Energy Step Code over the current baseline (i.e., incremental over the BCBC), as well as the total estimate market demand over a time period inclusive of the BCBC[105]. The Model was initially set up for the Metro Vancouver region (within Climate Zone 4), although it was designed in a way that will allow it to be scaled to other regions and climate zones across BC in the future.

BC Regions & Climate Zones	•Initially calibrated for Metro Vancouver and Climate Zone 4 (CZ4) •Scalable for other BC regions and CZs in the future
BC Energy Step Code Levels for 5 Building Typologies	•Part 9 (including single detached and MURB) – 5 levels •Part 3 MURB (including low- and high-rise) – 4 levels •Part 3 Commercial Office – 3 levels
BC Energy Step Code Adoption Timelines by Municipality	•As stated by municipalities •Adjustable within the model
Product / Equipment Quantities & Market Size Estimates	•Metrics study (2018 data for Part 3 buildings) •Metrics study (2018 data for Part 9 buildings) •Validated through various additional sources
New Construction Growth Projections by Building Type & Municipality	•BC Housing (New Home Registrations) •Metro Vancouver Regional Growth Strategy (2015) •Other real estate projections (Avison Young, CBRE, TD Bank)

Figure A1: Variables and data sources for the BC Energy Step Code Product Demand Forecasting Model.

[105] The Model currently refers to the 2012 BC Building Code as the baseline.

Model Inputs & Assumptions

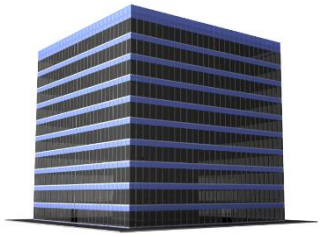
Building Archetype Assumptions

The underlying inputs and assumptions were developed for five building archetypes (see Table A1), sourced from the information originally published in the September 2017 Metrics Research study[106] and updated in 2018.

Table A1: Building archetypes and assumptions included in the Product Demand Forecasting Model.

Archetypes	Description	Representative Illustration
Mid-sized Single Detached Home Part 9 BC Building Code	• GFA (sf): 2,550 • 2 storeys plus full basement • Roof (flat) and under-slab area (sf): 850 • Front (ft): 40 • Side (ft): 21.25 • Floor to floor height (ft): 9 • Envelope area (wall and windows above grade) (sf): 2,205 • Foundation wall area (sf): 1,103	
10-Suite Multi-Unit Residential Building (MURB) Part 9 BC Building Code	• GFA (sf): 10,650 • Units: 10 • 3 storeys over U/G garage: 3 • Roof (flat) & under-slab area (sf): 3,550 • Front (ft): 44 • Side (ft): 80 • Floor to floor height (ft): 9 • Envelope area (wall and windows above grade) (sf): 6,715 • Foundation wall area (sf): 2,238	
Low-Rise Multi-Unit Residential Building (MURB) Part 3 BC Building Code	• GFA (sf): 63,900 • Units: 100 • Number of occupants: 211 • 6 storeys over U/G garage: 6 • Roof (flat) and under-slab area (sf): 10,650 • Front (ft): 125 • Side (ft): 85 • Floor to floor height (ft): 9 • Envelope area (wall and windows above grade) (sf): 22,702 • Foundation wall area (sf): N/A	
High-Rise Multi-Unit Residential Building (MURB) Part 3 BC Building Code	• GFA (sf): 191,700 • Units: 290 • Number of occupants: 640 • 30 storeys over U/G garage: 30 • Roof (flat) and under-slab area (sf): 6,390 • Front (ft): 80 • Side (ft): 80 • Floor to floor height (ft): 10 • Envelope area (wall and windows above grade) (sf): 95,925 • Foundation wall area (sf): N/A	

[106] BC Housing Metrics Research Summary Report (September 2017, updated in 2018). See: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/reports/bc_energy_step_code_metrics_research_report_summary.pdf

Commercial Office Building Part 3 BC Building Code	• GFA (sf): 196,000 • Units: 290 • Number of occupants: 790 • 10 storeys over U/G garage: 10 • Roof (flat) and under-slab area (sf): 19,600 • Front (ft): 125 • Side (ft): 157 • Floor to floor height (ft): 12 • Envelope area (wall and windows above grade) (sf): 67,632 • Foundation wall area (sf): N/A	

BC Energy Step Code Adoption Rate Assumptions

Table A2 provides the assumptions around specific adoption rates for local governments in the Metro Vancouver region with respect to the BC Energy Step Code and the various building typologies. As of October 2018, nine local governments in Metro Vancouver are now referencing the BC Energy Step Code in a policy, program, or bylaw (i.e., the City of Burnaby is only consulting at present) and one is in consultation.[107]

Adoption plans are not clearly stated for several of these local governments; in these cases, the District of North Vancouver was used as a proxy in terms of its adoption rate – these municipalities are marked with an asterisk in Table A2.

In addition, the City of Vancouver was included in the Model, based on that local government's current adoption plans under the VBBL. Where other Metro Vancouver municipalities are not yet consulting industry or referencing the BC Energy Step Code, it was assumed in the Model that they will move through the Steps of the BC Energy Step Code in line with advancements of the BCBC and related updates over the next decade (as stated in the BC Clean Growth Strategy Intention Paper for Clean and Efficient Buildings).[108]

The impact from both the evolution of BC's Building Code toward net zero energy ready new construction by 2032 as well as the accelerated adoption rates for the BC Energy Step Code were built into the modelling results presented in this report.

[107] See: https://energystepcode.ca/implementation_updates/
[108] See: https://engage.gov.bc.ca/app/uploads/sites/391/2018/07/MoE-IntentionsPaper-Buildings.pdf

Table A2: BC Energy Step Code adoption rate assumptions for local governments in Metro Vancouver.

Municipality	Description
City of Richmond	Part 9 SFD – Step 3 in Q3 2018, Step 4 Jan 2022 Part 9 MURBS - Step 3 in Jan 2018, Step 4 Jan 2025 Part 3 LR MURBS - Step 2 in Q3 2018, Step 3 Jan 2022, Step 4 Jan 2025 Part 3 HR MURBS - Step 3 in Q3 2018, Step 4 Jan 2022 Part 3 Office - Step 2 in Q3 2018, Step 3 Jan 2022
City of North Vancouver	Part 9 SFD - Step 1 in Q3 2018 Part 9 MURBS - Step 3 in Q3 2018 Part 3 MURBS - Step 2 in Q3 2018 Part 3 Office - Step 1
District of North Vancouver	Part 9 SFD - Step 3 Q3 2018 Part 9 MURBS – Step 3 Q3 2018 Part 3 MURBS - Step 2 Q2 2018 Part 3 Office – Not stated
District of West Vancouver	Part 9 SFD - Step 3 Q2 2018 Part 9 MURBS - Step 3 Q2 2018 Part 3 MURBS - Step 2 Q2 2018 Part 3 Office – Not stated
Township of Langley*	Part 9 SFD - Not stated Part 9 MURBS – Not stated Part 3 MURBS - Not stated Part 3 Office – Not stated
City of New Westminster	Part 9 SFD - Step 3 starts late 2018–2022, then Step 4 Part 9 MURBS - Step 3 starts late 2018–2022, then Step 4 Part 3 MURBS – Not stated Part 3 Office – Not stated
City of Surrey	Part 9 SFD - Step 3 in 2021 Part 9 MURBS - Step 3 in 2021 Part 3 MURBS - Step 3 in Q2 2019 Part 3 Office - Step 2 in Q2 2019
City of Burnaby*	Part 9 SFD - Not stated Part 9 MURBS – Not stated Part 3 MURBS - Not stated Part 3 Office – Not stated
City of Belcarra*	Part 9 SFD - Not stated Part 9 MURBS – Not stated Part 3 MURBS - Not stated Part 3 Office – Not stated
City of Port Moody*	Part 9 SFD - Not stated Part 9 MURBS – Not stated Part 3 MURBS - Not stated Part 3 Office – Not stated
City of Vancouver *(BC Energy Step Code equivalencies)*	All Step Codes start with Step 2 Part 9 SFD - Step 4 in 2021, Step 5 in 2025 Part 9 MURBS - Step 4 in 2021, Step 5 in 2025 Part 3 MURBS - Step 2 in 2018, Step 3 in 2021, Step 4 in 2029 Part 3 Office - Step 2 in Q2 2019, Step 3 by 2029 Net zero by 2030 (highest Steps for each building code)
All Other Local Governments in Metro Vancouver *(as per BC Building Code updates)*	Part 9 SFD - Step 3 in 2022, Step 4 in 2027 Part 9 MURBS - Step 3 in 2022, Step 4 in 2027 Part 3 MURBS – Not stated Part 3 Office – Not stated

Sources: Local government websites and BC Clean Growth Strategy Intention Paper for Clean and Efficient Buildings.

Real Estate / New Construction Growth Rate Assumptions

The Model incorporates new construction forecasts from 2018 to 2032 for the Metro Vancouver region for both residential and commercial office buildings by municipality (see Table A3). Growth projections for residential new construction are based on Metro Vancouver's 2040 Regional Growth Strategy[109] (updated data from July 28, 2017). The breakout for multi-unit residential buildings between the three different building typologies was based on the June 2018 New Home Registrations from BC Housing for Metro Vancouver. For commercial office buildings, the projected growth rate considered various real estate data sources for the Metro Vancouver region but is largely based on Avison Young's commercial office floorspace historical data and their 2-year forecasts for the Metro Vancouver region[110].

Table A3: New construction growth estimates for Metro Vancouver by building typology, 2019-2032.

		Part 9 Single Family Detached	Part 9 MURB	Part 3 Low-rise MURB	Part 3 Highrise MURB	Part 3 Commercial Office
Local Government	**2016 Population Distribution**	**Units Added Per Year (2018-2032)**	**Units Added Per Year (2018-2032)**	**Units Added Per Year (2018-2032)**	**Units Added Per Year (2018-2032)**	**Floor Space (m2) Added Per Year (2018-2032)**
Vancouver	25.72%	1,170	873	473	1,029	13.1
Surrey	21.09%	1,421	1,060	575	1,249	10.8
Burnaby	9.48%	812	606	328	714	4.8
Richmond	8.08%	495	370	200	435	4.1
Coquitlam	5.67%	680	507	275	598	2.9
Langley	1.05%	523	390	212	460	0.5
Langley (District)	4.78%	83	62	33	73	2.4
Delta	4.16%	83	62	33	73	2.1
Maple Ridge	3.35%	259	193	105	228	1.7
New Westminster	2.89%	198	148	80	174	1.5
Port Coquitlam	2.39%	170	127	69	149	1.2
North Vancouver	2.15%	83	62	33	73	1.1
North Vancouver (District)	3.50%	160	119	65	141	1.8
West Vancouver	1.73%	78	58	31	68	0.9
Port Moody	1.37%	73	54	29	64	0.7
White Rock	0.81%	35	26	14	30	0.4
Pitt Meadows	0.76%	40	30	16	35	0.4
Electoral Area A	0.66%	97	72	39	85	0.3
Bowen Island	0.15%	-	-	-	-	0.1
Anmore	0.09%	9	7	4	8	0.0
Lions Bay	0.05%	3	2	1	3	0.0
Tsawwassen First Nation	0.03%	13	10	5	12	0.0
Belcarra	0.03%	1	1	1	1	0.0

Source: Metro Vancouver 2040 Regional Growth Strategy[111]

[109] Metro Vancouver 2040 Regional Growth Strategy: See: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf
[110] Avison Young Office Market Report 2017. See: https://www.avisonyoung.ca/documents/95750/1691318/Avison+Young+Office+Market+Report_2017+Year+End.pdf
[111] http://www.metrovancouver.org/services/regional-planning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf

Product & Equipment Assumptions

The Model is designed to estimate approximate quantities of key products and equipment related to the BC Energy Step Code, based on cost and product assumptions developed for BC's Housing's Metrics study (updated in 2018). A description of these key products is provided in Table A4 below.

Table A4: Description of products and materials considered within the Product Demand Forecasting Model.

Product	Product Category	Description
Windows_Low Perf (ft2)	Fenestration (windows, doors)	Baseline equal to double-pane, U-value 1.8 (W/m2.K), 0.33 (SHGC)
Windows_Low-Med Perf (ft2)	Fenestration (windows, doors)	Baseline equal to double-pane, U-value 1.6 (W/m2.K), 0.33 (SHGC)
Windows_Med-High Perf (ft2)	Fenestration (windows, doors)	Baseline equal to double-pane, U-value 1.4 (W/m2.K), 0.33 (SHGC)
Windows_High Perf (ft2)	Fenestration (windows, doors)	Baseline equal to triple-pane, U-value 1.2 (W/m2.K), 0.2 (SHGC)
Insulation_Wall (ft2)	Insulation	Baseline equal to 6" batt or blown insulation (square feet)
Insulation_Roof (ft2)	Insulation	Baseline equal to 12" batt or blown insulation (square feet)
Insulation_Under Slab (ft2)	Insulation	Baseline equal to 4" rigid / PU/PI insulation (square feet)
Insulation_Foundation Wall (ft2)	Insulation	Baseline equal to 2" rigid / PU/PI insulation (square feet)
HRV_60% Efficiency_Residential	Heat Recovery Ventilator	Baseline is equal to a 100 cfm unit manufactured by Venmar or similar at 60% efficiency
HRV_70% Efficiency_Residential	Heat Recovery Ventilator	Baseline is equal to a 100 cfm unit manufactured by Venmar or similar at 70% efficiency
HRV_75% Efficiency_Residential	Heat Recovery Ventilator	Baseline is equal to a 100 cfm unit manufactured by Venmar or similar at 75% efficiency
HRV_60% Efficiency_Commercial	Heat Recovery Ventilator	Baseline is equal to a 600 cfm unit manufactured by Lifebreath, Fantech, or similar at 60% efficiency
HRV_70% Efficiency_Commercial	Heat Recovery Ventilator	Baseline is equal to a 600 cfm unit manufactured by Lifebreath, Fantech, or similar at 70% efficiency
HRV_75% Efficiency_Commercial	Heat Recovery Ventilator	Baseline is equal to a 600 cfm unit manufactured by Lifebreath, Fantech, or similar at 75% efficiency
HRV_80% Efficiency_Commercial	Heat Recovery Ventilator	Baseline is equal to a 600 cfm unit manufactured by Lifebreath, Fantech, or similar at 80% efficiency
HRV_84% Efficiency_Commercial	Heat Recovery Ventilator	Baseline is equal to a 600 cfm unit manufactured by Lifebreath, Fantech, or similar at 84% efficiency
DWHR_30% Efficiency_Residential	Drain Water Heat Recovery	Baseline is equal to a unit manufactured by PowerPipe or similar at 30% efficiency
DWHR_42% Efficiency_Residential	Drain Water Heat Recovery	Baseline is equal to a unit manufactured by PowerPipe or similar at 42% efficiency
DWHR_55% Efficiency_Residential	Drain Water Heat Recovery	Baseline is equal to a unit manufactured by PowerPipe or similar at 55% efficiency
DWHR_Unspecified Efficiency_Commercial	Drain Water Heat Recovery	Baseline is equal to an 18 kw unit manufactured by Sharc Energy Systems or similar
DWHR_30% Efficiency_Commercial	Drain Water Heat Recovery	Baseline is equal to an 18 kw unit manufactured by Sharc Energy Systems or similar
DWHR_42% Efficiency_Commercial	Drain Water Heat Recovery	Baseline is equal to an 18 kw unit manufactured by Sharc Energy Systems or similar
DWHR_55% Efficiency_Commercial	Drain Water Heat Recovery	Baseline is equal to an 18 kw unit manufactured by Sharc Energy Systems or similar
HW System_Gas Instantaneous_Residential	Domestic Hot Water	Baseline is equal to a 7.5 gal/min system manufactured by Rinnai, Navien, or similar
HW System_Electric Storage_Residential	Domestic Hot Water	Baseline is equal to a 40 gal system manufactured by Rheem, John Wood, or similar
HW System_HP Hot Water_Residential	Domestic Hot Water	Baseline is equal to a 50 gal system manufactured by A.O. Smith or similar
HW System_Gas Instantaneous_Commercial	Domestic Hot Water	Baseline is equal to a 14.5 gal/min system manufactured by Takagi T-M50 or similar

HW System_Electric Storage_Commercial	Domestic Hot Water	Baseline is equal to a 500 mbh system
HW System_Combo_Commercial	Domestic Hot Water	Baseline is equal to a 400 mbh system
HW System_HP Hot Water_Commercial	Domestic Hot Water	Baseline is equal to a 963 mbh system
HW System_Condensing boiler_Commercial	Domestic Hot Water	Baseline is equal to a399 mbh system
HVAC_Electric Baseboard_Residential	HVAC Equipment	Baseline is equal to a 1 kW electric baseboard unit
HVAC_95% AFUE Gas Furnace_Residential	HVAC Equipment	Baseline is equal to a 60 mbh gas furnace at 95% AFUE
HVAC_Cold Climate AS HP_Residential	HVAC Equipment	Baseline is equal to a 25 mbh cold climate air source heat pump
HVAC_Cold Climate AS HP_Commercial	HVAC Equipment	Baseline is equal to a 720 mbh large commercial air source heat pump
HVAC_Gas combo heat_Commercial	HVAC Equipment	Baseline is equal to a 60 mbh gas combination roof top unit
HVAC_Fan coil_Commercial	HVAC Equipment	Baseline is equal to a 1000 cfm commercial, 4-pipe connection fan coil
HVAC_Heat pump_Commercial	HVAC Equipment	Baseline is equal to a 60 mbh split-type commercial heat pump

Estimates for the total quantities of building envelope products (i.e., fenestration and insulation products) were developed based on the five building typologies described in Table A1. For certain building types (particularly, high-rise residential buildings and offices), it has been customary to provide high proportions of glazed wall area; sometimes in excess of 70% window-to-wall ratio (WWR). It is worth noting that at higher levels of the BC Energy Step Code, the amount of window area becomes an important consideration in controlling heat loss/gain and the WWR will likely decrease. While there is no sliding scale of WWR in the Model[112], the Model has adopted a conservative approach and accounted for WWRs as shown in Table A5.

Table A5: Window-to-wall ratios applied within the Product Demand Forecasting Model.

Typology	WWR
Single-family home	14.7%
Part 9 MURB	27%
Low-rise MURB	40%
High-rise MURB	40%
Commercial office	50%

For mechanical systems (i.e., HVAC, HRVs, DHW, and DWHR equipment), a percentage distribution of these products across the various levels of the BC Energy Step Code for each of the building typologies was estimated, based on a blend of the top 10 lowest incremental cost and the top 10 highest net present value (NPV) permutations from the Metrics Research study. This approach was deemed more realistic than simply applying the lowest cost or highest NPV combination as it takes into account that developers and building / home owners invest in new building projects for various reasons (e.g., some build to sell while others build to own) and provides a more likely accurate picture of market demand. These product and equipment assumptions were further refined through additional research and validated by the project's Advisory Committee.

[112] No WWR sliding scale was introduced because it implied too many design permutations and trade-offs with mechanical system selections to be accommodated within the model.

Product and equipment quantities for each building typology are provided in Tables A6-A10. It should be noted that the Model assumptions do not account for changes to product and equipment costs over time but utilized the results from the 2018 data provided through the Metrics study. As such, it is recommended that product and equipment assumptions with the Model be revisited and updated on a regular (annual or biannual basis).

In addition, mechanical equipment estimates include only the incremental products above the current 2012 BCBC (i.e., only products that perform better than the lowest energy performance required by the 2012 BCBC are included); as such, the demand for base DHW systems and natural gas-powered furnaces are not accounted for in the product estimates. Furthermore, changes over time to mechanical equipment sizing was not accounted for within the current Model for HVAC equipment given the complexity of building in these assumptions, although it is recognized as an important consideration (i.e., as building performance increases at higher levels of the BC Energy Step Code due to thicker, more efficient building envelopes, heating equipment requirements will likely decrease).

Table A6: Product and equipment assumptions for mid-sized single detached home in Metro Vancouver (Part 9 BC Building Code).

		Quantity per Archetype						
Material Quantities	**Unit**	**ESC 1**	**ESC 2**	**ESC 3**	**ESC 4**	**ESC 5**		
Insulation - all		1	2	3	4	5		
Wall	ft^2	1,881	1,881	2,633	3,009	3,386		
Roof	ft^2	850	850	1,275	1,417	1,700		
Under slab	ft^2	-	-	-	850	850		
Foundation wall	ft^2	1,103	1,103	1,103	2,205	6,615		
Windows								
Low Performance Windows	ft^2	324	324					
Low-Med Performance Windows	ft^2			324				
Med-High Performance Windows	ft^2				324			
High Performance Windows	ft^2					324		
HRV								
60% Efficiency_Residential	No.	N/A	0.344	0.553	0.375	0.281		
70% Efficiency_Residential	No.	N/A	0.219	0.213	0.250	0.375		
75% Efficiency_Residential	No.	N/A			0.125	0.250	Multiplier	
60% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per unit
70% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per unit
75% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per unit
80% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per unit
84% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per unit
DWHR								
30% Efficiency_Residential	No.	N/A		0.340	0.265	0.244		
42% Efficiency_Residential	No.	N/A		0.043	0.122	0.156		
55% Efficiency_Residential	No.	N/A		0.064	0.020	0.133	Multiplier	
Unspecified Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
30% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
42% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
55% Efficiency_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Hot water system - all								
Gas Instantaneous_Residential	No.	N/A	0.563	0.340	0.694	0.244		
Electric Storage_Residential	No.	N/A	-	0.340	0.245	0.111		
HP Hot Water_Residential	No.	N/A	0.188	0.021	-	0.644	Multiplier	
Gas Instantaneous_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Electric Storage_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Combo_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
HP Hot Water_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Condensing boiler_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
HVAC								
Electric Baseboard_Residential	No.	N/A	6.875	7.660	8.980	4.000		
95% AFUE Gas Furnace_Residential	No.	N/A	0.094	0.064	0.020	0.111		
Cold Climate AS HP_Residential	No.	N/A	0.156	0.085	0.143	0.356	Multiplier	
Cold Climate AS HP_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Gas combo heat_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Fan coil_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building
Heat pump_Commercial	No.	N/A	N/A	N/A	N/A	N/A	1	Per building

Table A7: Product and equipment assumptions for small multi-unit residential building in Metro Vancouver (Part 9 BC Building Code).

		Quantity per Archetype						
Material Quantities	**Unit**	**ESC 1**	**ESC 2**	**ESC 3**	**ESC 4**	**ESC 5**		
Insulation - all		1	2	3	4	5		
Wall	ft^2	4,902	4,902	4,902	7,843	8,824		
Roof	ft^2	3,550	3,550	5,325	5,917	5,917		
Under slab	ft^2	3,550	3,550	3,550	7,100	7,100		
Foundation wall	ft^2	-	-	-	-	-		
Windows								
Low Performance Windows	ft^2	1,813	1,813					
Low-Med Performance Windows	ft^2			1,813				
Med-High Performance Windows	ft^2				1,813			
High Performance Windows	ft^2					1,813		
HRV								
60% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
70% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
75% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
60% Efficiency_Commercial	No.	N/A	0.577	0.776	0.972	0.469	0.25	Per unit
70% Efficiency_Commercial	No.	N/A	0.641	0.581	0.370	0.677	0.25	Per unit
75% Efficiency_Commercial	No.	N/A	-	0.202	0.509	0.938	0.25	Per unit
80% Efficiency_Commercial	No.	N/A	-	-	-	-	0.25	Per unit
84% Efficiency_Commercial	No.	N/A	-	0.092	0.231	0.313	0.25	Per unit
DWHR								
30% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
42% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
55% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Unspecified Efficiency_Commercial	No.	N/A	-	-	-	-	1	Per building
30% Efficiency_Commercial	No.	N/A	-	0.042	0.167	0.146	1	Per building
42% Efficiency_Commercial	No.	N/A	-	0.037	0.148	0.188	1	Per building
55% Efficiency_Commercial	No.	N/A	-	0.037	0.148	0.167	1	Per building
Hot water system - all								
Gas Instantaneous_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Electric Storage_Residential	No.	N/A	N/A	N/A	N/A	N/A		
HP Hot Water_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Gas Instantaneous_Commercial	No.	N/A	-	0.037	0.074	0.146	1	Per building
Electric Storage_Commercial	No.	N/A	0.051	0.090	0.130	0.125	1	Per building
Combo_Commercial	No.	N/A	0.410	0.400	0.389	0.188	1	Per building
HP Hot Water_Commercial	No.	N/A	0.128	0.064	-	0.333	1	Per building
Condensing boiler_Commercial	No.	N/A	-	-	-	-	1	Per building
HVAC								
Electric Baseboard_Residential	No.	N/A	N/A	N/A	N/A	N/A		
95% AFUE Gas Furnace_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Cold Climate AS HP_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Cold Climate AS HP_Commercial	No.	N/A	1.154	1.270	1.389	1.563	5	Per building
Gas combo heat_Commercial	No.	N/A	0.410	0.400	0.389	0.188	1	Per building
Fan coil_Commercial	No.	N/A	-	-	-	-	1	Per building
Heat pump_Commercial	No.	N/A	-	-	-	-	5	Per building

Table A8: Product and equipment assumptions for low-rise multi-unit residential building in Metro Vancouver (Part 3 BC Building Code).

		Quantity per Archetype						
Material Quantities	**Unit**	**ESC 1**	**ESC 2**	**ESC 3**	**ESC 4**	**ESC 5**		
Insulation - all		1	2	3	4	5		
Wall	ft^2	13,621	13,621	13,621	20,431	N/A		
Roof	ft^2	10,650	10,650	14,200	17,750	N/A		
Under slab	ft^2	-	-	-	-	N/A		
Foundation wall	ft^2	-	-	-	-	N/A		
Windows								
Low Performance Windows	ft^2	9,081	9,081			N/A		
Low-Med Performance Windows	ft^2			9,081		N/A		
Med-High Performance Windows	ft^2				9,081	N/A		
High Performance Windows	ft^2					N/A		
HRV								
60% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
70% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
75% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
60% Efficiency_Commercial	No.	N/A	14.192	12.571	10.448	N/A	0.25	Per unit
70% Efficiency_Commercial	No.	N/A	-	-	-	N/A	0.25	Per unit
75% Efficiency_Commercial	No.	N/A	-	-	-	N/A	0.25	Per unit
80% Efficiency_Commercial	No.	N/A	10.808	12.429	14.552	N/A	0.25	Per unit
84% Efficiency_Commercial	No.	N/A	-	-	-	N/A	0.25	Per unit
DWHR								
30% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
42% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
55% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Unspecified Efficiency_Commercia	No.	N/A	-	-	-	N/A	1	Per building
30% Efficiency_Commercial	No.	N/A	-	-	-	N/A	1	Per building
42% Efficiency_Commercial	No.	N/A	-	-	-	N/A	1	Per building
55% Efficiency_Commercial	No.	N/A	-	-	-	N/A	1	Per building
Hot water system - all								
Gas Instantaneous_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Electric Storage_Residential	No.	N/A	N/A	N/A	N/A	N/A		
HP Hot Water_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Gas Instantaneous_Commercial	No.	N/A	-	-	-	N/A	1	Per building
Electric Storage_Commercial	No.	N/A	-	-	-	N/A	1	Per building
Combo_Commercial	No.	N/A	-	-	-	N/A	1	Per building
HP Hot Water_Commercial	No.	N/A	-	-	-	N/A	1	Per building
Condensing boiler_Commercial	No.	N/A	0.539	0.522	0.542	N/A	1	Per building
HVAC								
Electric Baseboard_Residential	No.	N/A	N/A	N/A	N/A	N/A		
95% AFUE Gas Furnace_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Cold Climate AS HP_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Cold Climate AS HP_Commercial	No.	N/A	-	-	-	N/A	10	Per building
Gas combo heat_Commercial	No.	N/A	-	-	-	N/A	2	Per building
Fan coil_Commercial	No.	N/A	0.547	0.684	0.606	N/A	2	Per building
Heat pump_Commercial	No.	N/A	2.475	3.207	2.073	N/A	10	Per building

Table A9: Product and equipment assumptions for high-rise multi-unit residential building in Metro Vancouver (Part 3 BC Building Code).

		Quantity per Archetype						
Material Quantities	**Unit**	**ESC 1**	**ESC 2**	**ESC 3**	**ESC 4**	**ESC 5**		
Insulation - all		1	2	3	4	5		
Wall	ft^2	57,555	57,555	57,555	86,333	N/A		
Roof	ft^2	6,390	6,390	8,520	10,650	N/A		
Under slab	ft^2	-	-	-	-	N/A		
Foundation wall	ft^2	-	-	-	-	N/A		
Windows								
Low Performance Windows	ft^2	38,370				N/A		
Low-Med Performance Windows	ft^2		38,370			N/A		
Med-High Performance Windows	ft^2			38,370		N/A		
High Performance Windows	ft^2				38,370	N/A		
HRV								
60% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
70% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
75% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
60% Efficiency_Commercial	No.	N/A	25.172	28.193	22.630	N/A	0.25	Per unit
70% Efficiency_Commercial	No.	N/A	-	-	-	N/A	0.25	Per unit
75% Efficiency_Commercial	No.	N/A	-	-	-	N/A	0.25	Per unit
80% Efficiency_Commercial	No.	N/A	20.995	30.350	37.370	N/A	0.25	Per unit
84% Efficiency_Commercial	No.	N/A	-	-	-	N/A	0.25	Per unit
DWHR								
30% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
42% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
55% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Unspecified Efficiency_Commercia	No.	N/A	1.084	1.101	1.346	N/A	2	Per building
30% Efficiency_Commercial	No.	N/A	-	-	-	N/A	2	Per building
42% Efficiency_Commercial	No.	N/A	-	-	-	N/A	2	Per building
55% Efficiency_Commercial	No.	N/A	-	-	-	N/A	2	Per building
Hot water system - all								
Gas Instantaneous_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Electric Storage_Residential	No.	N/A	N/A	N/A	N/A	N/A		
HP Hot Water_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Gas Instantaneous_Commercial	No.	N/A	-	-	-	N/A	2	Per building
Electric Storage_Commercial	No.	N/A	-	-	-	N/A	2	Per building
Combo_Commercial	No.	N/A	-	-	-	N/A	2	Per building
HP Hot Water_Commercial	No.	N/A	-	-	-	N/A	2	Per building
Condensing boiler_Commercial	No.	N/A	1.067	1.053	1.092	N/A	2	Per building
HVAC								
Electric Baseboard_Residential	No.	N/A	N/A	N/A	N/A	N/A		
95% AFUE Gas Furnace_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Cold Climate AS HP_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Cold Climate AS HP_Commercial	No.	N/A	-	-	-	N/A	20	Per building
Gas combo heat_Commercial	No.	N/A	-	-	-	N/A	2	Per building
Fan coil_Commercial	No.	N/A	0.548	0.697	0.574	N/A	2	Per building
Heat pump_Commercial	No.	N/A	5.137	6.236	3.728	N/A	20	Per building

Table A10: Product and equipment assumptions for a commercial office building in Metro Vancouver (Part 3 BC Building Code).

		Quantity per Archetype						
Material Quantities	**Unit**	**ESC 1**	**ESC 2**	**ESC 3**	**ESC 4**	**ESC 5**		
Insulation - all		1	2	3	4	5		
Wall	ft^2	33,816	33,816	33,816	N/A	N/A		
Roof	ft^2	19,600	19,600	19,600	N/A	N/A		
Under slab	ft^2	-	-	-	N/A	N/A		
Foundation wall	ft^2	-	-	-	N/A	N/A		
Windows								
Low Performance Windows	ft^2				N/A	N/A		
Low-Med Performance Windows	ft^2	33,816			N/A	N/A		
Med-High Performance Windows	ft^2		33,816		N/A	N/A		
High Performance Windows	ft^2			33,816	N/A	N/A		
HRV								
60% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
70% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
75% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
60% Efficiency_Commercial	No.	N/A	10.414	10.000	N/A	N/A	20	Per building
70% Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	20	Per building
75% Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	20	Per building
80% Efficiency_Commercial	No.	N/A	9.186	10.000	N/A	N/A	20	Per building
84% Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	20	Per building
DWHR								
30% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
42% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A		
55% Efficiency_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Unspecified Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
30% Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
42% Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
55% Efficiency_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
Hot water system - all								
Gas Instantaneous_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Electric Storage_Residential	No.	N/A	N/A	N/A	N/A	N/A		
HP Hot Water_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Gas Instantaneous_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
Electric Storage_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
Combo_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
HP Hot Water_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
Condensing boiler_Commercial	No.	N/A	-	-	N/A	N/A	1	Per building
HVAC								
Electric Baseboard_Residential	No.	N/A	N/A	N/A	N/A	N/A		
95% AFUE Gas Furnace_Residential	No.	N/A	N/A	N/A	N/A	N/A		
Cold Climate AS HP_Residential	No.	N/A	N/A	N/A	N/A	N/A	Multiplier	
Cold Climate AS HP_Commercial	No.	N/A	-	-	N/A	N/A	10	Per building
Gas combo heat_Commercial	No.	N/A	-	-	N/A	N/A	2	Per building
Fan coil_Commercial	No.	N/A	-	-	N/A	N/A	2	Per building
Heat pump_Commercial	No.	N/A	0.076	10.000	N/A	N/A	10	Per building

Appendix B: Product Demand Forecasting Model Outputs

Table B1 to B3 provide summaries of product demand by category across the Metro Vancouver region from 2019-2028, as well as the two five-year periods, based on assumptions built in to the current Model scenario (described in Appendix A).

Table B1: Product demand by building type in Metro Vancouver, 2019-2028.

Products	Part 3 - Commercial	Part 3 - HR MURB	Part 3 - LR MURB	Part 9 – MURB	Part 9 - Mid SF	Grand Total (2019-2028)
Windows_Low Perf (ft2)	-	939,128	1,187,392	1,541,913	3,617,307	**7,285,740**
Windows_Low-Med Perf (ft2)	264,894	3,396,009	964,533	3,537,757	8,551,169	**16,714,362**
Windows_Med-High Perf (ft2)	640,803	3,691,091	229,294	3,060,289	7,325,855	**14,947,332**
Windows_High Perf (ft2)	54,276	1,086,228	-	633,329	1,516,758	**3,290,591**
Insulation_Wall (ft2)	959,973	14,483,344	3,743,786	30,054,619	174,316,198	**223,557,920**
Insulation_Roof (ft2)	556,418	1,843,086	3,349,108	25,462,604	83,095,585	**114,306,801**
Insulation_Under Slab (ft2)	-	-	-	24,409,865	23,188,517	**47,598,382**
Insulation_Foundation Wall (ft2)	-	-	-	-	122,179,192	**122,179,192**
HRV_60% Efficiency_Residential	-	-	-	-	27,275	**27,275**
HRV_70% Efficiency_Residential	-	-	-	-	14,885	**14,885**
HRV_75% Efficiency_Residential	-	-	-	-	4,006	**4,006**
HRV_60% Efficiency_Commercial	229	5,612	3,105	3,726	-	**12,672**
HRV_70% Efficiency_Commercial	-	-	-	2,445	-	**2,445**
HRV_75% Efficiency_Commercial	-	-	-	1,618	-	**1,618**
HRV_80% Efficiency_Commercial	205	5,864	2,838	-	-	**8,907**
HRV_84% Efficiency_Commercial	-	-	-	718	-	**718**
DWHR_30% Efficiency_Residential	-	-	-	-	16,155	**16,155**
DWHR_42% Efficiency_Residential	-	-	-	-	4,655	**4,655**
DWHR_55% Efficiency_Residential	-	-	-	-	2,803	**2,803**
DWHR_Unspecified Efficiency_Commercial	-	279	-	-	-	**279**
DWHR_30% Efficiency_Commercial	-	-	-	453	-	**453**
DWHR_42% Efficiency_Commercial	-	-	-	425	-	**425**
DWHR_55% Efficiency_Commercial	-	-	-	418	-	**418**
HW System_Gas Instantaneous_Residential	-	-	-	-	30,525	**30,525**
HW System_Electric Storage_Residential	-	-	-	-	15,068	**15,068**
HW System_HP Hot Water_Residential	-	-	-	-	5,167	**5,167**
HW System_Gas Instantaneous_Commercial	-	-	-	286	-	**286**
HW System_Electric Storage_Commercial	-	-	-	517	-	**517**
HW System_Combo_Commercial	-	-	-	1,805	-	**1,805**
HW System_HP Hot Water_Commercial	-	-	-	353	-	**353**

HW System_Condensing boiler_Commercial	-	262	161	-	-	**423**
HVAC_Electric Baseboard_Residential	-	-	-	-	480,963	**480,963**
HVAC_95% AFUE Gas Furnace_Residential	-	-	-	-	3,486	**3,486**
HVAC_Cold Climate AS HP_Residential	-	-	-	-	8,480	**8,480**
HVAC_Cold Climate AS HP_Commercial	-	-	-	6,142	-	**6,142**
HVAC_Gas combo heat_Commercial	-	-	-	1,805	-	**1,805**
HVAC_Fan coil_Commercial	-	169	179	-	-	**348**
HVAC_Heat pump_Commercial	42	1,190	682	-	-	**1,914**

Table B2: Product demand by building type in Metro Vancouver, 2019-2023.

Products	Part 3 - Commercial	Part 3 - HR MURB	Part 3 - LR MURB	Part 9 – MURB	Part 9 - Mid SF	Grand Total (2019-2023)
Windows_Low Perf (ft2)	-	939,128	777,435	1,541,913	3,617,307	**6,875,783**
Windows_Low-Med Perf (ft2)	221,582	1,827,191	413,175	2,170,980	5,301,416	**9,934,344**
Windows_Med-High Perf (ft2)	242,892	1,650,738	-	673,751	1,586,820	**4,154,201**
Windows_High Perf (ft2)	15,508	139,171	-	-	-	**154,679**
Insulation_Wall (ft2)	479,982	6,938,715	1,785,908	12,953,124	78,790,389	**100,948,118**
Insulation_Roof (ft2)	278,204	865,881	1,557,906	11,593,745	37,274,568	**51,570,304**
Insulation_Under Slab (ft2)	-	-	-	9,908,120	4,161,218	**14,069,338**
Insulation_Foundation Wall (ft2)	-	-	-	-	41,130,430	**41,130,430**
HRV_60% Efficiency_Residential	-	-	-	-	13,760	**13,760**
HRV_70% Efficiency_Residential	-	-	-	-	6,548	**6,548**
HRV_75% Efficiency_Residential	-	-	-	-	613	**613**
HRV_60% Efficiency_Commercial	82	2,507	1,417	1,678	-	**5,684**
HRV_70% Efficiency_Commercial	-	-	-	1,260	-	**1,260**
HRV_75% Efficiency_Commercial	-	-	-	445	-	**445**
HRV_80% Efficiency_Commercial	73	2,453	1,211	-	-	**3,737**
HRV_84% Efficiency_Commercial	-	-	-	212	-	**212**
DWHR_30% Efficiency_Residential	-	-	-	-	6,878	**6,878**
DWHR_42% Efficiency_Residential	-	-	-	-	1,310	**1,310**
DWHR_55% Efficiency_Residential	-	-	-	-	1,158	**1,158**
DWHR_Unspecified Efficiency_Commercial	-	119	-	-	-	**119**
DWHR_30% Efficiency_Commercial	-	-	-	128	-	**128**
DWHR_42% Efficiency_Commercial	-	-	-	113	-	**113**
DWHR_55% Efficiency_Commercial	-	-	-	113	-	**113**
HW System_Gas Instantaneous_Residential	-	-	-	-	13,661	**13,661**
HW System_Electric Storage_Residential	-	-	-	-	6,777	**6,777**
HW System_HP Hot Water_Residential	-	-	-	-	1,927	**1,927**

HW System_Gas Instantaneous_Commercial	-	-	-	87	-	**87**
HW System_Electric Storage_Commercial	-	-	-	211	-	**211**
HW System_Combo_Commercial	-	-	-	904	-	**904**
HW System_HP Hot Water_Commercial	-	-	-	177	-	**177**
HW System_Condensing boiler_Commercial	-	115	69	-	-	**184**
HVAC_Electric Baseboard_Residential	-	-	-	-	226,441	**226,441**
HVAC_95% AFUE Gas Furnace_Residential	-	-	-	-	1,945	**1,945**
HVAC_Cold Climate AS HP_Residential	-	-	-	-	3,411	**3,411**
HVAC_Cold Climate AS HP_Commercial	-	-	-	2,791	-	**2,791**
HVAC_Gas combo heat_Commercial	-	-	-	904	-	**904**
HVAC_Fan coil_Commercial	-	72	76	-	-	**148**
HVAC_Heat pump_Commercial	8	540	303	-	-	**851**

Table B3: Product demand by building type in Metro Vancouver, 2024-2028.

Products	Part 3 - Commercial	Part 3 - HR MURB	Part 3 - LR MURB	Part 9 – MURB	Part 9 - Mid SF	Grand Total (2024-2028)
Windows_Low Perf (ft2)	-	-	409,957	-	-	**409,957**
Windows_Low-Med Perf (ft2)	43,312	1,568,818	551,358	1,366,777	3,249,753	**6,780,018**
Windows_Med-High Perf (ft2)	397,911	2,040,353	229,294	2,386,538	5,739,035	**10,793,131**
Windows_High Perf (ft2)	38,768	947,057	-	633,329	1,516,758	**3,135,912**
Insulation_Wall (ft2)	479,991	7,544,629	1,957,878	17,101,495	95,525,809	**122,609,802**
Insulation_Roof (ft2)	278,214	977,205	1,791,202	13,868,859	45,821,017	**62,736,497**
Insulation_Under Slab (ft2)	-	-	-	14,501,745	19,027,299	**33,529,044**
Insulation_Foundation Wall (ft2)	-	-	-	-	81,048,762	**81,048,762**
HRV_60% Efficiency_Residential	-	-	-	-	13,515	**13,515**
HRV_70% Efficiency_Residential	-	-	-	-	8,337	**8,337**
HRV_75% Efficiency_Residential	-	-	-	-	3,393	**3,393**
HRV_60% Efficiency_Commercial	147	3,105	1,688	2,048	-	**6,988**
HRV_70% Efficiency_Commercial	-	-	-	1,185	-	**1,185**
HRV_75% Efficiency_Commercial	-	-	-	1,173	-	**1,173**
HRV_80% Efficiency_Commercial	132	3,411	1,627	-	-	**5,170**
HRV_84% Efficiency_Commercial	-	-	-	506	-	**506**
DWHR_30% Efficiency_Residential	-	-	-	-	9,277	**9,277**
DWHR_42% Efficiency_Residential	-	-	-	-	3,345	**3,345**
DWHR_55% Efficiency_Residential	-	-	-	-	1,645	**1,645**
DWHR_Unspecified Efficiency_Commercial	-	160	-	-	-	**160**
DWHR_30% Efficiency_Commercial	-	-	-	325	-	**325**
DWHR_42% Efficiency_Commercial	-	-	-	312	-	**312**

DWHR_55% Efficiency_Commercial	-	-	-	305	-	**305**
HW System_Gas Instantaneous_Residential	-	-	-	-	16,864	**16,864**
HW System_Electric Storage_Residential	-	-	-	-	8,291	**8,291**
HW System_HP Hot Water_Residential	-	-	-	-	3,240	**3,240**
HW System_Gas Instantaneous_Commercial	-	-	-	199	-	**199**
HW System_Electric Storage_Commercial	-	-	-	306	-	**306**
HW System_Combo_Commercial	-	-	-	901	-	**901**
HW System_HP Hot Water_Commercial	-	-	-	176	-	**176**
HW System_Condensing boiler_Commercial	-	147	92	-	-	**239**
HVAC_Electric Baseboard_Residential	-	-	-	-	254,522	**254,522**
HVAC_95% AFUE Gas Furnace_Residential	-	-	-	-	1,541	**1,541**
HVAC_Cold Climate AS HP_Residential	-	-	-	-	5,069	**5,069**
HVAC_Cold Climate AS HP_Commercial	-	-	-	3,351	-	**3,351**
HVAC_Gas combo heat_Commercial	-	-	-	901	-	**901**
HVAC_Fan coil_Commercial	-	97	103	-	-	**200**
HVAC_Heat pump_Commercial	34	650	379	-	-	**1,063**

Appendix C: Market Size by Product Category

Table C1 provides an estimate of the total market value for the various products and equipment volumes expected across the Metro Vancouver region over the 2019-2028 period under the current adoption plans for local governments in line with the BC Energy Step Code and the BCBC, based on current pricing estimates (in Canadian dollars). Average cost estimates are based on information provided through the Integral Group, construction estimators, and suppliers that serve the Metro Vancouver region and work with relevant high-performance building products.

Table C1: Estimated market value for relevant products and equipment by category based on product demand forecasts for the Metro Vancouver region from the Product Demand Forecasting Model, 2019-2028.

Product / Equipment	Total Volume / Quantities (2019-2028)	Estimated Average Cost ($CAD)	Estimated Market Value ($CAD)
Glazing_Low Perf (ft2)	7,285,740	$25.00	$182,143,500
Glazing_Low-Med Perf (ft2)	16,714,362	$27.50	$459,644,955
Glazing_Med-High Perf (ft2)	14,947,332	$30.00	$448,419,960
Glazing_High Perf (ft2)	3,290,591	$40.00	$131,623,640
TOTAL Glazing / Fenestration			**$1,221,832,055**
Insulation_Wall (ft2)	223,557,920	$0.65	$145,312,648
Insulation_Roof (ft2)	114,306,801	$1.10	$125,737,481
Insulation_Under Slab (ft2)	47,598,382	$2.50	$118,995,955
Insulation_Foundation Wall (ft2)	122,179,192	$1.10	$134,397,111
TOTAL Insulation			**$524,443,195**
HRV_60% Efficiency_Residential	27,275	$800	$21,820,000
HRV_70% Efficiency_Residential	14,885	$900	$13,396,500
HRV_75% Efficiency_Residential	4,006	$1,055	$4,226,330
HRV_60% Efficiency_Commercial	12,672	$4,027	$51,030,144
HRV_70% Efficiency_Commercial	2,445	$4,832	$11,815,218
HRV_75% Efficiency_Commercial	1,618	$5,316	$8,600,705
HRV_80% Efficiency_Commercial	8,907	$5,847	$52,081,046
HRV_84% Efficiency_Commercial	718	$7,309	$5,247,865
TOTAL Heat Recovery Ventilation Equipment			**$168,217,809**
DWHR_30% Efficiency_Residential	16,155	$605	$9,773,775
DWHR_42% Efficiency_Residential	4,655	$650	$3,025,750
DWHR_55% Efficiency_Residential	2,803	$695	$1,948,085
DWHR_Unspecified Efficiency_Commercial	279	$2,800	$781,200
DWHR_30% Efficiency_Commercial	453	$2,800	$1,268,400
DWHR_42% Efficiency_Commercial	425	$5,000	$2,125,000
DWHR_55% Efficiency_Commercial	418	$7,500	$3,135,000

TOTAL Drain Water Heat Recovery Systems			**$22,057,210**
DHW System_Gas Instantaneous_Residential	30,525		$47,313,750
DHW System_Electric Storage_Residential	15,068	$1,550	$7,534,000
DHW System_HP Hot Water_Residential	5,167	$500	$9,300,600
DHW System_Gas Instantaneous_Commercial	286	$1,800	$2,309,450
DHW System_Electric Storage_Commercial	517	$8,075	$13,390,300
DHW System_Combo_Commercial	1,805	$25,900	$12,033,333
DHW System_HP Hot Water_Commercial	353	$6,667	$15,461,400
DHW System_Condensing boiler_Commercial	423	$43,800	$2,523,900
TOTAL Domestic Hot Water Systems			**$109,866,733**
HVAC_Electric Baseboard_Residential	480,963	$50	$24,048,150
HVAC_95% AFUE Gas Furnace_Residential	3,486	$1,667	$5,810,000
HVAC_Cold Climate AS HP_Residential	8,480	$1,867	$15,829,333
HVAC_Cold Climate AS HP_Commercial	6,142	$123,500	$758,537,000
HVAC_Gas combo heat_Commercial	1,805	$6,667	$12,033,333
HVAC_Fan coil_Commercial	348	$800	$278,400
HVAC_Heat pump_Commercial	1,914	$2,233	$4,274,600
TOTAL Heating & Cooling			**$820,810,817**

Source: Product volumes / quantities from the Product Demand Forecast Model; Product costing estimates from Integral Group, Core Two, and Small Planet Supply.

Appendix D: Leading Global Manufacturers & Suppliers

Below is a list of leading Canadian and global manufacturers and suppliers of high-performance building envelope and mechanical systems which could be targeted for partnership development and/or investment attraction purposes. These companies were identified through industry interviews and market research.

Leading International Manufacturers of High-Performance Building Envelope Products	
CertainTeed – Insulation	USA (Valley Forge, PA)
Gutex – Insulation and tapes	Germany (Waldshut-Tiengen)
Havelock Wool – Insulation	USA (Sparks, NV)
Icynene – Insulation	USA (Houston, TX)
Johns Manville – Insulation	USA (Denver, CO)
Owens Corning – Insulation	USA (Toledo, OH)
ProClima – Air sealing adhesives and tapes	Germany (Schwetzingen)
Quik Therm – Insulation	Canada (Winnipeg, MB)
Rockwool – Insulation	Denmark (Copenhagen)
Schock – Structural Thermal Breaks	Germany (Baden-Baden)
SIGA – Insulation membranes and tapes	Switzerland (Ruswil)
Solitex - Membranes	USA (Valley Forge, PA)

Leading International HVAC Manufacturers	Leading HRV Manufacturers
AERMEC – Italy	Aldes – France
Daikin – Japan	Broan – Canada (Quebec)
Fujitsu – Japan	Lifebreath – Canada (Ontario)
Jaeger – France	Lunos – Germany
LG – USA	Fujitsu – Japan
Mitsubishi – Japan	Panasonic – Japan
Rheem – USA	Swegon – Sweden
Sanden – USA	Systemair – Sweden
Trane / Ingersoll Rand – Ireland	Venmar / VanEE – Canada (Quebec)
Viessman – Germany	Zehnder – Switzerland

Appendix E: BC-based Manufacturers

Below is a list of BC-based manufacturers and suppliers of high-performance building envelope and mechanical equipment which could be targeted for partnership development. These companies were identified through industry interviews and market research.

Company	Product	BC Office
Allied Engineering Technology	Boilers	North Vancouver
IBC Boilers	Boilers	Burnaby
Gasmaster Industries Ltd	Boilers	Delta
International Thermal Research	Boilers	Richmond
SHARC Energy Systems	DWHR	Port Coquitlam
A-1 Window Manufacturing Ltd.	EE Windows	Burnaby
Cascadia Windows Ltd.	EE Windows	Langley
Centra Windows Inc.	EE Windows	Langley
EuroLine Windows Inc.	EE Windows	Delta
Fenstur	EE Windows	Duncan
Innotech Windows & Doors Inc.	EE Windows	Abbotsford
Morrison Windows Ltd.	EE Windows	Surrey
Starline Windows	EE Windows	Langley
Van Isle Windows Ltd.	EE Windows	Victoria
Westeck Windows Manufacturing Ltd.	EE Windows	Chilliwack
Windowland Construction Inc. DBA	EE Windows	Salmon Arm
Thermoproof Manufacturing Ltd.	EE Windows	Chemainus
Vinyltek Windows	EE Windows	Delta
Unison	EE Windows (curtain wall)	North Vancouver
Prestige Joinery Ltd.	EE Windows (glazing)	Victoria
Valor	Fireplace and furnace	North Vancouver
Advance Metalpres, Inc.	Heat exchangers	Richmond
Advanced Metalpres	Heat exchangers	Richmond
Axton Mf. Ltd.	Heat exchangers	Delta
Ellett Industries	Heat exchangers	Port Coquitlam
Enermax Fabricators Ltd.	Heat exchangers	Maple Ridge
Johnstone Boiler & Tank	Heat exchangers and boilers	Vancouver
CORE Energy Recovery Solutions	HRV / ERV	Vancouver
Beaver Plastics	Insulation	Chilliwack
Rockwool	Insulation (stonewool)	Grand Forks
Hal Industries	Insulation (protection membranes)	Surrey
Masonville Plastics Group	Insulation (sprayfoam)	Surrey