BC Energy Step Code

Handbook for Building Officials

Part 9 Residential Buildings

Version 1.0 - October 2019

Acknowledgments

This guide was funded and commissioned by the Zero Emissions Building Exchange (ZEBx) and the Building Officials' Association of British Columbia (BOABC). Acknowledgment is extended to all those who participated in this project as part of the project team or as external reviewers.

Contributors/Steering Committee

Graham Barbour | District of Saanich

John Bennet | City of Prince George

Andy Christie | City of Kimberley

Greg Cormier | Bowen Island Municipality

Reece Garcea | City of Surrey

Robyn MacLeod | City of Port Moody

Manda McIntyre | Regional District of Central Kootenay

Ryan Morhart | City of Victoria

David Schioler | Building Officials' Association of BC

Timo Vahamaki | Regional District of Oak Bay

Robyn Wark | BC Hydro

Disclaimer

Produced by:

RDH Building Science Inc.
James Higgins, Kelsey Saunders, Elyse Henderson, Graham Finch

Introductory Letters

The BC Energy Step Code provides a clear, long-term pathway to help industry achieve the ambitious energy efficiency goals established in CleanBC, along with specific commitments for future editions of the BC Building Code. With the BC Energy Step Code, builders, Building Officials, and all other trusted partners in the construction sector can prepare ahead of time for a 20% improvement in energy efficiency in the 2022 Building Code, 40% in 2027, and Net Zero Energy Ready by 2032.

The success of BC's transition to Net Zero Energy Ready by 2032 will depend on the ability of project teams, local governments, utilities and the provincial government's ability to collaborate. Documents like this handbook help builders, trades, professionals, and Building Officials to start understanding and discussing high-performance buildings in the same way. This is especially important as high-performance buildings become a minimum expectation enforced by Building Officials as part of the BC Building Code. This transition requires changes in the way buildings are designed and built, but also in how they are permitted and inspected. A strong understanding of the core concepts of the BC Energy Step Code is the right foundation to build towards the Net Zero Energy Ready future.

This handbook would not be possible without a generous contribution from Natural Resources Canada and the efforts and support of BC Hydro, the Building Officials' Association of BC, and the Vancouver Zero Emissions Building Centre of Excellence.

Zachary D. May, MBA
Director, Building Codes and Standards
Building and Safety Standards Branch | Ministry of Municipal Affairs and Housing

Along with other parties, the Building Officials' Association of BC has been an instrumental partner in the design and roll out of the BC Energy Step Code. As more local governments adopt the BC Energy Step Code, and builders voluntarily submit applications using and adhering to the Code, it is important that Building Officials have a clear and concise handbook – with information gathered and assembled into one readily available resource, complete with ease of capacity to update and amend when necessary. We thank the 13 Building Officials who volunteered their time to review and shape this handbook, and our funding partners for making this document possible. As Codes modernize, Building and Plumbing Officials are on the front lines, and we will continue to be partners in guiding smooth market transition for our construction community.

David Schioler, MBA, JD
Chief Executive Officer
Building Officials' Association of BC

Contents

For users who are new to the BC Energy Step Code

For users familiar with the BC Energy Step Code

Background information on energy efficient buildings

In Short

The BC Building Code (BCBC) has laid out a pathway to reach a net-zero energy ready target by 2032. Each step in this path requires a reduction in building energy use, increasing the performance of buildings.

01 Overview of the BC Energy Step Code

Section Includes:

Glossary of Terms

Airtightness Testing	A test using blower door fans to pressurize and/or depressurize the building, with the goal of measuring the building enclosure air leakage rate. Better airtightness testing results indicate a more continuous air barrier system. Airtightness testing is a requirement for all Steps of the BC Energy Step Code.
Energy Advisor	Third-party consultants who have been registered by Service Organizations licensed by Natural Resources Canada (NRCan) to deliver NRCan's EnerGuide Rating System (ERS), ENERGY STAR® for New Homes and R-2000 programs. An Energy Advisor can provide both energy modelling and airtightness testing – the two compliance services needed to demonstrate compliance under the BC Energy Step Code for Part 9 buildings.
Energy Modeller	Similar to Energy Advisors, but may not be affiliated with a Service Organization and the EnerGuide Rating System. Energy modellers may use other energy simulation software that meets the BC Energy Step Code's requirements. (All Energy Advisors are energy modellers, but not all energy modellers are Energy Advisors.)
Energy Modelling	A computer-based mathematical replication of aspects of a building, including its overall shape and size, enclosure thermal performance and airtightness, and mechanical systems usage and efficiencies. Whole-building energy modelling is used to quantify the energy use of a building using standardized operation parameters and climate conditions. Energy modelling is also part of the building design process, where theoretical modifications can be tested for their impact on overall energy usage, and for showing code compliance.
High-Performance Building	A building built to high energy-efficiency standards with reduced energy needs compared to current standards.
Performance Path	Designing a building to comply with the parameters defined in the BCBC Subsections 9.36.5. and 9.36.6. which requires energy modelling to be carried out and uses energy usage requirements based on overall thermal energy demand and mechanical energy use intensity.
Prescriptive Path	Designing a building to comply with the prescriptive requirements defined in the BCBC Subsections 9.36.2. to 9.36.4. which uses requirements based on specific R-values, U-Values, and mechanical system efficiencies.
Step Code Metrics	The energy performance measurements for thermal energy demand, mechanical energy use, and airtightness, usually normalized (i.e. divided) over the size of the building to allow for comparison between buildings and reference to Code requirements.

Goals of the BC Energy Step Code

The BC Energy Step Code is a part of the BC Building Code (BCBC) that provides a performance-based path to support a market transformation from current energy efficiency requirements to net-zero energy ready buildings by 2032. The Province has committed to taking these incremental steps as a part of its overarching commitments to improving energy efficiency in the built environment.

The path to net-zero energy ready buildings is set out through a series of increasingly stringent requirements for energy use, thermal energy demand, and airtightness. The performance requirements that have been set were the result of a lengthy consensus-building process among a number of key stakeholders from across the province (see below), and supported by energy modelling and analysis. The process of establishing the BC Energy Step Code took a period of approximately two years through the efforts of the Energy Efficiency Working Group and the BC Energy Step Code Council, and is still ongoing.

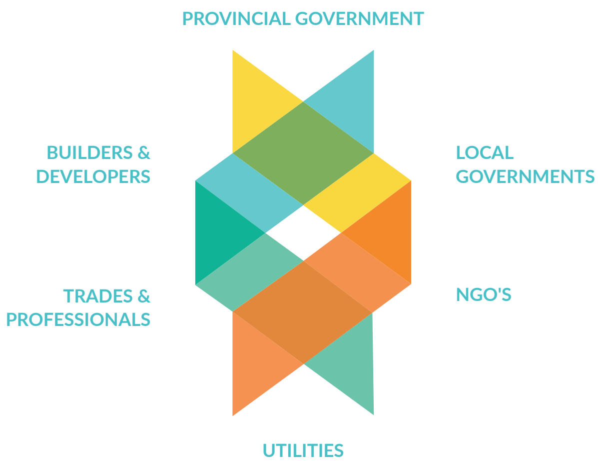


Figure 1.1 BC Energy Step Code development process among a number of key stakeholders from across the province

Motivations Behind Developing the BC Energy Step Code

Its implementation is intended to allow for the following improvements to building design and construction in BC in regards to energy efficiency:

- Unify the energy performance requirements for buildings across the province.
- Prompt a shift to modern performance-based Code requirements rather than prescriptive-based compliance that doesn't measure overall building energy usage.
- Promote a better design and construction process that encompasses all parts of the building (i.e. "house as a system") which encourages more collaboration across the design and construction team.
- Align the BCBC with the energy improvement targets for buildings as set out in the CleanBC provincial program, which aims to achieve net-zero energy ready design as a code minimum by 2032.

The BC Energy Step Code Applies Across the Province

One of the central purposes of the BC Energy Step Code is to provide province-wide consistency in technical building requirements, including requirements for energy efficiency. As of December 15th, 2017, all authorities having jurisdiction who enforce the BCBC can opt to require or incentivize levels of the BC Energy Step Code. No other energy efficiency program other than those listed in the BCBC may be enforced. The BC Energy Step Code is set to become the mandatory energy compliance pathway starting in 2022 across the province, with Step 5 for Part 9 buildings becoming the code minimum by 2032.

BC Energy Step Code Local Government Implementation

For more resources and information on implementation and the opt-in process, refer to the Resources for Local Governments page on the BC Energy Step Code website, and in particular the Provincial Policy: Local Government Implementation from the Office of Housing and Construction Standards, Province of British Columbia.

Note that any step of the BC Energy Step Code is available as an optional compliance pathway for any Part 9 residential building throughout the province where the BCBC applies, regardless of the local implementation. For this reason, it is beneficial for local jurisdictions to be familiar with the basic requirements and recommended compliance process for the BC Energy Step Code.

The BC Energy Step Code applies to Part 9 residential buildings, with different performance requirements for each climate zone. The requirements are set in steps, as shown in the illustration below for Part 9 residential buildings. The BC Energy Step Code does not apply in the City of Vancouver. It does not apply in federal lands within the province.

The BC Energy Step Code also applies to Part 3 buildings, though this version of the Handbook is applicable to Part 9 residential buildings only.

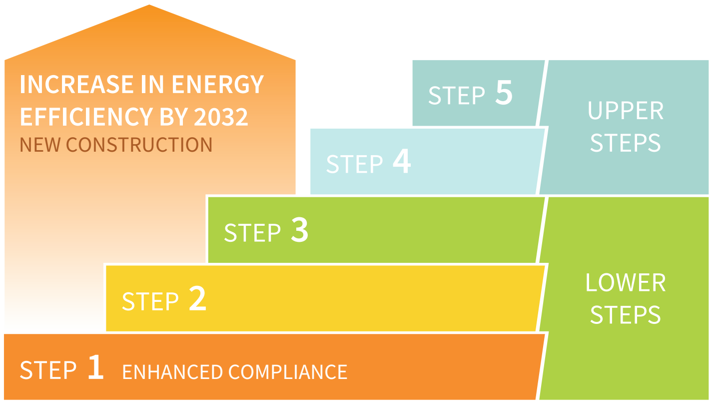
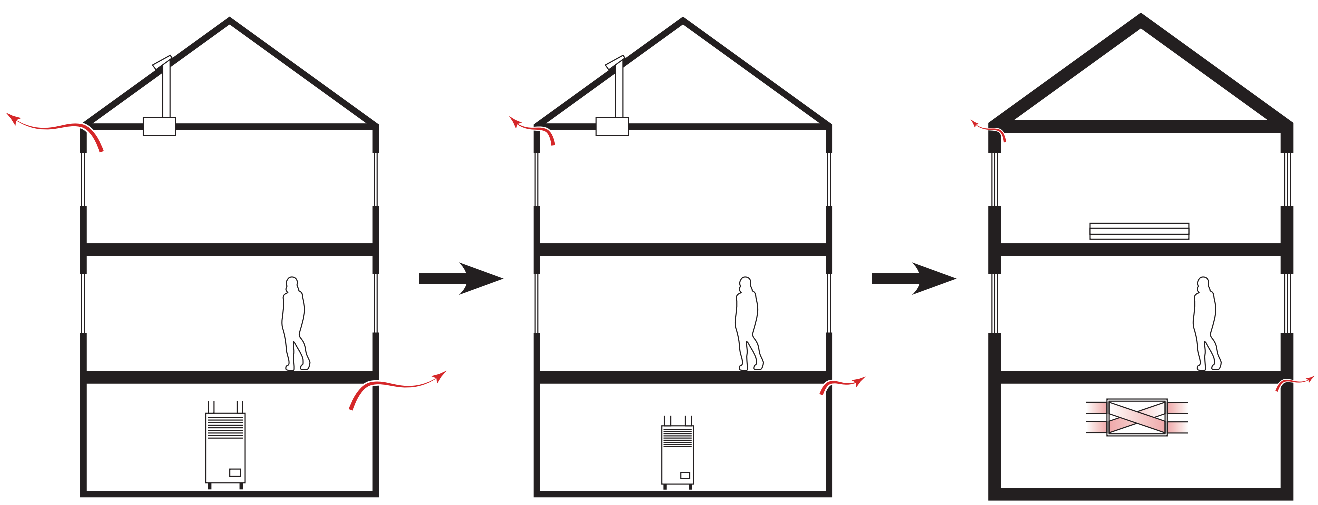


Figure 1.2 Steps of the BC Energy Step Code for Part 9 residential buildings

Achieving the Steps of the BC Energy Step Code

The BC Energy Step Code provides a clear path to achieving net-zero energy ready buildings. An enclosure-first approach helps to minimize energy demand and enables the use of lower capacity and highly efficient mechanical equipment. Airtightness testing ensures that a continuous air barrier is considered throughout the design process, which minimizes air leakage and thus heating/cooling demand. Energy modelling is used to assess the building as a whole system to show that the design meets the performance requirements.

Designers and builders learn how to construct energy-efficient buildings through practice, including feedback from energy modelling and airtightness testing. Lower Steps are anticipated to be achieved with little to no market transformation. Mature market pricing and technology availability will develop as demand grows for better products and more efficient design strategies. The capacity for airtightness testing and energy modelling, as well as general knowledge and skills to execute high-performance buildings, will also increase.



Step 1:

Code requirements and compliance promotes a learning process so that the industry can become familiar with energy modelling and airtightness testing.

Steps 2 and 3:

Improvements made to the building systems based on lessons learned from Step 1, including, for example, better enclosures and potentially smaller mechanical systems.

Upper Steps:

High-performance buildings successfully constructed based on lessons learned from the Lower Steps and facilitated by a mature market.

Figure 1.3 Example progression of homes reaching the requirements of the BC Energy Step Code

Changes to the Design and Construction Processes

Under the BC Energy Step Code, Part 9 buildings move from the option to follow the prescriptive- or performance-based requirements in Subsections 9.36.2. to 9.36.5. of the BCBC, toward the performance-based requirements as defined by Subsection 9.36.6. The key changes to this process are the requirements for energy modelling and airtightness testing (see Figure 1.4 and Figure 1.5). Refer to Section 02 Processes, Compliance, & Roles on page 11 for specific details on how the compliance process and the role of the Building Official changes under the BC Energy Step Code.

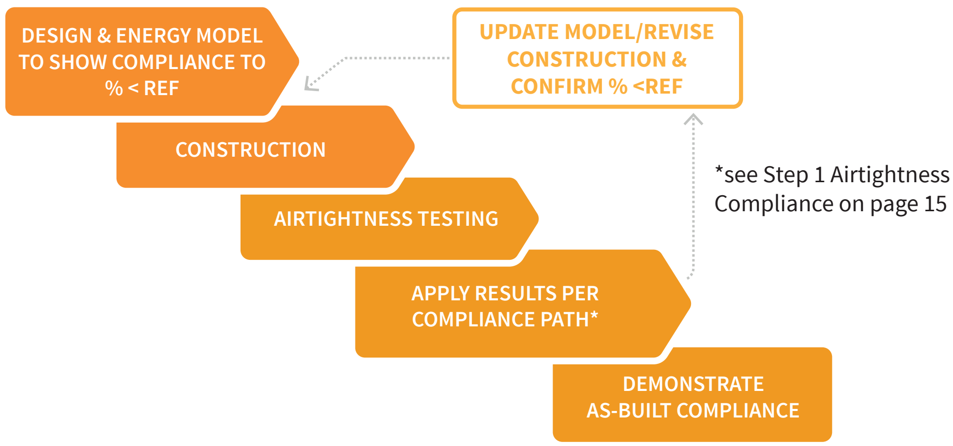


Figure 1.4 New design and construction process for Step 1: Building to be designed and constructed to comply to the % Lower than Reference House performance target as set out in Subsection 9.36.6. Both energy modelling and airtightness testing are required.

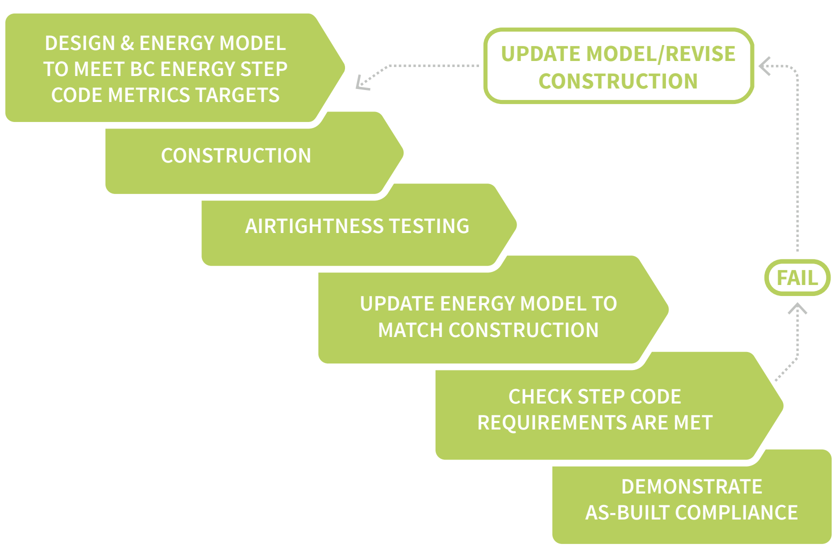


Figure 1.5 New design and construction process for Steps 2-5: Building to be designed and constructed to comply with the BC Energy Step Code metrics. The requirements include minimum airtightness, maximum energy used by the building equipment and systems, and maximum thermal energy demand intensity. Energy modelling and airtightness testing is required, and the as-built construction must meet the BC Energy Step Code requirements.

Energy Modelling

The BC Energy Step Code has introduced mandatory energy modelling at all steps. Projects may have used modelling in the past, for example to comply with energy efficiency programs such as R-2000 or ENERGY STAR, or for code compliance using the Subsection 9.36.5. performance path option.

Energy Modellers

The BC Energy Step Code design and compliance process includes significant participation from the building *Energy Advisor* or *energy modeller* (see Glossary of Terms on page 1). For more information on Energy Advisors, see the Energy Advisors page on the BC Energy Step Code website and The Energy Modeller on page 20.

Energy modelling is integral to confirming that the design meets the requirements of the BC Energy Step Code. However, **the results of code compliance energy modelling for a particular building are not predictive.** They are based on standardized building operation parameters and occupancy levels (i.e. "base loads"). This is so that the building's modelled energy usage can be used to measure building performance regardless of its specific occupancy or usage patterns that may change with different owners. Setting standard protocols helps to eliminate variability in parameters that were not indented to be used as pathways for energy savings, which is particularly important for performance-based codes. The actual energy use of a building on a monthly or annual basis may not match the modelled results, and compliance under the BC Energy Step Code does not guarantee the modelled energy performance.

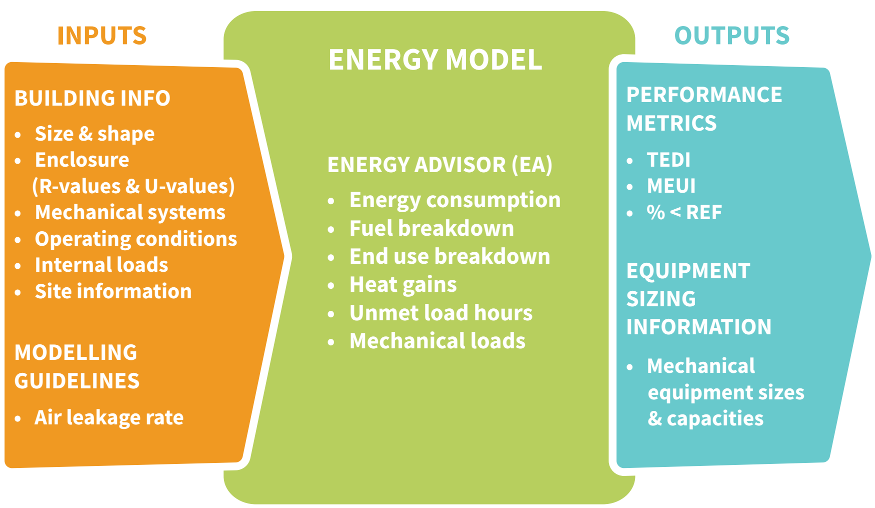


Figure 1.6 Basic energy modelling inputs and outputs required for showing compliance with the BC Energy Step Code

Houses With a Suite

Houses with secondary suites are considered multi-unit residential buildings (MURBs) and can be modelled as such or as individual dwelling units. See further details on energy modelling for MURBs in the latest version of the EnerGuide Rating System Standard.

Airtightness Testing

Whole-building airtightness testing is required in all steps of the BC Energy Step Code. This work requires coordination across all members of the design and construction team. Whole-building airtightness testing is completed using blower door fans to pressurize and/or depressurize the building. The various measured results of testing, including fan airflow and pressure difference across the enclosure, are used to indicate the overall building airtightness characteristics. Building airtightness is an energy model input, both at the initial design stage (i.e. Pre-construction) and after completion of the building (i.e. as-built).

See the Illustrated Guide - Achieving Airtight Buildings and the BC Energy Step Code Builder Guide published by BC Housing for more information on whole-building airtightness testing.

The steps for airtightness testing vary depending on building type and size, and the testing standard used. In general, it follows the basic flowchart shown in Figure 1.7. Testing is generally done by an Energy Advisor (required under ERS) or other qualified contractor, since it involves a good understanding of testing and airflow measurement, specialized equipment, and specific reporting capabilities.

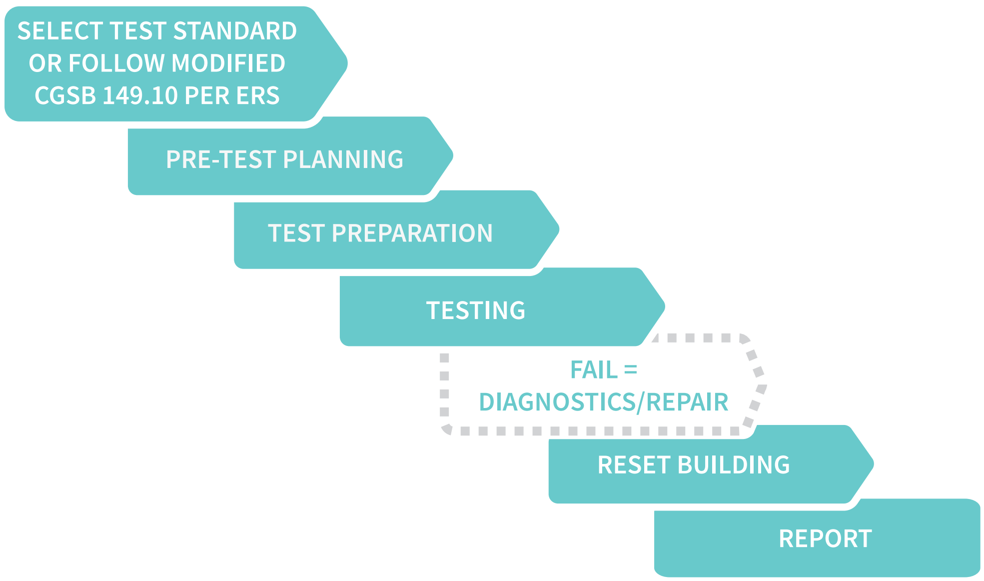


Figure 1.7 Basic steps of building airtightness testing for showing compliance with the BC Energy Step Code

BC Energy Step Code Metrics

Overview of the BC Energy Step Code Metrics

The key performance *metrics* (see Glossary of Terms on page 1) of the BC Energy Step Code can be separated into three categories which must all be met:

- airtightness,
- equipment and systems, and
- building enclosure.

See Appendix B: BC Energy Step Code Requirements Based on Climate Zone on page 42 for a detailed outline of the current energy performance requirements for all metrics for all climate zones in BC. The airtightness and building enclosure metrics direct the building design toward an enclosure-first approach, which is integral to minimizing heating demand. The equipment and systems metrics consider the total energy consumption of the building. This section provides more detail on the key performance metrics as well as the area of conditioned space measurement, which is used to calculate most of the metrics.

Airtightness	Equipment and Systems	Building Enclosure
ACH	MEUI OR % < REF	TEDI
Testing and reporting is required at all steps and for all building types. Specific targets have been set for Steps 2-5.	Mechanical Energy Use Intensity (MEUI) and % lower than Reference House (% < REF) include the energy consumption from HVAC systems and domestic hot water (DHW), pumps, and fans, **but omit base loads such as plug loads and lighting.**	Thermal Energy Demand Intensity (TEDI) is a measure of the annual heating demand and considers the energy gains and losses through the enclosure, internal heat gains and heat recovery efficiencies.

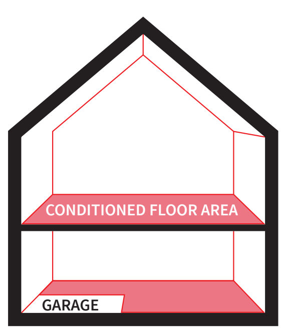


Figure 1.8 The area of conditioned space includes all floor areas within the thermal building enclosure and excludes the garage.

Area of Conditioned Space

The BC Energy Step Code MEUI and TEDI metrics normalize the buildings annual energy use or demand over the floor area of conditioned space. The area of conditioned space includes all floor areas within the thermal building enclosure. The International System of Units is used, thus area is measured in square metres (m^2). It is good practice to use the floor area from the energy model for all metrics calculations.

Step Code Normalization:

$$\text{Step Code Metrics} = \frac{\text{Annual Energy Use/Demand}}{\text{Area of Conditioned Space}} = \frac{\text{kWh}}{\text{m}^2 \cdot \text{year}}$$

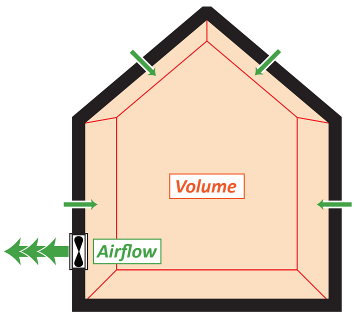


Figure 1.9 The air changes per hour is calculated from the hourly airflow of the test fan divided by the building volume (in equivalent volume units)

Airtightness

Airtightness is a metric used throughout the industry to measure how much air leaks in or out of a building enclosure, commonly referred to as “air leakage rate”.

Airtightness is measured in the BC Energy Step Code as air changes per hour (ACH) and shall be tested to an induced test pressure of not less than 50 Pascals pressure difference and in accordance with BCBC Article 9.36.6.5., which lists the acceptable airtightness testing standards.

Hourly Air Change Rate (the lower the better):

$$\textit{Air Changes per Hour}_{\textit{at test pressure}} = \frac{\textit{Hourly Airflow}_{\textit{at 50 Pascals}}\ (m^3/hr)}{\textit{Building Volume}\ (m^3)} = \mathbf{ACH}_{50}$$

Equipment and Systems

The equipment and systems metrics address the energy used by the building over one year normalized per conditioned floor area (kWh/(m²·year).

Mechanical Energy Use Intensity (MEUI) includes the energy consumption from space-heating and cooling equipment, fans, service water heating equipment, pumps, and auxiliary HVAC equipment, but omits base loads such as plug loads and lighting. Base loads are omitted so that the building’s modelled energy usage can be used to measure building performance regardless of its specific occupancy or usage patterns that may change with different occupants.

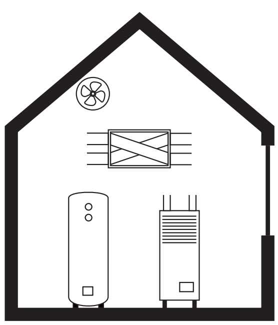


Figure 1.10 MEUI excludes base loads such as miscellaneous receptacles and lighting.

Mechanical Energy Use Intensity (the lower the better):

$$\textit{MEUI} = \frac{\textit{Total Yearly Mech. Energy Usage (kWh/year)}}{\textit{Area of Conditioned Space}\ (m^2)} = \textit{kWh/(m}^2\textit{·year)}$$

The MEUI metric includes additional allowances for buildings with floor areas equal to or less than 210 m² (2357 ft²) as small houses would otherwise have difficulties meeting the targets. Relaxations are also provided for buildings that include mechanical cooling in at least 50% of their floor area to remove a barrier to provide cooling where it is necessary. See Appendix B: BC Energy Step Code Requirements Based on Climate Zone on page 42.

Note that for Step 1 compliance the % < REF metric must be used (see next page), for Step 2–4 compliance offers a choice of using either % < REF or MEUI, and for Step 5 compliance only the MEUI metric must be used.

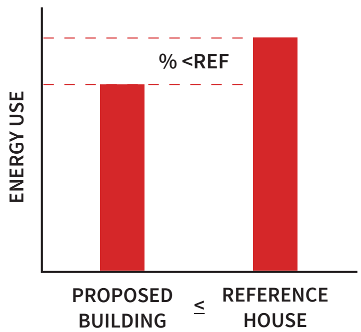


Figure 1.11 Percent lower than reference house is calculated from the difference between modelled house energy usage and the reference house energy usage.

% Lower than Reference House (% < REF) uses comparative analysis of the proposed buildings mechanical energy use intensity excluding base loads versus that of a reference house.

The mechanical energy use of the reference building and the proposed building is determined by energy modelling following any one of two methods:

1. Using the latest versions of Natural Resource Canada's EnerGuide Rating System and HOT2000 software which develops an automatically-generated reference house. The EnerGuide assumed electric base loads are to be excluded from the energy consumption for both the proposed building and the reference house.
2. By following BCBC Subsection 9.36.5. excluding base loads.

% Lower than Reference House (the higher the better):

$$\% < REF \;=\; 1 - \left(\frac{\textit{Total Yearly Mech. Energy Usage of Modelled House (kWh/year)}}{\textit{Total Yearly Mech. Energy Usage of Reference House (kWh/year)}} \right) \times 100$$

Thermal Energy Demand Intensity (TEDI)

Thermal Energy Demand Intensity (TEDI) metric addresses energy gains and losses through the building enclosure and ventilation. TEDI limits the annual demand by the building for space conditioning and for conditioning of ventilation air, estimated through the energy model, normalized per square metre of area of conditioned space, and expressed in kWh/(m^2·year). TEDI considers thermal transmittance of the building enclosure (including opaque assemblies and glazing), solar heat gains, air leakage through the air barrier system, internal heat gains from occupants and equipment, and heat recovery from exhaust air.

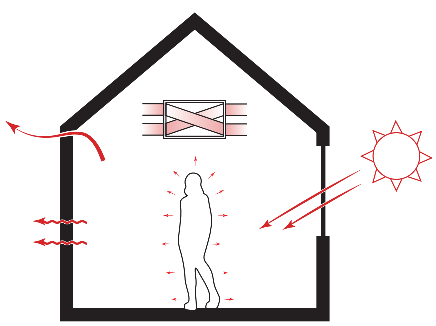


Figure 1.12 TEDI measures energy gains and losses through the building enclosure and ventilation.

Thermal Energy Demand Intensity (the lower the better):

$$TEDI \;=\; \frac{\textit{Net Yearly Thermal Energy Demand (kWh/year)}}{\textit{Area of Conditioned Space (m}^2\textit{)}} \;=\; kWh/(m^2{\cdot}year)$$

Relationship Between Metrics & Performance

All BC Energy Step Code metrics relate to one another in terms of overall building energy efficiency. For example, an airtight enclosure (i.e. low ACH) enables smaller mechanical equipment because less heating/cooling energy is needed on a yearly basis to properly condition the house, since there is less heat loss. The lower the mechanical energy use the lower the resulting MEUI. Likewise, a home with a high R-value enclosure (and good airtightness) that minimizes heat transfer through it require less thermal energy to heat or cool the home, resulting in a lower TEDI. The combinations of variations and improvements to any one of the metrics and the resulting changes to the others are numerous. See Section 03 Principles of High-Performance Buildings on page 22 for more details.

02 Processes, Compliance, & Roles

Section Includes:

New Compliance Process for Performance-Based Buildings

The specific requirements of the BC Energy Step Code set out the overall building energy performance, rather than specific R-value, U-value, or mechanical efficiency requirements. While the documentation and energy modelling must follow the code requirements, the approach to meeting the energy performance requirements will vary across buildings. As a result, the submission, review, and compliance process for Part 9 buildings meeting performance-based requirements involves different steps than the strictly prescriptive-based process.

Division C Subsection 2.2.8. of the BCBC outlines the minimum compliance submission requirements for the BC Energy Step Code. However, as with all code compliance processes, exactly how code compliance is demonstrated to the authority having jurisdiction through submissions, reviews, inspections and approvals is up to each jurisdiction to establish. **The guidance provided in these highlighted text boxes throughout this section outlines the best-practice compliance process steps which may be beyond minimum Code-specific compliance items and should be considered for implementation by the local authority through policies and bylaws.**

!

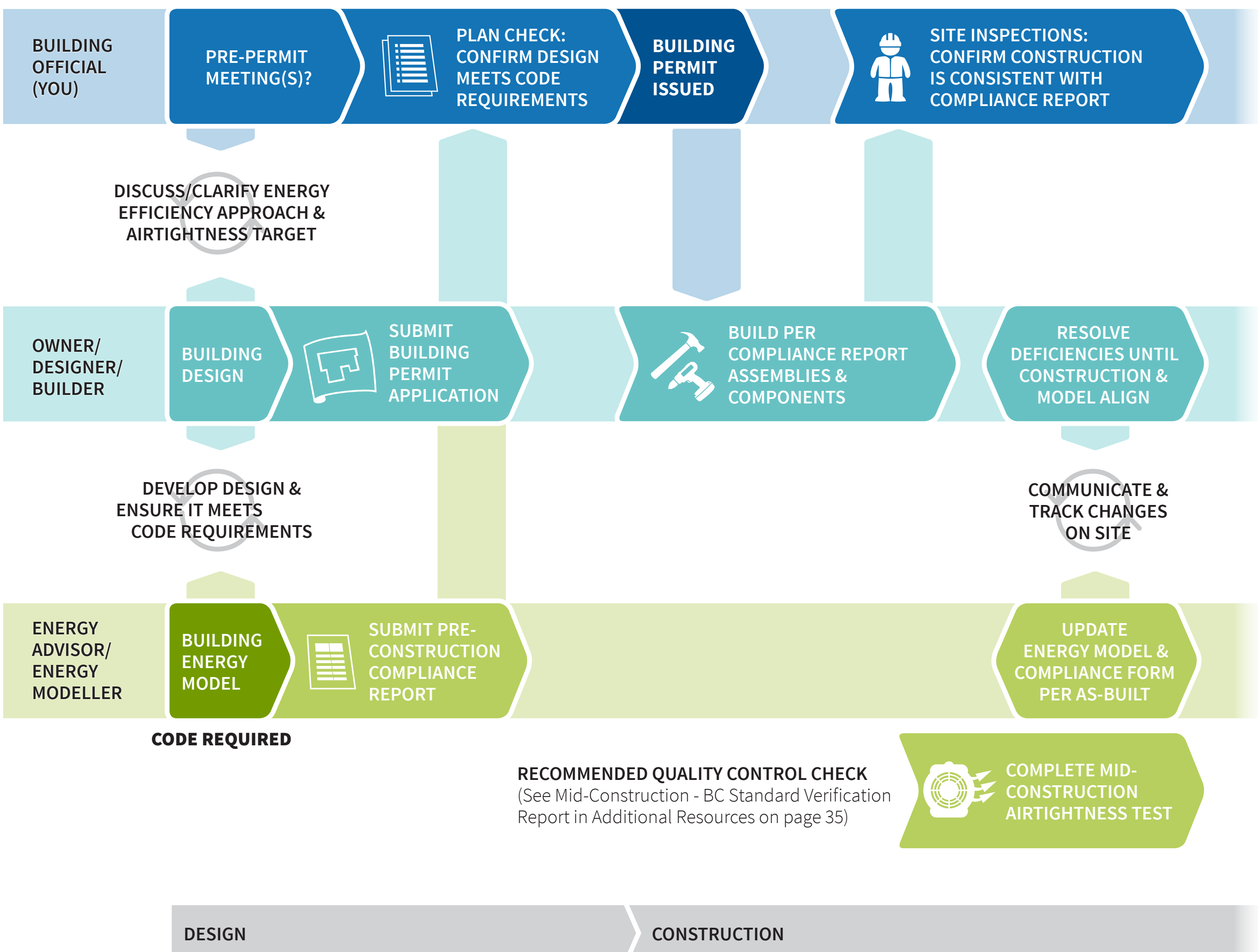
Indications of a building's BC Energy Step Code performance metrics are derived from a computer model and, in most cases, the Building Official will rely on the confirmation of compliance given on the compliance reports (see page 16) by Energy Advisors/energy modellers, rather than checking the inputs and outputs of the model directly.

Section 743 of the Local Government Act provides statutory immunity for local governments that approve submissions from professional architects or engineers. However, no immunity is provided for reliance on non-professional confirmations of compliance. For this reason and as a best practice, the degree to which a Building Official will rely on such confirmations should be set out in Council or Board policy.

The flowchart on the following page outlines the recommended code compliance/permitting process for Part 9 residential projects.

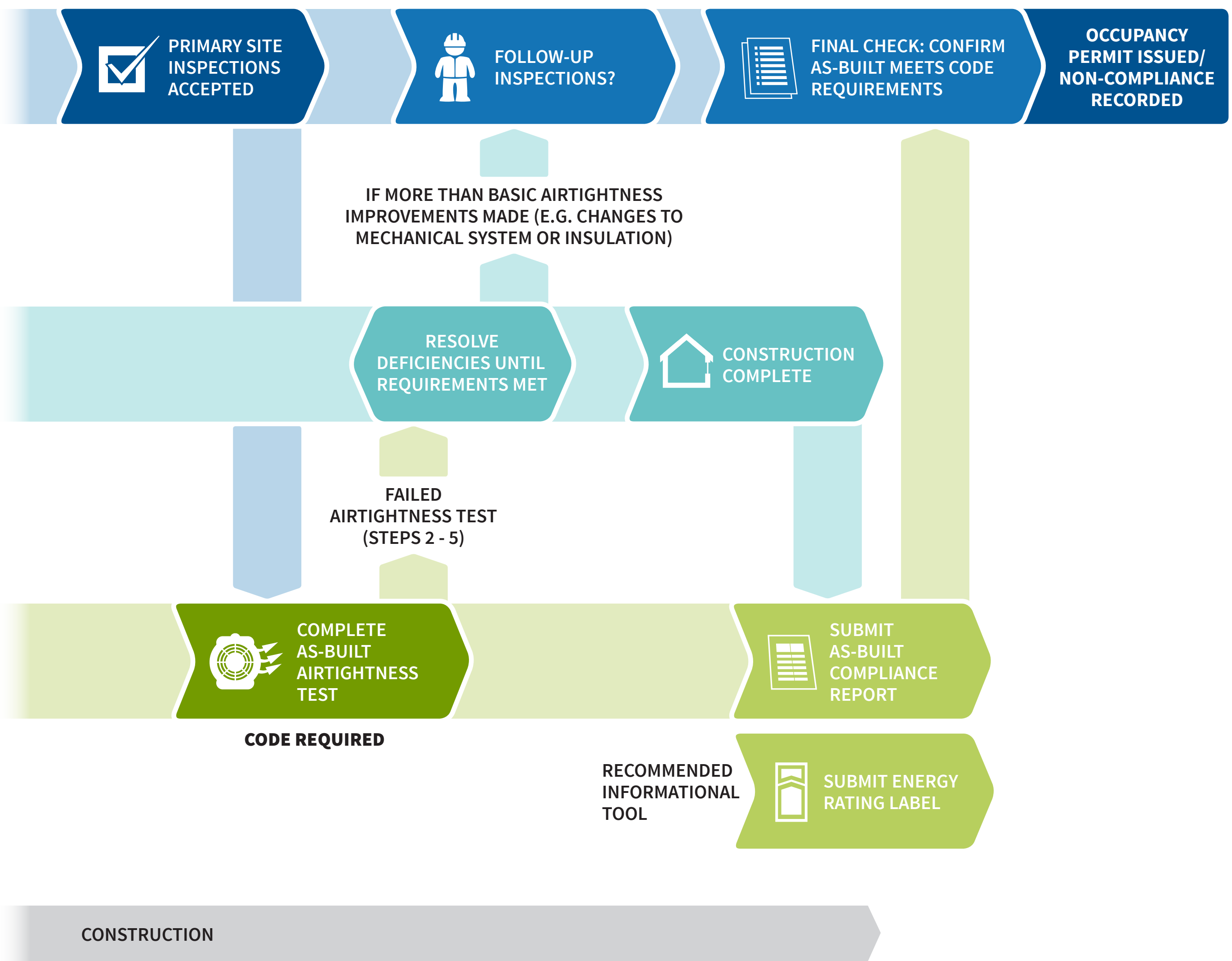
Recommended BC Energy Step Code Part 9 Compliance Flowchart

The following flowchart (see also the following page) outlines a typical recommended BC Energy Step Code compliance/permitting process for a Part 9 project. Each role is separated by row/colour, with compliance steps and various responsibilities listed for each. The steps and compliance items are discussed further in the following section. Note once again that only energy modelling, as-built airtightness testing, compliance reporting, and meeting the performance-based energy requirements are required by the BC Energy Step Code, and implementation of the specific compliance process steps used are the responsibility of the local jurisdiction. As with all Code items, it is the responsibility of the Owner (and usually through contract the Designer and Builder) to ensure that the building complies with the BCBC. It is your responsibility as the Building Official to oversee and apply your jurisdiction's code compliance process and serve in an auditing role. This flowchart should serve as a way to track the various potential compliance steps that may need to be taken and by whom.



SEE NEXT PAGE

Recommended BC Energy Step Code Part 9 Compliance Flowchart Continued



New Items in the Compliance Review Process

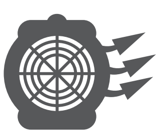
The new process outlined in the flow chart will mean the role and responsibilities of the Building Official has to change compared to the current compliance process. It is important for you as the Building Official to understand the new steps and the roles and responsibilities for showing BC Energy Step Code compliance. The most significant change to the design and construction process is that more information must be determined earlier in the design process.

Energy Modelling

Energy modelling is required for all steps of the BC Energy Step Code (Article 9.36.6.4.). Although energy modelling has been used in the past for performance path compliance or to comply with energy efficiency programs, this process may be new to some. The purpose of the energy model is to confirm that the design meets the targeted performance requirements. The energy modeller will create a pre-construction design energy model of the proposed building. As required by Article 2.2.8.2. in Division C of the BCBC, the inputs of this energy model (i.e. building shape, size, enclosure assemblies and components, mechanical systems) along with the modelling results/calculations (i.e. TEDI and MEUI) will form the basis of the building permit submission for energy compliance. It is your role to confirm that the information included in the report matches the information included on the drawings and in the specifications submitted as part of the building permit application, and that it meets the Code requirements.

The energy model results for the building design can be provided by the Energy Advisor/energy modeller using the **Pre-Construction Compliance Report**, discussed further on page 16, which is submitted as part of the building permit application. The **As-Built Compliance Report** can be included in the closeout/occupancy submission.

! Local governments are authorized to, by bylaw and in select circumstances, require "qualified professionals" (i.e. professional architects and engineers) to certify that submissions comply with building regulations, including the BC Energy Step Code. The authorization is found in section 55 of the Community Charter and might be employed in a limited number of cases for BC Energy Step Code projects with unusual site conditions, size, or complexity.



Airtightness Testing

Whole-building airtightness testing must be completed for all steps of the BC Energy Step Code (Article 9.36.6.5.). The use of the airtightness test result varies based on compliance pathway, but it is one of the most important measures of the building energy performance. The minimum requirement for testing is that it be completed after the building construction is completed (e.g. after inspections are accepted but before occupancy). Airtightness testing will usually be completed by the Energy Advisor (as required under the Energuide Rating System) or it can be done by a qualified airtightness testing contractor. The airtightness testing must be done in accordance with any of the test standards listed in Sentence 9.36.5.6.(1), under an induced pressure of at least 50 Pascals.

Though not required by Code, it may be prudent for you to require the completion of a **mid-construction** whole-building airtightness test to check that the building is on-track to achieve the intended airtightness results, especially for Steps 2-5 which set minimum airtightness levels. See the Mid-Construction - BC Standard Verification Report on the BC Energy Step Code website.

Step 1 Airtightness Compliance

This section outlines the compliance pathways for building airtightness and the use of the whole-building airtightness testing results for complying with Step 1 of the BC Energy Step Code.

See the following Building and Safety Standards Branch Information Bulletins for more information on compliance with Step 1 of the BC Energy Step Code:

- B19 – 01: Complying with Step 1 of the BC Energy Step Code for Part 9 Buildings
- B19 – 02: Step 1 for Part 9 Buildings in the BC Energy Step Code: Airtightness, Enhanced Compliance and Compliance Paths
- B19 – 03: Guidelines for Energy Advisors – Setting Airtightness Values for Energy Modelling of Part 9 Buildings for Compliance with the BC Energy Step Code

Buildings constructed to comply with the BC Energy Step Code must undergo airtightness testing. There are two basic Step 1 compliance pathways for airtightness and how testing results are used, based on the energy modelling method used:

1. **The EnerGuide Rating System (ERS)**: To comply with the BC Energy Step Code following the ERS compliance path, an Energy Advisor must model the proposed house using the measured building airtightness. The ERS reference house assumes 2.5 ACH_{50} as its baseline reference air leakage rate. This airtightness target must be met unless other offsetting energy performance improvements are achieved (e.g. better windows, ventilation heat recovery, etc.). **The ERS building energy model must always include the as-built airtightness once it is determined**.

2. **The Subsection 9.36.5. Compliance Path**: Buildings can comply with the BCBC using Subsection 9.36.5. under Step 1 by demonstrating that they can perform as well as a building constructed to the minimum prescriptive requirements in Subsections 9.36.2. to 9.36.4. of the BCBC. The 9.36.5. reference house uses 2.5 ACH_{50} as its air leakage rate, but **the 9.36.5. proposed house must set the assumed building air leakage rate at:**

    - **4.5** ACH_{50} for homes with enclosures built in accordance with Section 9.25., or
    - **3.5** ACH_{50} for homes with enclosures built in accordance with Subsection 9.25.3. and the prescriptive air barrier requirements of Articles 9.36.2.9. and 9.36.2.10.

    In any case, **under Subsection 9.36.5. the as-built building airtightness must always be at least tested and reported**. The as-built energy model may include the as-built tested airtightness result if it is better than the assumed air leakage rate. But note that, because the proposed house airtightness value must be assumed to be at least 3.5 ACH_{50} (i.e. less airtight than the reference house airtightness value of 2.5 ACH_{50}), the building pre-construction design will need to include offsetting energy performance improvements (e.g. better windows, ventilation heat recovery, etc.) that are above the current BCBC minimum prescriptive requirements.

You may choose to require that the **airtightness test reports** be included as part of the final submission package. The specific testing and results information that must be included in the airtightness report are outlined within the test standards as listed under Sentence 9.36.5.6.(1).

Step 2 to 5 Airtightness Compliance

Buildings constructed to comply with Step 2 to 5 of the BC Energy Step Code must undergo airtightness testing and must meet the minimum building airtightness targets set out in Tables 9.36.6.3.-A to 9.36.6.3.-F (see Appendix B: BC Energy Step Code Requirements Based on Climate Zone on page 42). For Steps 2 to 5, the proposed building must be **at most** the air leakage listed in the tables, and the as-built building must achieve or surpass these requirements.

The assumed building airtightness influences most other aspects of the building energy efficiency, and, while this assumption should be made by an experienced Energy Advisor/energy modeller in collaboration with the builder, there may be times when the target is not met or is met with much difficulty (see Non-Compliance with the BC Energy Step Code on page 17). For early stages of the BC Energy Step Code implementation, buildings that target a better-than-maximum air leakage rate should be reviewed carefully.

Compliance Reports

All projects must submit compliance reports that include information as listed under Division C Article 2.2.8.3. **House Performance Compliance Calculation Report**. The compliance report is a summary of the inputs of the building energy model, with the results of the energy performance calculations given for each BC Energy Step Code metric. It gives information on the building enclosure, the mechanical systems, the assumed airtightness, and building size. This compliance report is used to record and track the information required to demonstrate a building meets the energy performance requirements of the BCBC. During construction, it is used to confirm that the building matches the design.

The BC Energy Step Code website includes two fillable compliance reports that can be used to fulfill the requirements of Article 2.2.8.3. The compliance reports contain all of the information required and present it in the order established in the wording in the BCBC. It also gives supplementary information that can be used as part of your jurisdiction's specific compliance process. When completely and correctly filled out, the reports provide a consistent and convenient approach to gathering the information needed to check for compliance.

Pre-Construction Compliance Report: The Pre-Construction Compliance Report is completed during the design phase by an Energy Advisor/energy modeller prior to construction of the building. This report represents the proposed building and should be submitted with the building permit application.

As-Built Compliance Report: The As-Built Compliance Report provides the same information as the pre-construction report, except with the inputs based on the actual constructed building. It is generally used as part of final submissions and plays an important role in recording how changes in construction from the approved plans are accounted for the in the energy model and code compliance.

The supplementary information provided in the reports can also be used to check calculations and assumptions. See Appendix A: Part 9 BC Energy Step Code Compliance Reports on page 36 for more information on these reports.

The BC Energy Step Code compliance process may benefit from direct contact between you and the design/construction team prior to building permit application submission. Design changes affect the energy model, which takes considerable time and effort, and so it may be beneficial to hold a pre-permit meeting to allow discussion between all parties, to avoid repeated formal submissions.

Site Inspections

While site inspections are not a new part of the compliance review process, the requirements of the BC Energy Step Code mean that the inspections of the work relating to the building energy performance (i.e. enclosure insulation, window U-values, etc.) do not reference prescriptive requirements. Instead, the site inspections reference the pre-construction compliance report, and all the building information it includes.

Variations on site need to be accounted for in the energy model or fixed on site to match the design. Discrepancies between what is designed/reported pre-construction (e.g. noted in the filled-out Pre-Construction Compliance Report) and what is built can be considered to fail an inspection until either the modelling or the site work is modified to match. The Mid-Construction - BC Standard Verification Report can also be used as part of the compliance review process.

Note that this approach to compliance review can usually be completed during the same typical site inspections (i.e. below-grade, pre-insulation, pre-drywall, etc.) but additional inspections may be warranted, especially with high-performance buildings. These inspections may include:

- Airtightness test inspection to verify procedure follows test and building preparation requirements.
- Mechanical rough-in and equipment inspection of system arrangement and components.
- Pre-cladding inspection of air barrier and exterior insulation (where applicable).
- Pre-occupancy as-built inspection to verify the As-Built Compliance Report accuracy.

Non-Compliance with the BC Energy Step Code

Most compliance report items can be directly reviewed on site, cause a failed inspection, or even prompt a stop-work order, but performance-based compliance items require more careful consideration. This is especially the case for building airtightness. Using the as-built whole building airtightness in a performance-based energy efficiency compliance pathway means that the building airtightness cannot be guaranteed at design or during construction (i.e. at plan-checks or site inspections). Unlike assembly requirements like R-values and mechanical system specifications, which can be met with assemblies and products as needed, the building airtightness is the result of a combination of the efforts from the designer and the builder throughout the project. Steps 2 to 5 require a minimum whole building airtightness to be met, and failure cannot be confidently known until close to completion of the building.

If by the time the building is reaching completion it does not meet the minimum required energy performance requirements, additional energy improvement measures may be warranted before the building is completed. The energy modeller and builder should be tasked with determining what may be possible. Lack of building airtightness is the most likely issue.

Authorities having jurisdiction should have policies and bylaws that allow for strong enforcement. Wording such as “every reasonable effort” in regard to building repairs/improvements (for example before the occupancy permit is to be issued) can allow discretion but still promote strict compliance. Non-compliance that cannot be rectified should be recorded in some way, either through labelling or on the building title. Code-compliance with respect to the design energy efficiency should be treated as a serious task that the design and construction team must complete, just like other code items.

Roles and Responsibilities

The BC Energy Step Code compliance review process includes all parties involved in the construction project. The following section outlines the roles and responsibilities of each party.

The Building Official (You)

Pre-Construction:

When reviewing the building permit package submitted for BC Energy Step Code compliance, you will be reviewing all submitted plans but will also review the Pre-Construction Compliance Report (or equivalent). It is important to review the drawings together with this report to assess if the information submitted in the report matches the information in the drawings and specifications. For example, if the report states a wall effective R-value of R-30 but the drawings show a typical 2x6 wood-framed wall assembly with batt insulation, the package should not be accepted as sufficiently detailed enough. It should be made clear in the building permit drawings that the thermal performance values and associated assemblies in the compliance report have been accounted for in the drawings.

Apart from basic compliance checks with the BC Energy Step Code metrics based on the energy model calculations, the building permit package review may be limited or detailed, depending on your jurisdiction's process. Since each submission will be unique and will not follow standard prescriptive requirements, a standard procedure for checking items that follow from the compliance report can be set up. A review of the building design and assemblies/components can also be completed with the understanding of basic energy efficiency principals in mind, as outlined in Chapter 03 of this Handbook.

You may wish to seek additional assurances on the quality of the energy modelling and design at early stages of BC Energy Step Code implementation, without having to be directly involved in the process outside of compliance report review. For details on the differences between an Energy Advisor and an energy modeller and the potential differences in quality control for each, see page 20. In short, **Energy Advisors following the ERS process undergo third-party oversight and audits of their work that energy modellers do not**.

It is your role to check that the building's design meets the metrics of the BC Energy Step Code. It is not your responsibility to ensure the building design is the ideal solution (i.e. based on energy usage or cost) for meeting the BC Energy Step Code or that the building will operate with the energy use modelled or as a high-performance building (see Energy Modelling on page 6).

For buildings aiming to reach a high level of airtightness, and arguably for most buildings complying with the BC Energy Step Code, it may be prudent for you to request **detail drawings of critical interfaces** so that the continuity of the air barrier system is made clear. This can provide some assurance that building airtightness has been considered by the designer/builder. If there is not enough detail provided or the airtightness strategy is unclear, further information should be submitted from the designer/builder.

During Construction:

Much like typical site inspections for prescriptive code compliance items, the BC Energy Step Code compliance process involves checking that the building matches the compliance reports as it is constructed. The Pre-Construction Compliance Report (or equivalent) can be considered the reference for code compliance. Regular site inspections should be completed for:

- Below-grade and above-grade insulation
- Windows and doors
- The air barrier system (i.e. membranes, sealant, tapes etc.)
- The ventilation, heating and cooling, water heating, and any other mechanical systems affecting the Mechanical Energy Use Intensity (see Mechanical Equipment and Systems on page 29)

Where the building does not match the proposed design, request that the builder, designer, and energy modeller work to correct the issue before it is accepted. This may involve either updating the energy model or modifying the construction.

Note that whole-building airtightness cannot be confirmed until after the building is complete, but this aspect of the building can be reviewed carefully and tested during construction. You may choose to require a **mid-construction airtightness test to qualitatively indicate if the proposed building airtightness is likely to be met before the air barrier is covered by finishes or cladding**. A whole-building airtightness test can be completed in a similar manner as the post-construction test, though at a lower pressure, and use theatrical fog and/or thermography to indicate the airtightness of critical details. This is a valuable method to resolve early deficiencies. See the Additional Resources on page 35 for further guidance on airtightness testing, and the Mid-Construction - BC Standard Verification Report.

Record keeping should be maintained in accordance with the local policies and bylaw requirements. Recording of deficiencies or discrepancies between the building and the pre-construction or subsequent submissions of the compliance report are the responsibility of the builder and where applicable, the designer and energy modeller.

It may be prudent to require the builder keep a clear record of construction or energy modelling changes that occur during construction. This will allow the design and construction team to keep track of discrepancies and show if and how they have been addressed. Variations on site such as lower-than-proposed assembly R-values, equipment efficiencies, and building airtightness all impact the building's compliance with the BC Energy Step Code.

As-Built Construction:

Once construction is complete, an as-built compliance report as a minimum should be checked for compliance and reviewed once more to confirm that the information provided matches the as-built construction as reviewed during site inspections.

Unlike life-safety code issues such as structural or fire safety, energy performance and airtightness code infractions are less obvious. **Withholding the occupancy permit is typically the last enforcement tool an authority may have and should be considered as an option**. However, where possible, specific bylaws should be used to provide compliance and enforcement tools during the project design and construction to facilitate compliance.

The Energy Modeller

The building energy modelling is carried out by either an Energy Advisor (EA) under the Energuide Rating System (ERS), or by an energy modeller working outside the ERS framework. In both cases the building energy modelling and BC Energy Step Code compliance process for Part 9 buildings needs careful attention and detailed record-keeping.

Roles and Responsibilities of the Energy Advisor versus the energy modeller	
Energy Advisor (Energuide Rating System)	**Energy Modeller (9.36.5.)**
Pre-Construction Energy Modelling:	
The specific requirements of this system include home labelling and third-party review. The EA is registered with a Service Organization and completes the building energy model following the ERS modelling parameters. **The proposed building energy model (i.e., the "P-file") is submitted to Natural Resources Canada (NRCan) for review.** The accepted model can then be used to populate the BC Energy Step Code Pre-Construction Compliance Report (or equivalent).	The energy modelling is completed following the requirements of BCBC Subsection 9.36.5., the Passive House Planning Package (PHPP), or the NECB Part 8 and the City of Vancouver Energy Modelling Guidelines. No official third-party oversight exists for this compliance pathway except where the PHPP is used. It would be the responsibility of the authority having jurisdiction to set the requirements for qualifications of an energy modeller. Note that there are currently efforts to standardize the qualifications/prerequisites for Part 9 energy modellers, but at the time of publication no framework has yet been implemented.
It is the responsibility of the EA/energy modeller to ensure the modelled building matches the proposed building drawings and specifications, and to work with the designer/builder to make changes needed based on the results of your pre-construction compliance review. The EA/energy modeller should be included in all correspondence during the building permit application process and confirm changes are made as needed.	
During Construction	
The EA/energy modeller should be required to confirm that the construction is consistent with inputs of the Pre-Construction Compliance Report. Any discrepancies must be rectified either on the building or in the model. It is prudent for the EA/energy modeller to complete site reviews as part of the scope of their work, including completing or witnessing the mid-construction airtightness testing. The requirement for a mid-construction compliance report (such as the Mid Construction - BC Standard Verification Report) could help prompt this review from the EA/energy modeller. It is the responsibility of the EA/energy modeller to energy the energy model matches construction.	
Airtightness Testing:	
The EA is required to complete the final post-construction airtightness testing under the ERS, following the specific test standard set by the system (modified CGSB 149.10).	The energy modeller is not required to be the one to complete the testing, though it is recommended. If not, it should be done by a qualified airtightness testing contractor who can provide a detailed test report.
As-Built Construction:	
The EA/energy modeller should confirm that the construction is consistent with Pre-Construction Compliance Report (or equivalent), or make changes as needed. If improvements on site are required to reach compliance, the EA/energy modeller should provide input on what approaches can be taken. The EA/energy modeller should be required to submit a completed As-Built Compliance Report as part of the occupancy/closeout process.	

The Builder

Pre-Construction:

The builder must work with the energy modeller to formulate the building design. Each builder will likely have unique preferences for how the building is to be constructed to meet the BC Energy Step Code. However, they should allow flexibility and be able to adapt their approach based on energy modelling results and compliance review feedback as part of the BC Energy Step Code design process.

The builder is usually the one responsible for the building permit application and agreement of the drawings and specifications with the Pre-Construction Compliance Report (or equivalent). If there is a dedicated designer or architect involved in the project, they may be better suited to complete this task as they likely have access to all drawings and specifications during the design work.

During Construction:

The builder is responsible for either notifying the energy modeller of changes during construction that will need to be updated in the energy model, or for making construction modifications to match the energy model. This may include changes to insulation placement or thickness, mechanical systems, building enclosure areas, and window or door components used.

If required by the authority having jurisdiction or requested by the EA/energy modeller, a mid-construction airtightness test may identify improvements needed to the overall building airtightness before completion.

As-Built Construction:

The builder, generally through contract with the owner, is usually ultimately responsible for ensuring compliance with the BC Energy Step Code. They must complete the changes and repairs needed to align with the energy model inputs including whole-building airtightness and allow completion and submission of the As-Built Compliance Report by providing the EA/energy modeller with all necessary information.

Review

There are many roles and responsibilities as part of the BC Energy Step Code compliance review process, and the Building Official, the energy modeller, and the builder must coordinate to align the submissions, reviews, site inspections and any other steps deemed necessary. Most compliance items can be covered in a thorough design approach that includes feedback and input from all parties before construction begins. The pre-construction planning, design and energy modelling should account for the skills and experience of the builder, especially with regard to whole-building airtightness. Where additional oversight is needed, you can use additional compliance tools (through bylaws) to increase confidence in achieving the BC Energy Step Code requirements, such as through third-party review and mid-construction airtightness testing.

Unlike the strictly prescriptive Part 9 Code energy performance requirements, the performance-based approach uses compliance reports to outline the inputs and calculations based on the energy model, which form the basis for code compliance review and tracking. Through this process you should have a moderate understanding of each of the items required in the compliance report, and good knowledge of the basics of energy efficient design and construction principles to meet the BC Energy Step Code.

See Section 03 Principles of High-Performance Buildings on page 22 and the Additional Resources on page 35 for more guidance on energy efficient design, BC Energy Step Code metrics, and compliance reports/reviews.

03 Principles of High-Performance Buildings

In Short

All the parts of the building including its contents and occupants interact together to form an integrated system. This is imperative to understand when designing high-performance buildings.

High-Performance Buildings Have:

- Low thermal transmittance
- Low air leakage
- Solar control
- Low energy use

Low Performance Buildings Have:

- High thermal transmittance
- High air leakage
- No solar control
- High energy use

The various components of the building enclosure serve as critical barriers, functioning to control the elements and separate the interior from the exterior environment.

Section Includes:

Building as a System

A building is made up of numerous parts, including the building enclosure, the structure, interior finishes, mechanical equipment, and electrical and lighting, which all interact with each other to form a system. The relationship between ventilation, thermal performance and space conditioning should be evaluated to ensure thermal comfort throughout the year. When designing high-performance buildings, an enclosure-first approach is commonly chosen. This entails a highly insulated and airtight building enclosure. This strategy reduces heat loss during the heating season and heat gain in the cooling season. Coupled with solar control, it reduces the demand on heating and cooling equipment. Heat Recovery Ventilators (HRVs) are typically incorporated into high-performance buildings to ensure healthy ventilation rates while recovering the heat from the air leaving the building.

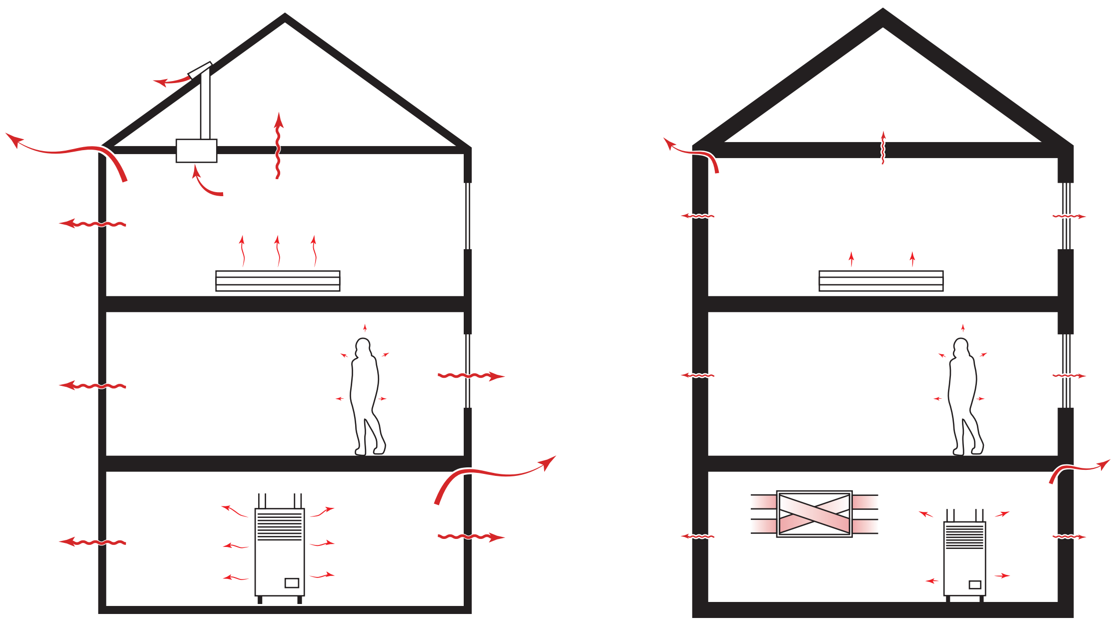
The building enclosure, also called the building envelope, is itself a system of materials, components, and assemblies which together physically separate the interior environment of a building from the exterior. It is comprised of assemblies and components which in combination control air and heat flow through the building enclosure. For durability, safety, and occupant comfort and health, the assemblies and components must also control liquid water, water vapour, sound, fire, and smoke.

Building enclosure assemblies (roofs, walls, and floors) typically use a series of layers, each intended to serve one or more functions within the building enclosure. The insulation and air barrier materials are intended to provide the most direct control of energy flow through the building enclosure. Components (windows, doors and skylights) should be installed with the use of accessories, such as tapes and sealants, to provide continuous airtightness and protection from water ingress.

Thermal Performance and Mechanical Equipment & Systems

The building enclosure resists heat flow using materials with a low thermal conductivity (i.e. high thermal resistance). The measure of the resistance to heat flow in opaque assemblies is generally expressed in the metric units of **RSI** (m^2·K/W) and the imperial measurement of **R-value** (ft^2·°F·hr/Btu). The measure of heat loss through enclosure components like windows and doors is often expressed in the metrics units of **USI** (W/ m^2·K) and the imperial measurement of **U-value** (Btu/ft^2·°F·hr). The more insulation in the assembly, the higher the assembly R-value and the greater its resistance to heat flow. Conversely, the lower the U-value, the lower the heat loss through the component.

The mechanical system of a building includes heating, ventilation, and air conditioning (HVAC), as well as domestic hot water (DHW) heating and potentially cooling. They are particularly important in the context of energy efficiency. One of the main goals of the enclosure-first approach is to reduce energy loss through the enclosure and thus reduce space heating (and cooling) needs. The mechanical equipment itself can also be used to reduce the heating and cooling needs. As noted, HRVs are commonly incorporated into high-performance buildings.



Low-Performance Building

High thermal transmittance
=
Low thermal performance

High-Performance Building

Low thermal transmittance
=
High thermal performance

Figure 3.1 Progression from a low-performance building to a high-performance building involves overall improvements to the building enclosure and mechanical system.

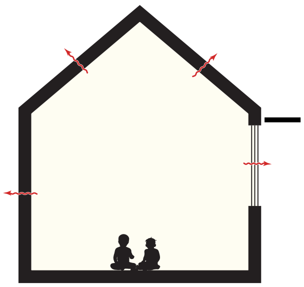


Figure 3.2 The enclosure-first approach incorporates an airtight and thermally efficient building enclosure that allows thermal comfort in all seasons.

Building Components

Enclosure-First Approach

The enclosure-first approach reduces energy consumption and provides a comfortable indoor environment for the occupants. A key strategy in achieving high-performance buildings is the use of well-insulated assemblies. These assemblies use insulation with minimal thermal bridging to resist heat loss or gain and can lower the overall mechanical heating or cooling load. The enclosure components in a high-performance building like windows and doors are also thermally efficient to minimize heat loss or, if needed, heat gain.

The restriction of air movement by the air barrier system is one of the most important functions of the building enclosure. Air is a transport mechanism for water, vapour, heat energy, airborne contaminants, and even noise. Uncontrolled air leakage results in excessive heat loss that leads to discomfort and energy waste and can lead to moisture issues within the building enclosure.

Besides improving the energy efficiency of the building, an enclosure-first approach can also contribute to better occupant comfort, since the building will allow less uncontrolled airflow and interior surfaces are warmer and a more uniform temperature.

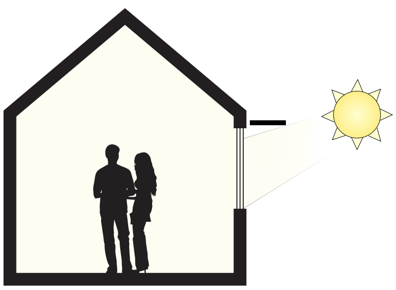


Figure 3.3 Horizontal shades can be sized to allow winter passive solar heating

Windows and Shading

Passive solar heating from solar radiation can be beneficial in the heating season if the building is oriented optimally. However, overheating can be a challenge if no measures are taken to limit solar heat gains during the non-heating season, especially late summer.

The solar angle (or elevation) varies seasonally and is lower in the winter when passive solar heat gains are beneficial. The sun is higher in the sky in the summer when heat gains are detrimental. Building components like shading devices, overhangs, and vegetation can be used to limit solar radiation from the summer sun and allow solar radiation in the winter.

If no shading devices are used, glass with a low solar heat gain coefficient can serve to limit solar radiation. This approach to reducing summer heat gain also limits winter heat gain.

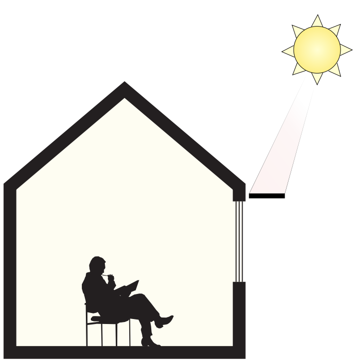


Figure 3.4 Horizontal shades can reduce summer solar radiation

SHGC

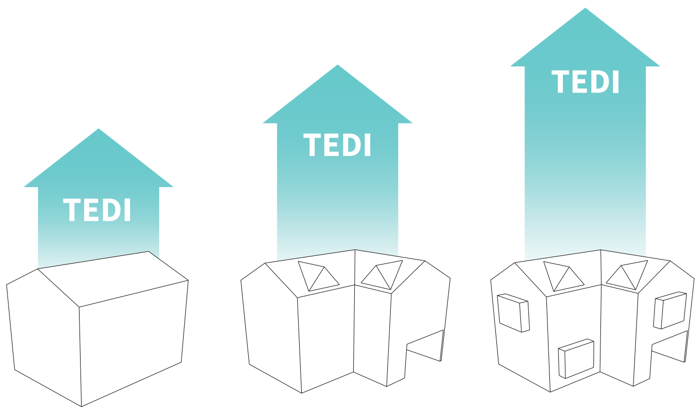
The Solar Heat Gain Coefficient (SHGC) is the proportion of solar radiation transferred through the glass and framing of a product and is a decimal fraction between 0.0 (totally opaque) and 1.0 (a hole in the wall). Higher SHGCs may help reach TEDI targets through passive gains, although care should be taken to minimize overheating. Builders should aim to optimize SHGC to help reach TEDI targets while using strategies such as exterior shading to maintain occupant thermal comfort.

Building Form and Exposure

Form Factor

Form factor refers to a building's overall shape, form and size. A building's massing is central to the achievement of TEDI targets, in that the more complex a building shape, the greater the number of opportunities for heat loss through the enclosure. A building with several complex junctions and corners will lose far more heat through the enclosure than a building that has been designed as a simple, solid form.

Form factor can also be assessed in terms of a building's vertical surface area to floor area ratio (VFAR). A lower VFAR indicates a lower overall potential for heat loss through the enclosure, as a building's vertical surfaces (e.g. walls) tend to have lower R-values than its horizontal surfaces (e.g. roofs). Higher VFAR values are often a function of the building's floor plate size, as well as the level of articulation or complexity.



Vertical Surface Area to Floor Area Ratio (VFAR)

$$\text{VFAR} = \frac{\text{Surface area of vertical enclosure}}{\text{Building floor area}}$$

Figure 3.5 Simple form (left) results in low VFAR, moderately complex form (centre) results in mid-range VFAR, and complex form (right) results in high VFAR.

Detailing

Continuity of the Air Barrier and Thermal Insulation

Careful consideration and attention to detail is required to ensure a continuous air barrier between assemblies, penetrations and building components. This is important as each is part of the air barrier system, which should provide a durable and continuous air barrier across the entire building enclosure.

The continuity of thermal insulation should also be considered while detailing. Conductive materials that penetrate the thermal insulation lead to heat loss, as well as potential durability issues. These thermal bridges should be avoided and/or reduced to a minimum.

While thermal bridging of building interfaces may not be directly accounted for in energy modelling software, it should be included as a reduction in the overall assembly R-value.

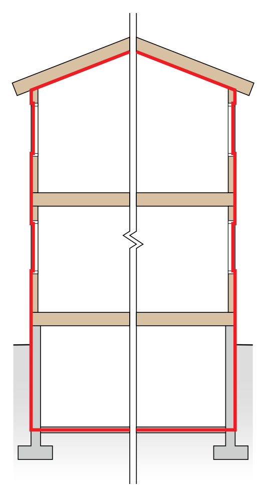


Figure 3.6 Air barrier lines of continuity should be able to be drawn across the entire building enclosure and including all transitions.

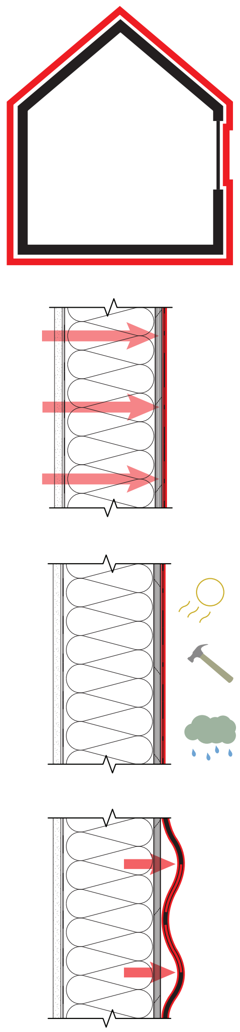


Figure 3.7 Air barrier basic characteristics

Air Barrier Performance

Interior penetrations for services like plumbing and electrical, and disruptions at floors, stairs, and interior walls, do not affect the continuity of the exterior air barrier. **Whole-building air leakage tests have shown that exterior air barrier approaches consistently perform better than interior air barrier approaches** (see Additional Resources).

Air Barrier Requirements

The design of an effective air barrier system requires materials, components, and accessories that can be combined to control air leakage. While relatively straightforward to achieve in the field of an assembly, ensuring continuity of the air barrier at interfaces and penetrations of the building enclosure is more challenging and hence critical to performance. An effective air barrier should have the following features:

Continuity: Continuity is the single most important criteria for an effective air barrier system, but also one of the most challenging. Designers and builders must ensure continuity of the air barrier around penetrations, transitions, and interfaces in the enclosure. The system must completely enclose the conditioned space.

Air Impermeability: All materials, components, and accessories making up the air barrier system must be able to prevent airflow.

Durability: The air barrier system must be designed to last for the entire service life of the building or of the materials that cover it. To do so, it may be necessary to regularly maintain sealants or other components of the system, which should be designed to be easily accessible. Interfaces in particular should be designed to be resilient and able to accommodate expected deflections, for example at floor slabs. The durability of the enclosure system itself is important. Air barrier selection must account for vapour movement within the system and exterior moisture loads. Exterior vapour-impermeable membranes may risk trapping moisture inside the assembly.

Strength and Stiffness: From construction to occupancy, the air barrier system must resist forces acting on it. The design should account for mechanical forces created by wind and stack effect pressures and allow for dimensional changes in the structure caused by thermal expansion and moisture absorption. A combination of fasteners, tapes, sealants, strapping, exterior insulation, or fully adhered products may be used to achieve this requirement.

Air Barrier Strategies

Air barrier systems are usually two conventional types: exterior air barrier systems, with the primary airtight elements placed at the exterior side of the enclosure, and interior air barrier systems, with the primary airtight elements installed at the interior side of the enclosure. Within these systems there are various approaches and components used to achieve the air barrier.

In general, the exterior approach is simpler, because it does not interface with numerous interior elements like framing or service penetrations for electrical and plumbing. Also, because the components of the exterior air barrier are often also used as the water-resistive barrier (for example spun-bonded polyolefin membrane on walls), the effort and care required to achieve a continuous layer to resist moisture intrusion also contributes to the overall continuity of the air barrier.

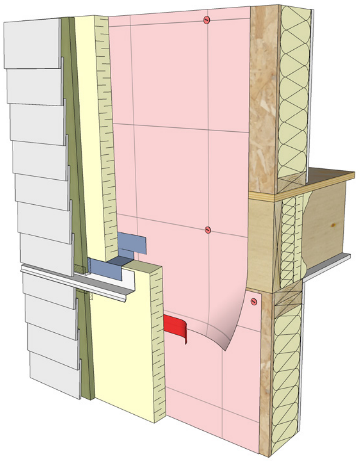


Figure 3.8 Sheathing Membrane

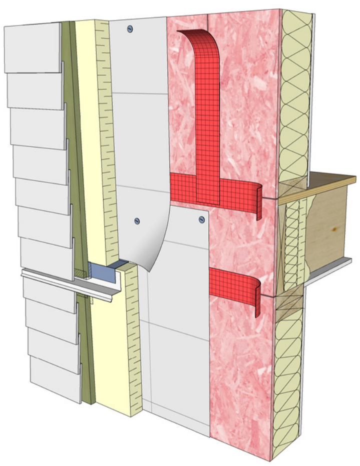


Figure 3.9 Sealed Exterior Sheathing

Air Barrier Materials

The red and pink materials shown highlight the components of the air barrier system, and are not intended to represent any specific brands or products.

Above-Grade Wall Exterior Air Barrier Systems

Exterior air barrier approaches use an airtight layer, usually a dedicated membrane, installed over the exterior face of the building structure, and made continuous with tapes, membranes, and sealants over joints, transitions and penetrations.

Sheathing Membrane Approach

Mechanically fastened systems use an airtight sheathing membrane, also referred to as house wrap, attached to the exterior sheathing with fasteners and washers. Joints, penetrations, and laps are made airtight using sealant, tape, and self-adhered sheathing membrane strips. Care should be taken to ensure the sheathing membrane is adequately attached to the building during construction and it should be supported by strapping or cladding to avoid damage.

Self-adhered sheathing membranes rely on the adhesion to the substrate as well as the adhesion at membrane laps. The membrane should be installed so that it is fully adhered to the substrate upon initial installation. The membrane should also be installed onto a suitable dry substrate that provides continuous backing.

Sealed Exterior Sheathing Approach

The exterior sheathing, when sealed at joints and interfaces, can also act as the primary air barrier element. This approach uses the exterior sheathing together with either sealant, liquid applied sheathing membrane, strips of membrane, or sheathing tape to create a continuous air barrier at the sheathing joints. A sheathing membrane is often required with this approach to provide the water-resistive barrier.

Liquid Applied Membrane

Exterior liquid applied membranes share many of the advantages of self-adhered membranes and are especially useful for complex detailing. Liquid applied membranes rely upon a supporting substrate to provide a continuous backing in order to achieve an airtight barrier.

Sealed Exterior Insulation Approach

Taped exterior foam sheathing can be used as an effective air barrier and is often supplied as a proprietary system of materials and components. The airtight foam is used as the primary air barrier element, and tape, gaskets and sealant are used to transition between insulation boards and across other enclosure elements. The permeability of the foam insulation is of particular importance with respect to the drying capacity of the wall assembly. An assembly with exterior foam insulation and an interior vapour control layer may benefit from using a relatively more permeable interior vapour retarder such as a smart vapour retarder or vapour barrier paint.

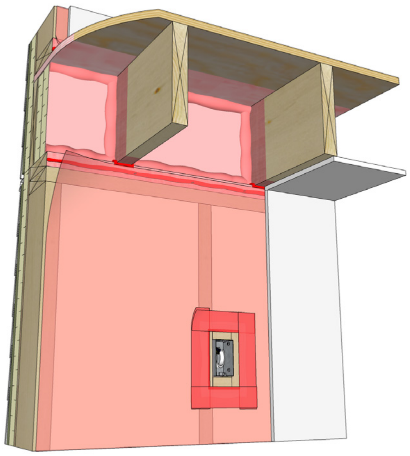


Figure 3.10 Sealed Polyethylene

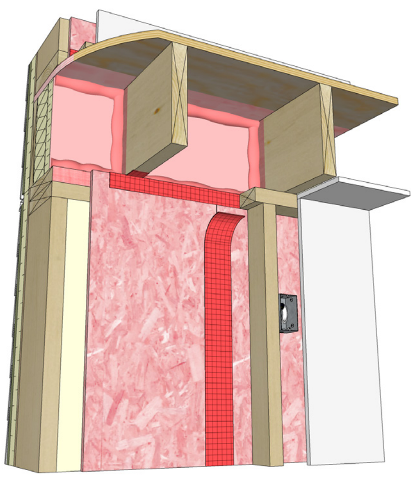


Figure 3.11 Sealed Interior Sheathing

Above-Grade Wall Interior Air Barrier Systems

The interior approaches use an airtight layer applied from the interior of the enclosure, interfacing with the various interior elements, transitions, and penetrations.

Sealed Polyethylene Approach

In this system, polyethylene sheets are sealed to the interior framing to form the air barrier. All joints in the polyethylene are also sealed and clamped between the framing and the interior finish (or service cavity framing). Locations where interior finishes are not normally provided require specific measures to ensure the polyethylene is supported.

Sealed Interior Sheathing Approach (with Service Cavity)

This approach uses an interior layer of sheathing as the primary air barrier element. The sheathing joints are sealed with tape or membrane strips, and the perimeter is set onto gaskets or sealant on the wall framing.

Airtight Drywall Approach

In the airtight drywall approach, the interior gypsum board and framing members provide the air barrier. Continuity between different materials is created with sealants or gaskets. Special attention is required to seal penetrations in the gypsum board at electrical fixtures and other services, as well as the intersection of partition walls with exterior walls and the ceiling.

Interior Spray Foam Approach

In this approach, interior spray foam is used as the primary airtight element around the framing and service components inside the exterior wall assembly. Closed-cell spray foam should be used as it is airtight and specifically permitted in the BCBC for Part 9 construction. In this approach, all wall cavities are filled with insulation, and framing members are sealed at joints and junctions. The airtightness of this assembly relies on both continuous and uniform spray foam insulation, as well as sealing of framing members with high-quality construction sealant like silicone or urethane.

Panelized Approaches

Proprietary panelized and modular systems that use specialized concealed gaskets or sealant at perimeter edges to achieve air barrier continuity are also becoming more common. However, since it is difficult to visually confirm that a continuous air barrier has been achieved with these types of systems, qualitative airtightness testing during construction is recommended.

Air Barrier Strategies

For more information on air barrier strategies, refer to the BC Energy Step Code Builder Guide and the Illustrated Guide - Achieving Airtight Buildings developed by BC Housing.

Equipment Operating Efficiencies

Equipment operating efficiency measures the efficiency at which input energy is converted to useful output energy. Besides efficiencies, other factors such as equipment capacities and distribution should be evaluated when designing the mechanical systems and choosing equipment.

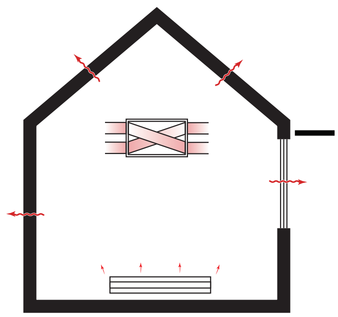


Figure 3.12 Example solution: a house with a high-performance enclosure where an HRV provides good indoor air quality while recovering heat from the exhaust air. Primary heating is provided by electric baseboards.

Mechanical Equipment and Systems

The mechanical equipment and systems of a building can have a large impact on its energy efficiency and overall energy consumption, and hence have a large impact on the Building Equipment and Systems metrics. The required capacity of the mechanical equipment and systems will vary with the performance of the enclosure, and vice versa. This section briefly describes examples of mechanical equipment and systems that may be used to reach various steps of the BC Energy Step Code. This section is not intended to limit the use of any mechanical system or specific product. Both Part 9 and Part 3 buildings can use a wide variety of options, as long as the systems are modelled for compliance with BC Energy Step Code metric targets. Furthermore, the operating efficiencies that can be achieved with the different systems are not the sole indicator of their appropriateness for use in high-performance buildings.

House as a System

It is imperative to understand that building components, mechanical equipment, and occupants work as a system. When incorporating an enclosure-first approach the thermal performance of a building is designed to reduce thermal losses and thermal gains throughout the year, which reduces the required capacity of heating and cooling equipment. Furthermore, the mechanical systems can be more easily controlled where the losses are reduced, and the systems can be optimized to further reduce the energy use of the building.

For example, with an airtight enclosure the code-required minimum ventilation rate is more easily accounted for and controlled since indirect ventilation through building air leakage is reduced. Where an energy-efficient ventilation system like a heat recovery ventilator (HRV) is used, the energy load required to heat the incoming outdoor ventilation air can be minimized. Here the enclosure and the mechanical equipment in combination provide energy-efficient building operation.

Mechanical Equipment Examples

The following sections provides examples of some common mechanical equipment likely to be used in Part 9 buildings designed to meet the various steps of the BC Energy Step Code.

Further information on various common mechanical equipment likely to be used in Part 9 buildings refer to the BC Energy Step Code Builder Guide.

Typical High-Performance Mechanical Systems Wayfinder

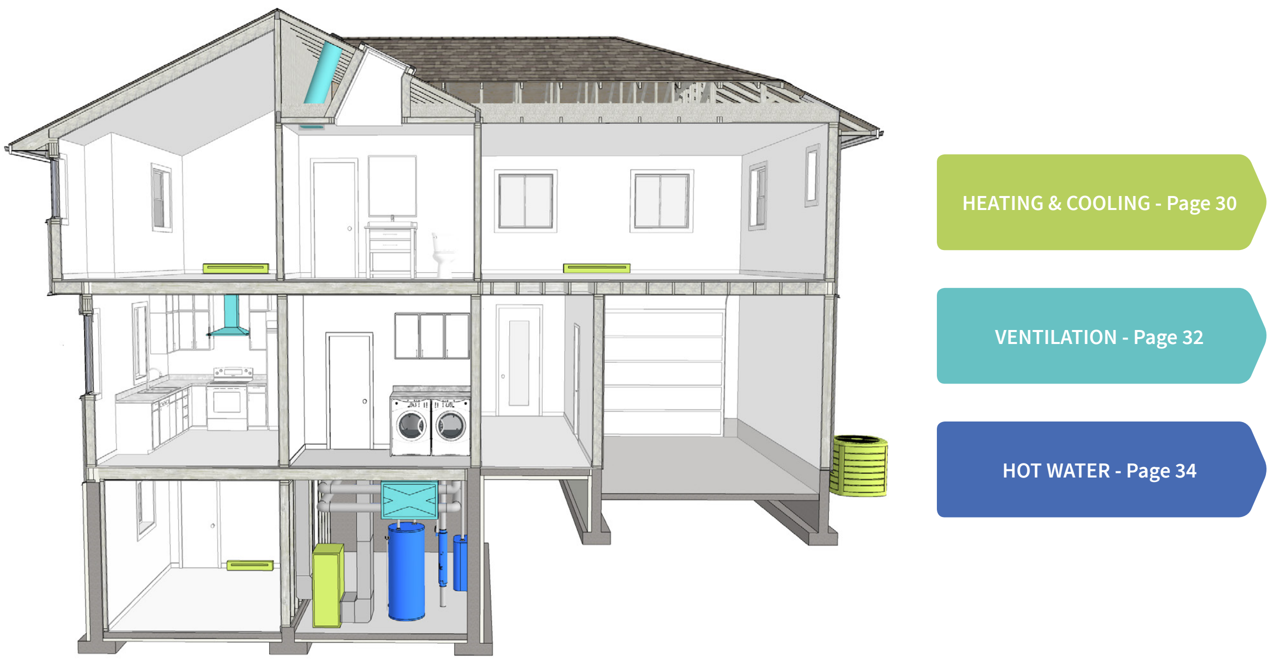


Figure 3.13 Mechanical Systems Wayfinder (systems shown for reference; not all items would be used at once in a house)

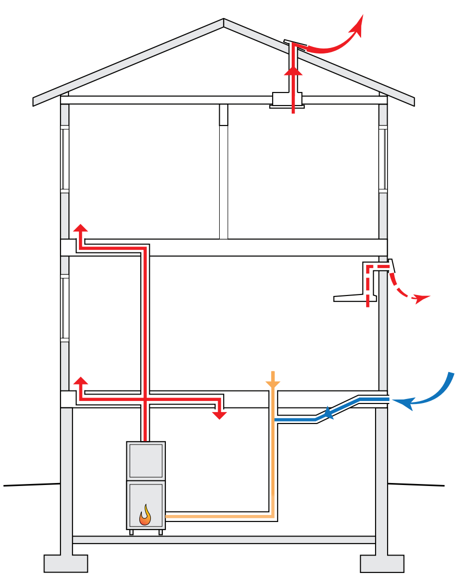


Figure 3.14 Schematic layout of a typical gas furnace system (with standard ventilation air arrangement)

Heating and Cooling

Gas furnaces, baseboards, heat pumps, and hydronic systems can all be used to meet the BC Energy Step Code performance targets.

Gas Furnace

High-efficiency (condensing) gas furnaces use two heat exchangers to extract heat energy from the combustion of fossil fuel (e.g. natural gas, propane, oil) to heat air.

Gas furnaces used in Part 9 buildings typically have efficiencies of at least 92%. The energy demand of these systems is based on the amount of air that must be heated to condition the home, and the temperature difference between the incoming air and the desired temperature. Therefore, the efficiency can be optimized by increasing the temperature of the (cold) ventilation air entering the system using heat recovery, or by using a dedicated ventilation system that uses heat recovery.

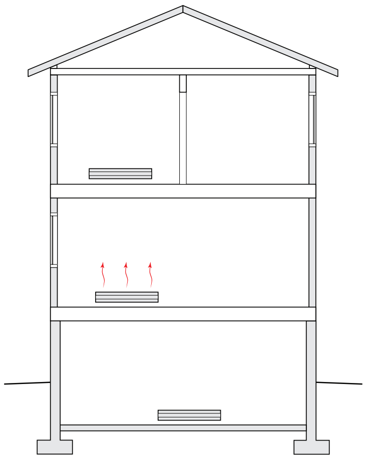


Figure 3.15 Schematic layout of a typical baseboard heater system

Baseboard (Electric)

Electric baseboards generate heat by electric resistance in a heating element. The heat is then distributed by radiating fins. They can be operated individually, which allows for easier operation in buildings with multiple zones.

These systems have an efficiency of 100%, however, ventilation must be provided through a dedicated system, because baseboards do not provide ventilation air.

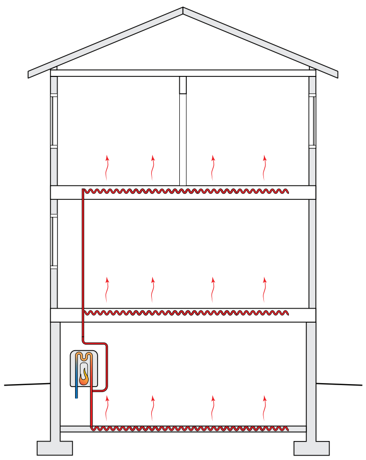


Figure 3.16 Schematic layout of a hydronic radiant floor heating system

Hydronic Systems (Baseboards, Fan-Coils, Radiant Floors)

In hydronic systems, a fluid is heated and/or cooled centrally, then piped through a building to terminal units. These systems can be used for heating, cooling, or both. The terminal units are commonly hydronic baseboards, fan-coil units, or radiant floors. Domestic hot water systems can also be coupled with a hydronic system.

There are many options for the central hydronic heating and cooling plants, each with different efficiencies and benefits. In buildings with high thermal performance, heat pumps may be used for low-temperature radiant systems, both for heating and cooling. Note that radiant systems may increase the risk of overheating without proper controls and commissioning, since they are often slow to react to temperature changes. This increased risk is most relevant for buildings with very high-performance enclosures. It is important to properly commission all systems in any installation.

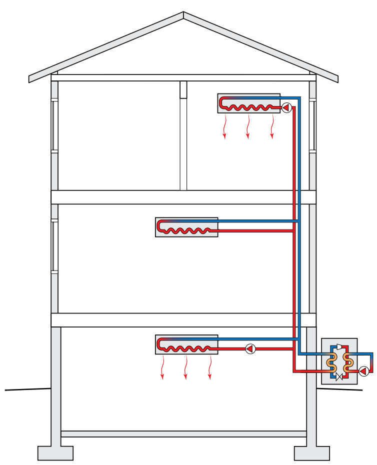


Figure 3.17 Schematic layout of a heat pump heating and cooling system

Heat Pump

A heat pump is a device that circulates refrigerant that absorbs and releases heat through evaporation and condensing of the refrigerant as it travels between and the indoors and outdoors. Heat is extracted from the outdoor environment in heating seasons and from the indoor environment in cooling seasons.

Heat pumps can operate at much higher efficiencies than other typical residential heating and cooling options, in some cases over 300% efficiency. Heat pump efficiencies are measured in Coefficient of Performance (COP), where a 300% efficiency would be denoted COP 3.0.

Ventilation

With increased building airtightness comes the need for sufficient mechanical ventilation to ensure a healthy indoor environment for building occupants. A well-designed and properly installed system will provide the right amount of ventilation and can be used to save energy.

In Part 9 buildings, various ventilation systems can be used, but each type must provide direct ventilation to each bedroom and living space per BCBC Section 9.32. Natural ventilation is permitted during the non-heating season using operable windows, but a mechanical ventilation system must be used during the heating season.

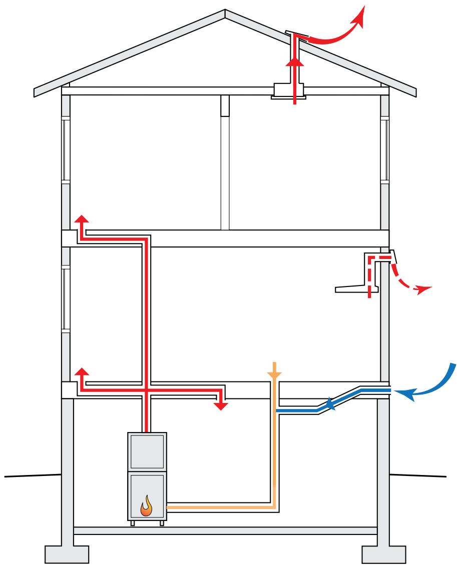


Figure 3.18 Ventilation arrangement for a typical central furnace, with direct fresh air and various dedicated exhaust fans

Dedicated Air Inlet and Exhaust Fan

A dedicated fresh air inlet combined with a central ducted heating system and an exhaust fan can serve as an effective basic ventilation strategy, especially for Part 9 buildings. This strategy uses the ducts for the heating system and a continuously running circulation fan to supply fresh air to all living areas, even if the heating system is not running. At the same time, a continuously running exhaust fan, such as a bathroom fan, extracts stale indoor air.

High-efficiency fans (≤0.2 W/cfm) can be used to minimize energy consumption of the fan operation itself, though the energy required to condition the ventilation air is often a greater energy load for the building. In this system, the ventilation air must be conditioned by the building heating equipment, and the greater the temperature difference between the outdoors and indoors, the greater the energy demand for this process.

Ventilation Heat Recovery

A heat recovery ventilator (HRV) or an energy recovery ventilator (ERV) can be used to recover energy from exhaust air and provide comfortable year-round ventilation to homes. A single unit is typically used for single family homes. In heating climates, HRVs and ERVs are primarily used to recover heat from the exhaust air to temper the supply air, but they can also work in reverse in the cooling season.

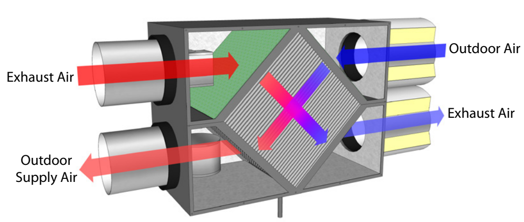


Figure 3.19 Cross section illustration of a heat recovery ventilator operation

These devices use a passive heat exchanger to transfer heat between outgoing exhaust and incoming supply air streams within the ventilation units. Additional benefits come from air filters within the units, which filter out pollutants and pollen. HRVs and ERVs use similar systems, but ERVs also transfer humidity between the supply and exhaust air streams through a specialized heat exchanger, called the enthalpy core. The moisture transfer is intended to improve occupant comfort by maintaining comfortable ambient moisture levels. It can also reduce the need for air conditioning or humidifiers, which contribute to the overall energy use of the building. The heat transfer effectiveness typically ranges from 60% to 85%.

There are two typical arrangements for HRVs in single-family dwellings:

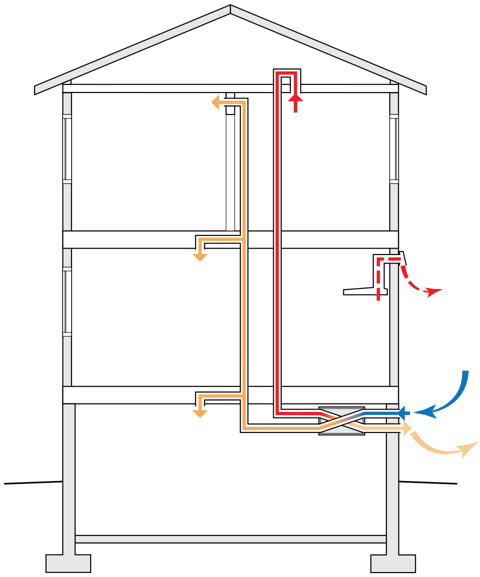


Figure 3.20 Schematic layout of a standalone HRV system

Standalone HRV Systems use dedicated ductwork for ventilation air, connected to a central HRV. The ducts include supply outlets and return inlets for each living space. This is a standalone system from any heating or cooling equipment. It is considered the optimal ventilation arrangement, since it can be sized and controlled based on ventilation air needs, regardless of heating or cooling demand. In most cases the ductwork is far smaller than typical heating or cooling ducts. Standalone HRV systems can also be more easily balanced and maintained, since they do not tie in to other fan systems or rely on passive air circulation between outlets and returns. However, the dedicated ductwork must be accounted for the building design; there should be enough service space to run the ducts as needed, apart from heating or cooling ductwork. Also note the ducted heating/cooling system in the home does not need to include a fresh air inlet (like typical furnace installations do for examples) since the ventilation air is handled by the HRV alone.

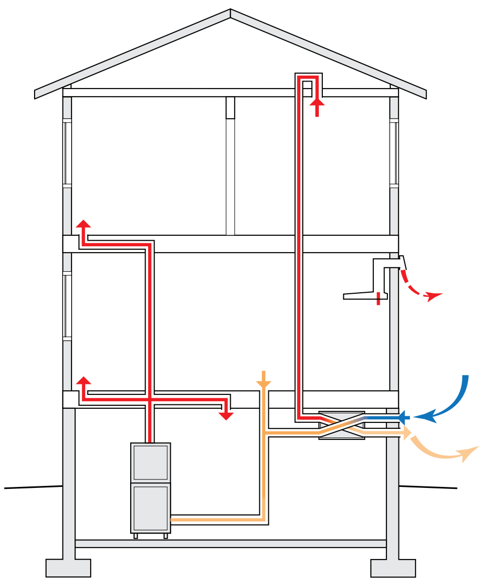


Figure 3.21 Schematic layout of an integrated HRV system in a central furnace

Integrated HRV Systems connect with the air-circulating central heating/cooling system and uses its ductwork to deliver and extract fresh air. The efficiency of the HRV is used to minimize the amount of additional energy needed to heat or cool incoming fresh air running through the system. The integrated approach provides the benefit of limiting the amount of ductwork needed while still using an HRV. However, HRVs are sensitive to the effects of inconsistent or varying airflow induced by a furnace fan for example. They are typically designed to operate using their own fan power for supply and exhaust, and they must be carefully installed following the manufacturer's instructions if installed in conjunction with a central furnace or other air handling unit.

Hot Water

The heating of domestic hot water (DHW) can account for 15-35% of a building's energy use, depending on the building type. DHW energy use may be reduced by selecting energy-efficient systems as well as drain water heat recovery. Incorporating low-flow fixtures (shower heads and faucets) is a good way to reduce hot water usage, but it is not accounted for in Part 9 energy modelling.

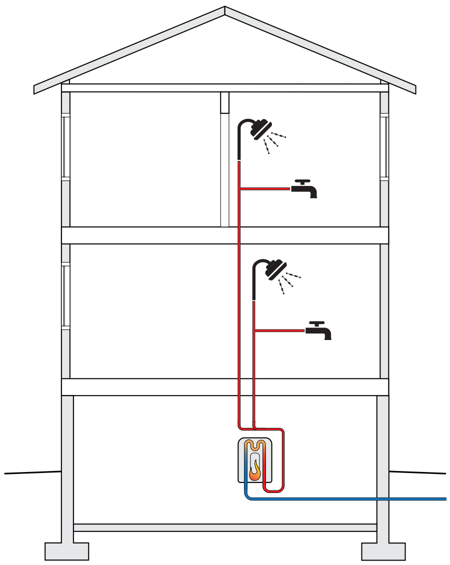


Figure 3.22 Schematic layout of a tankless hot water system

Tank-Type

Conventional DHW heaters typically heat the water with a gas boiler or electric coil, then store the heated water in an insulated tank sized for the demand of the building.

It is recommended to have at least a condensing efficiency natural gas boiler (90% or higher). For higher efficiencies, air-source heat pump hot water tanks can be incorporated (>300%). Hot water tanks may be heated by site-generated energy through heat pumps or solar thermal systems, further increasing efficiency.

Tankless Water Heaters ("On Demand"/"Instantaneous")

Tankless water heaters heat the water as it is being used. These systems can be used as the domestic hot water heating system and the central heating system (see page 31) if sized correctly.

Tankless heaters are generally condensing efficiency natural gas. For larger households, multiple tankless water heaters may be required to meet the hot water demand for multiple users simultaneously.

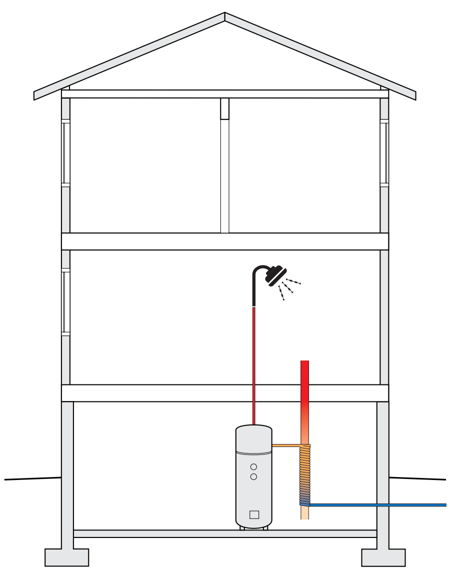


Figure 3.23 Tank-type water heater with drain water heat recovery

Drain Water Heat Recovery

Another way to reduce DHW energy use is by recovering heat from waste water through a drain water heat recovery system. These typically work through the installation of a copper pipe heat exchanger wound tightly around the main drain pipe (that drains from showers). The copper heat exchanger is connected to the supply line of the water heater. Heat is extracted from the drain water running along the walls of the drain pipe and raises the temperature of the incoming supply water.

This is an effective heat recovery strategy in residential buildings due to their high shower usage.

Auxiliary Equipment

The Mechanical Energy Use Intensity for Part 9 buildings (MEUI) requires that the auxiliary HVAC equipment be accounted for in the overall energy use. This includes fans, humidifiers and other devices that are not directly accounted for in the heating, cooling, ventilation, and domestic hot water energy use.

Additional Resources

BC Energy Step Code website - energystepcode.ca

BC Energy Step Code Resources for Local Governments
energystepcode.ca/for-local-governments

BC Energy Step Code: A Best Practices Guide for Local Governments
energystepcode.ca/for-local-governments

Published by BC Housing (bchousing.org/research-centre/library):

Building Enclosure Design Guide

Illustrated Guide - Achieving Airtight Buildings

Illustrated Guide - Energy Efficiency Requirements for Houses in BC

Illustrated Guide - R22+ Effective Walls in Residential Construction in BC

Illustrated Guide - R30+ Effective Vaulted & Flat Roofs in Residential Construction in BC

Residential Construction Performance Guide

Building and Safety Standards Branch Information Bulletins
gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/forms-resources/technical-bulletins

Builder's Guide to Cold Climates published by Building Science Corporation - buildingscience.com

Canadian Home Builders' Association Builders' Manual published by the Canadian Home Builders' Association - chba.ca

Compliance Tools for Part 9 Buildings (Compliance & Verification Reports)
energystepcode.ca/compliance-tools-part9

Energy Modelling Guidelines published by the City of Vancouver
vancouver.ca

Guide for Designing Energy-Efficient Building Enclosures for Wood-Frame Multi-Unit Residential Buildings published by FPInnovations, BC Housing, and the Canadian Wood Council - fpinnovations.ca

Information on the EnerGuide Rating System - nrcan.gc.ca

Pathways to High-Performance Housing in British Columbia published by FPInnovations - fpinnovations.ca

Appendix A: Part 9 BC Energy Step Code Compliance Reports

Example Pre-Construction Compliance Report (page 1/3, filled in based on ERS modelling)

Pre-Construction

Based on building design before construction has started. Review for compliance prior to issuance of building permit.

BC ENERGY COMPLIANCE REPORT - PERFORMANCE PATHS FOR PART 9 BUILDINGS

For Buildings Complying with Subsection 9.36.5. or 9.36.6. of the 2018 BC Building Code (see BCBC Article 2.2.8.3. of Division C)

A: PROJECT INFORMATION

Building Permit #:		Building Type:	Single Detached
Builder:	ABC	If Other, Please Specify:	
Project Address:	Sample Street	Number of Dwelling Units:	1
Municipality / District:	City of Sample	Climate Zone:	4
Postal Code:	A1C 2B3	Floor Area of Conditioned Space (m^2):	240.00
PID or Legal Description:	123456789		

Confirm that the climate zone matches local specified climate zone.

BC Building Code Performance Compliance Path (select one):

☐ 9.36.5. ➡ *Complete Sections A, B, C, & E*   ☑ 9.36.6. ➡ *Complete Sections A, B, D, & E*

Software Name: Hot2000   Version: v11.6   Climatic Data (Location): City of Sample

Check that the most recent version is being used

B: BUILDING CHARACTERISTICS SUMMARY (see BCBC Clause 2.2.8.3.(2)(b) of Division C)

	Details (Assembly / System Type / Fuel Type / Etc.)	**Effective RSI-Value / Efficiency**
Exterior Walls & Floor Headers	2x6, 16 OC, R20 batts, 12mm gypsum board, 12.7mm plywood sheating, hardy plank	2.78
Roof / Ceilings	2x4 truss, 24 OC, R40 batts, 12mm gypsum board	6.91
Foundation Walls, Headers, & Slabs	2.5'' XPS below slab **Slab Is:** ☐ Below **OR** ☑ Above Frost Line **AND** ☐ Heated **OR** ☑ Unheated	2.2
Floors Over Unheated Spaces	n/a	n/a
Fenestration & Doors	ABC Windows FDWR: 15.1 %	0.64
Air Barrier System & Location	Exterior sheathing membrane	n/a
Space Conditioning (Heating & Cooling)	Electric baseboards	100%
Service Water Heating	Electric hot water tank, 50 US gal	EF 0.82
Ventilation	ABC HRV	65/60% @ 0/-25degC
Other Energy Impacting Features	n/a	n/a

This section is what now sets the requirements for the building enclosure assemblies and systems specifications, unless changes are otherwise recorded and possibly re-modelled. Check that what is listed matches what is shown in the drawings package.

Based on information provided by the builder and drawings prepared by ABC Architects **, dated** 01-01-19

BCBC 2018 REVISION - EFFECTIVE 2018-12-10

1

Example Pre-Construction Compliance Report (page 2/3, filled in based on ERS modelling)

C: 9.36.5. ENERGY PERFORMANCE COMPLIANCE (see BCBC Clause 2.2.8.3.(2)(c) of Division C)

This section is used for 9.36.5. compliance under Step 1.

Complete this section only if using the Energy Performance Compliance Path in Subsection 9.36.5.

Proposed House Rated Energy Consumption (GJ/year)	
HVAC	
Hot Water Heating	
SUM	-

Reference House Rated Energy Target (GJ/year)	
HVAC	
Hot Water Heating	
SUM	-

The airtightness value used in the energy model calculations for the Proposed house is:

☐ 4.5 ACH @ 50Pa ☐ 3.5 ACH @ 50Pa **OR** ☐ Tested At ______ ACH @ 50Pa

This selection is not applicable for pre-construction under 9.36.5.

The above calculation was performed in compliance with Subsection 9.36.5. of Division B: ☐ Yes ☐ No

D: 9.36.6. ENERGY STEP CODE COMPLIANCE (see BCBC Sentence 2.2.8.3.(3) of Division C)

This section is used for 9.36.6. compliance for all steps.

Complete this section only if using the Energy Step Code Compliance Path in Subsection 9.36.6.

Proposed House Rated Energy Consumption (GJ/year): 39 Reference House Rated Energy Target (GJ/year): 47

Metric	Units	Required	Proposed
Step Code Level	Step 1, 2, 3, 4, or 5	1	1
Mechanical Energy Use Intensity (MEUI)	kWh/(m²·year)	- *(max)*	45
ERS Rating % Lower Than EnerGuide Reference House, *where applicable*	%	0 *(min)*	16.5
Thermal Energy Demand Intensity (TEDI)	kWh/(m²·year)	- *(max)*	26
Airtightness in Air Changes per Hour at 50 Pa differential	ACH @ 50 Pa	- *(max)*	2.5
		Step Code Design Requirements Met:	**Yes**

Check if minimum step matches local requirement.

Compliance check for BC Energy Step Code

The above calculation was performed in compliance with (see BCBC Clause 2.2.8.3.(2)(e) of Division C)

Select one:

☐ Subsection 9.36.5.,
☐ The Passive House Planning Package (PHPP), version 9 or newer, and the energy model was prepared by a Certified Passive House Designer or Certified Passive House Consultant,
☑ The EnerGuide Rating System (ERS), version 15 or newer, or
☐ The applicable requirements of NECB Part 8 and the City of Vancouver Energy Modelling Guidelines.

Energy modelling method used. It may be prudent to require that the energy modeller's qualifications/ credentials be included in the submission.

E: COMPLETED BY

Full Name (Print): Mike Sample
Company Name: ABC Advisors
Phone: 123-456-7890
Address: 1234 Sample Street, Sample, BC
Email: mike.sample@abc.com
Date (dd/mm/yyyy) 01-01-19

If applicable, enter ERS information:
Advisor ID Number: 1234P00012
Service Organization: Sample
EnerGuide P #: 1234P00012

Indicates QA check for ERS

BCBC 2018 REVISION - EFFECTIVE 2018-12-10

2

Example Pre-Construction Compliance Report (page 3/3, filled in based on ERS modelling)

SUPPLEMENTARY INFORMATION

Supplementary information is not required for Code Compliance but may be requested by the local municipality/district. Where applicable, all metrics within Section F are calculated with baseloads included. If required, complete the applicable sections below.

F: OTHER ENERGY MODELLING METRICS

Additional information, not required by BC Energy Step Code for compliance, but provides more detail.

#	Metric	Units	Reference House	Proposed House
1	Airtightness NLA@10Pa	cm^2/m^2	1.26	1.26
2	Rated Greenhouse Gas Emissions	kg/year	222	198
3	Rated Greenhouse Gas Intensity	$kg/m^2/year$	1	1
4	Rated Energy Use Intensity	$GJ/m^2/year$	0.3	0.27
5	Peak Thermal Load (PTL)	W/m^2	27	24
6	% of the Building's Conditioned Space Served by Space-Cooling Equipment	%	N/A	Not more than 50%
7	% Lower Than Reference House With Baseloads Included	%	N/A	11%

Previous versions of Compliance Reports included PTL as a BC Energy Step Code metric per an earlier version of the Code, though is only included here now for reference.

#	Energy Source	Reference House Energy Consumption (GJ/year)	Proposed House Energy Consumption (GJ/year)
8	Electricity	72.1	64.4
	Natural Gas	-	-
	Propane	-	-
	District Energy	N/A	-
	On-Site Renewables	N/A	-
	Other:	-	-
	Total	72.1	64.4

G: OPTIONAL CERTIFICATIONS

Additional information, not required by BC Energy Step Code, though may be useful for tracking/additional quality assurance

PENDING
- ☐ BUILTGREEN®, Level: ____________
- ☐ Certified Passive House
- ☐ CHBA Net Zero House

PENDING
- ☐ ENERGY STAR® for New Homes
- ☐ LEED® for Homes
- ☐ R2000
- ☐ Other: ____________

BCBC 2018 REVISION - EFFECTIVE 2018-12-10

3

Example As-Built Compliance Report (page 1/3, filled in based on ERS compliance)

As-Built

Based on building after construction is complete (i.e. after substantial completion or near/at occupancy)

BC ENERGY COMPLIANCE REPORT - PERFORMANCE PATHS FOR PART 9 BUILDINGS

For Buildings Complying with Subsection 9.36.5. or 9.36.6. of the 2018 BC Building Code (see BCBC Article 2.2.8.3. of Division C)

A: PROJECT INFORMATION

Building Permit #:	0	Building Type:	Single Detached
Builder:	ABC	If Other, Please Specify:	0
Project Address:	Sample Street	Number of Dwelling Units:	1
Municipality / District:	City of Sample	Climate Zone:	4
Postal Code:	A1C 2B3	Floor Area of Conditioned Space (m^2):	240.00
PID or Legal Description:	123456789		

BC Building Code Performance Compliance Path (select one):

☐ 9.36.5. ➡ *Complete Sections A, B, C, & E*   ☑ 9.36.6. ➡ *Complete Sections A, B, D, & E*

Software Name: Hot2000   Version: v11.6   Climatic Data (Location): City of Sample

B: BUILDING CHARACTERISTICS SUMMARY (see BCBC Clause 2.2.8.3.(2)(b) of Division C)

	Details (Assembly / System Type / Fuel Type / Etc.)	Effective RSI-Value / Efficiency
Exterior Walls & Floor Headers	2x6, 16 OC, R20 batts, 12mm gypsum board, 12.7mm plywood sheating, hardy plank	2.78
Roof / Ceilings	2x4 truss, 24 OC, R40 batts, 12mm gypsum board	6.91
Foundation Walls, Headers, & Slabs	2.5" XPS below slab **Slab Is:** ☐ Below **OR** ☑ Above Frost Line **AND** ☐ Heated **OR** ☑ Unheated	2.2
Floors Over Unheated Spaces	n/a	n/a
Fenestration & Doors	ABC Windows 15.1 %	0.64
Air Barrier System & Location	Exterior sheathing membrane	n/a
Space Conditioning (Heating & Cooling)	Electric baseboards	100%
Service Water Heating	Electric hot water tank, 50 US gal	EF 0.82
Ventilation	ABC HRV	65/60% @ 0/-25degC
Other Energy Impacting Features	n/a	n/a

These inputs must match what is built on site. They can be confirmed if needed based on previous site inspections. Any discrepancies need to be addressed

Based on information provided by the builder, and a site evaluation completed on 01-02-19

BCBC 2018 REVISION - EFFECTIVE 2018-12-10

1

Example As-Built Compliance Report (page 2/3, filled in based on ERS compliance)

C: 9.36.5. ENERGY PERFORMANCE COMPLIANCE (see BCBC Clause 2.2.8.3.(2)(c) of Division C)

Complete this section only if using the Energy Performance Compliance Path in Subsection 9.36.5.

As-Built House Rated Energy Consumption (GJ/year)	
HVAC	
Hot Water Heating	
SUM	-

Reference House Rated Energy Target (GJ/year)	
HVAC	
Hot Water Heating	
SUM	-

The airtightness value used in the energy model calculations for the As-Built house is:

☐ 4.5 ACH @ 50Pa ☐ 3.5 ACH @ 50Pa **OR** ☐ Tested At ______ ACH @ 50Pa

If used, check that this matches the airtightness report.

The above calculation was performed in compliance with Subsection 9.36.5. of Division B: ☐ Yes ☐ No

D: 9.36.6. ENERGY STEP CODE COMPLIANCE (see BCBC Sentence 2.2.8.3.(3) of Division C)

Complete this section only if using the Energy Step Code Compliance Path in Subsection 9.36.6.

As-Built House Rated Energy Consumption (GJ/year): 37 Reference House Rated Energy Target (GJ/year): 47

Metric	Units	Required		Proposed	As-Built
Step Code Level	Step 1, 2, 3, 4, or 5	*1*		1	1
Mechanical Energy Use Intensity (MEUI)	kWh/(m²·year)	-	*(max)*	45	43
ERS Rating % Lower Than EnerGuide Reference House, *where applicable*	%	*0*	*(min)*	16.5	20.3
Thermal Energy Demand Intensity (TEDI)	kWh/(m²·year)	-	*(max)*	26	24
Airtightness in Air Changes per Hour at 50 Pa differential	ACH @ 50 Pa	-	*(max)*	2.5	1.5
				Step Code Design Requirements Met:	**Yes**

As-built airtightness is likely to be different from the proposed (i.e. pre-construction) airtightness. For Step 2 and higher, if it is worse, other energy performance measures must be taken.

Compliance check for BC Energy Step Code.

The above calculation was performed in compliance with (see BCBC Clause 2.2.8.3.(2)(e) of Division C)

Select one:

- ☐ Subsection 9.36.5.,
- ☐ The Passive House Planning Package (PHPP), version 9 or newer, and the energy model was prepared by a Certified Passive House Designer or Certified Passive House Consultant,
- ☑ The EnerGuide Rating System (ERS), version 15 or newer, or
- ☐ The applicable requirements of NECB Part 8 and the City of Vancouver Energy Modelling Guidelines.

E: COMPLETED BY

Full Name (Print):	Mike Sample
Company Name:	ABC Advisors
Phone:	123-456-7890
Address:	1234 Sample Street, Sample, BC
Email:	mike.sample@abc.com
Date (dd/mm/yyyy):	43466

If applicable, enter ERS information:

Advisor ID Number:	1234P00012
Service Organizatior	Sample
EnerGuide P #:	1234P00012
EnerGuide N #:	1234N00012

Indicates QA check for ERS

BCBC 2018 REVISION - EFFECTIVE 2018-12-10

2

Example As-Built Compliance Report (page 3/3, filled in based on ERS compliance)

SUPPLEMENTARY INFORMATION

Supplementary information is not required for Code Compliance but may be requested by the local municipality/district. Where applicable, all metrics within Section F are calculated with baseloads included. If required, complete the applicable sections below.

F: OTHER ENERGY MODELLING METRICS

#	Metric	Units	Reference House	Proposed House	As-Built House
1	Airtightness NLA@10Pa	cm^2/m^2	1.26	1.26	0.76
2	Rated Greenhouse Gas Emissions	kg/year	222	198	193
3	Rated Greenhouse Gas Intensity	kg/m^2/year	1	1	1
4	Rated Energy Use Intensity	GJ/m^2/year	0.2	0.27	0.3
5	Peak Thermal Load (PTL)	W/m^2	27	24	23
6	% of the Building's Conditioned Space Served by Space-Cooling Equipment	%	N/A	#VALUE!	Not more than 50%
7	% Lower Than Reference House With Baseloads Included	%	N/A	11%	13%

As-built likely to be different from proposed

#	Energy Source	Reference House Energy Consumption (GJ/year)	Proposed House Energy Consumption (GJ/year)	As-Built House Energy Consumption (GJ/year)
8	Electricity	72.1	64.4	62.7
	Natural Gas	-	-	-
	Propane	-	-	-
	District Energy	N/A	-	-
	On-Site Renewables	N/A	-	-
	Other:	-	-	-
	Total	72.1	64.4	62.7

G: OPTIONAL CERTIFICATIONS

If selected, request that the certification/label be provided with the submission.

PENDING

- ☐ BUILTGREEN®, Level ____________
- ☐ Certified Passive House
- ☐ CHBA Net Zero House

PENDING

- ☐ ENERGY STAR® for New Homes
- ☐ LEED® for Homes
- ☐ R2000
- ☐ Other: ____________

BCBC 2018 REVISION - EFFECTIVE 2018-12-10

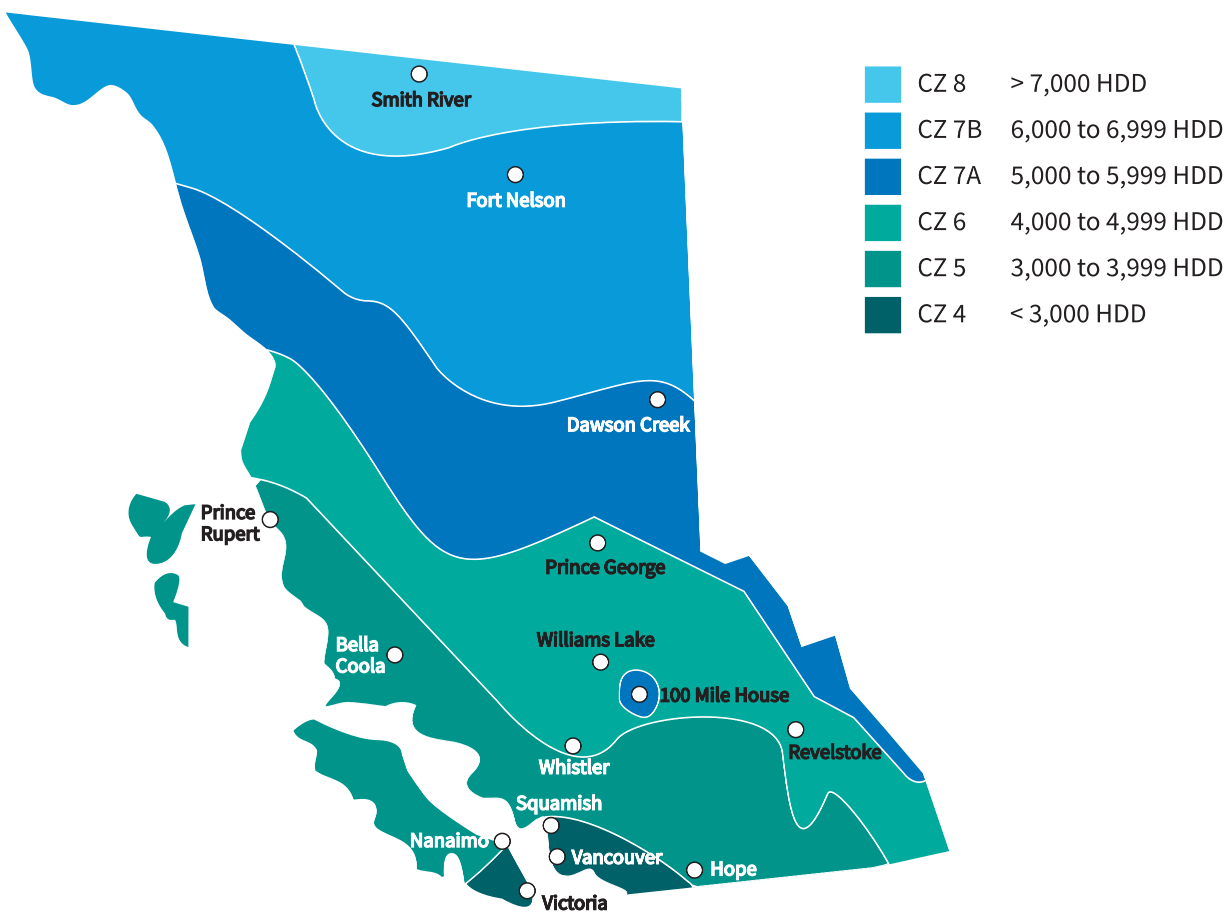
3

Appendix B: BC Energy Step Code Requirements Based on Climate Zone

Climate Zones

The BC Building Code (BCBC) defines the energy performance targets of the BC Energy Step Code based on the building's climate zone (CZ). The BC climate zones are defined by the average heating degree-days below 18° C (HDD). The BCBC states that the authority having jurisdiction can establish climatic values to define climate zones, typically based on information from Environment Canada. Note that in some locations, there may be several climate zones due to variations in elevation.

The following tables are adapted from the BC Energy Step Code requirements in Section 9.36. of the BCBC 2018. They reflect the requirements at the time of publication, but always check the current Code before using them.



Requirements For Part 9 Buildings Located In Climate Zone 4 (BCBC Table 9.26.6.3.-A)

	Airtightness	Equipment & Systems			Building Enclosure
	ACH_{50}	% < REF	OR	MEUI* (kWh/(m²·year))	TEDI (kWh/(m²·year))
STEP 1		0%			
STEP 2	≤ 3.0	10%	OR	60	35
STEP 3	≤ 2.5	20%	OR	50	30
STEP 4	≤ 1.5	40%	OR	40	20
STEP 5	≤ 1.0			25	15

Requirements For Part 9 Buildings Located In Climate Zone 5 (BCBC Table 9.26.6.3.-B)

	Airtightness	Equipment & Systems			Building Enclosure
	ACH_{50}	% < REF	OR	MEUI* (kWh/(m²·year))	TEDI (kWh/(m²·year))
STEP 1		0%			
STEP 2	≤ 3.0	10%	OR	70	45
STEP 3	≤ 2.5	20%	OR	65	40
STEP 4	≤ 1.5	40%	OR	50	30
STEP 5	≤ 1.0			30	20

Requirements For Part 9 Buildings Located In Climate Zone 6 (BCBC Table 9.26.6.3.-C)

	Airtightness	Equipment & Systems			Building Enclosure
	ACH_{50}	% < REF	OR	MEUI* (kWh/(m²·year))	TEDI (kWh/(m²·year))
STEP 1		0%			
STEP 2	≤ 3.0	10%	OR	85	60
STEP 3	≤ 2.5	20%	OR	75	50
STEP 4	≤ 1.5	40%	OR	55	40
STEP 5	≤ 1.0			40	25

**MEUI values represent requirement for buildings greater than 210 m2 (2357 ft²), where the amount of space served by space-cooling equipment is not more than 50%. Additional MEUI values can be found on page 45.*

Requirements For Part 9 Buildings Located In Climate Zone 7a (BCBC Table 9.26.6.3.-D)

	Airtightness	Equipment & Systems			Building Enclosure
	ACH_{50}	% < REF	OR	MEUI* (kWh/(m²·year))	TEDI (kWh/(m²·year))
STEP 1		0%			
STEP 2	≤ 3.0	10%	OR	110	80
STEP 3	≤ 2.5	20%	OR	95	70
STEP 4	≤ 1.5	40%	OR	70	55
STEP 5	≤ 1.0			55	35

Requirements For Part 9 Buildings Located In Climate Zone 7b (BCBC Table 9.26.6.3.-E)

	Airtightness	Equipment & Systems			Building Enclosure
	ACH_{50}	% < REF	OR	MEUI* (kWh/(m²·year))	TEDI (kWh/(m²·year))
STEP 1		0%			
STEP 2	≤ 3.0	10%	OR	130	100
STEP 3	≤ 2.5	20%	OR	115	90
STEP 4	≤ 1.5	40%	OR	85	65
STEP 5	≤ 1.0			65	50

Requirements For Part 9 Buildings Located In Climate Zone 8 (BCBC Table 9.26.6.3.-F)

	Airtightness	Equipment & Systems			Building Enclosure
	ACH_{50}	% < REF	OR	MEUI* (kWh/(m²·year))	TEDI (kWh/(m²·year))
STEP 1		0%			
STEP 2	≤ 3.0	10%	OR	150	120
STEP 3	≤ 2.5	20%	OR	130	105
STEP 4	≤ 1.5	40%	OR	100	80
STEP 5	≤ 1.0			75	60

**MEUI values represent requirement for buildings greater than 210 m2 (2357 ft^2), where the amount of space served by space-cooling equipment is not more than 50%. Additional MEUI values can be found on page 45.*

MEUI Adjustments

For houses, mechanical systems are often modelled the same regardless of home size. Since MEUI is normalized per square metre of area of conditioned space, smaller homes are burdened with higher MEUI values. Therefore, the MEUI targets defined in the previous tables have been adjusted for small homes by offering an increase in energy intensity budget, per Table 9.36.6.3.-G in the BCBC. The following table shows the additional MEUI allowance for small homes that can be added to the required climate zone targets shown in the previous tables.

For more information on MEUI targets and additional allowance, refer to the BC Energy Step Code 2018 Metrics Research Report.

Additional MEUI Allowance for Small Houses Based on Floor Area and Cooling (Adapted from BCBC Table 9.36.6.3.-G)

	≤ 50 m² (538 ft²)	≤ 75 m² (807 ft²)	≤ 120 m² (1292 ft²)	≤ 165 m² (1776 ft²)	≤ 210 m² (2357 ft²)	> 210 m² (2357 ft²)
Houses designed with **Space-Cooling Equipment Serving not more than 50% of Floor Area**						
STEP 2	+75	+60	+30	+15	+5	+0
STEP 3	+70	+50	+25	+13	+3	
STEP 4	+50	+40	+20	+8	+0	
STEP 5	+40	+30	+15	+5	+0	
Houses designed **with Space-Cooling Equipment Serving more than 50% of Floor Area**						
STEP 2	+110	+88	+48	+25	+13	+5
STEP 3	+105	+78	+43	+23	+11	
STEP 4	+85	+68	+38	+18	+8	
STEP 5	+75	+58	+33	+15	+8	

ENERGY STEPCODE
BUILDING BEYOND THE STANDARD

energystepcode.ca

Building Officials Association of British Columbia
BOABC
Promoting Building Safety and Professionalism

boabc.org