Net Zero Energy Ready Residential Buildings Resource Toolkit

Prepared by: Daniel Eden, UBC Sustainability Scholar, 2019
Prepared for: Christian Cianfrone, Executive Director, ZEBx

July 2019

Disclaimer

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and various local governments and organizations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability across the region.

This project was conducted under the mentorship of ZEBx staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of ZEBx or the University of British Columbia.

Acknowledgements

The author would like to thank the following individuals for their contribution, feedback, and support throughout this project:

- Christian Cianfrone, Executive Director, ZEBx
- Jessica Williams, Communications and Partnerships Manager, ZEBx
- Zahra Teshnizi, Manager, ZEBx-UBC Research at The University of British Columbia

Cover photo courtesy of ZEBx

Contents

List of Figures and Tables

Executive Summary

As the residential green building industry grows, there has been a proliferation of reports, guides, documents, and websites to help inform the building community on best practices. This rich documentation is spread over several websites and includes duplicated material, making it confusing and overwhelming to find targeted information.

The Net Zero Energy Ready (NZER) Residential Buildings Toolkit tackles this problem. It is a resource that identifies and gathers the most relevant and useful documents for "Part 9" residential construction and organizes them in an "easy-to-find" manner.

The Toolkit's content is partially informed by interviews with 18 experienced individuals from the residential construction community, including builders, architects, energy advisors, policy makers and educators. These discussions helped identify the major challenges to NZER construction and the best resources to overcome them, as well as any perceived "gaps" in documentation. To bridge these gaps, several recommendations are made in this report, summarized below:

- *Appoint City Resource to Answer Questions*
- *Create Approved Product Database*
- *Create Zoning/Relaxation Summary*
- *Create Skilled Builder/Trade Database*
- *Develop Airtightness Commitment Template*
- *Create a Tip & Tricks for "Hard-to-Find" Air Leakage*
- *Clarify the Airtightness Failure Resolution Process*
- *Provide Additional Design Aids*
- *Create Short Technical Videos*
- *Provide Cost Case Studies*
- *Provide User-Friendly Costing Estimator*
- *Continue Airtightness Training*
- *Build Mechanical Design Capacity*

The Toolkit is planned to be a live document that will continually be updated as new documentation is developed. The content follows the natural progression of a project:

- Getting Started: foundational information on the concepts of net zero energy homes and the BC Energy Step Code;
- My Project Requirements: guidance on the Energy Step Code performance requirements and targets for a specific project, based on location;
- My Construction & Design: specific information pertaining to construction, such as insulation, thermal bridging, assemblies, airtightness, and mechanical systems;
- My Process: helpful links to support the complete process, such as how to find an energy advisor, compliance forms, and incentive/cost information.

For a detailed outline of the draft Toolkit, please refer to Appendix B

Introduction

An Explosion of Green Building Documentation

Since 2008, the province of British Columbia has been introducing requirements for local governments to include greenhouse gas reduction targets in their community plans, driving energy efficiency in new building construction. For example, in 2010, the City of Vancouver released the Green Buildings Policy for Rezoning, and in 2015, the Zero Emissions Building Plan, two pieces of legislation fast-tracking the local high-performance building industry.

In response to these new requirements and the demand for greener and more efficient buildings, in-depth supporting material was produced by the building community. This documentation covers a wide range of information, e.g., from general material on the benefits of high-performance buildings, to specific information on wall and roof construction, to guidance on implementing the Energy Step Code, among many more.

Although each stand-alone document is useful, the quantity, variety, and distributed nature over many separate sources has resulted in an overwhelming spread of information. Specifically, for home builders, who have limited time and capacity to read lengthy reports, it has become too time-consuming to effectively and quickly locate answers to their high-performance building questions, as conceptually illustrated in Figure 1 below.

Figure 1 - Conceptual Illustration of the Wealth of Net Zero Energy Ready Material

A Solution to Finding What Matters Most – The Residential Toolkit

In response, the Zero Emissions Building Exchange, ZEBx, has created the "Net-Zero Energy Ready Residential Buildings Toolkit" for Part 9 residential construction, herein referred to as the "Toolkit". The Toolkit is a curated "meta resource" which gathers, organizes, and links to the most relevant sections of the high-performance building documents, as shown in Figure 2 below.

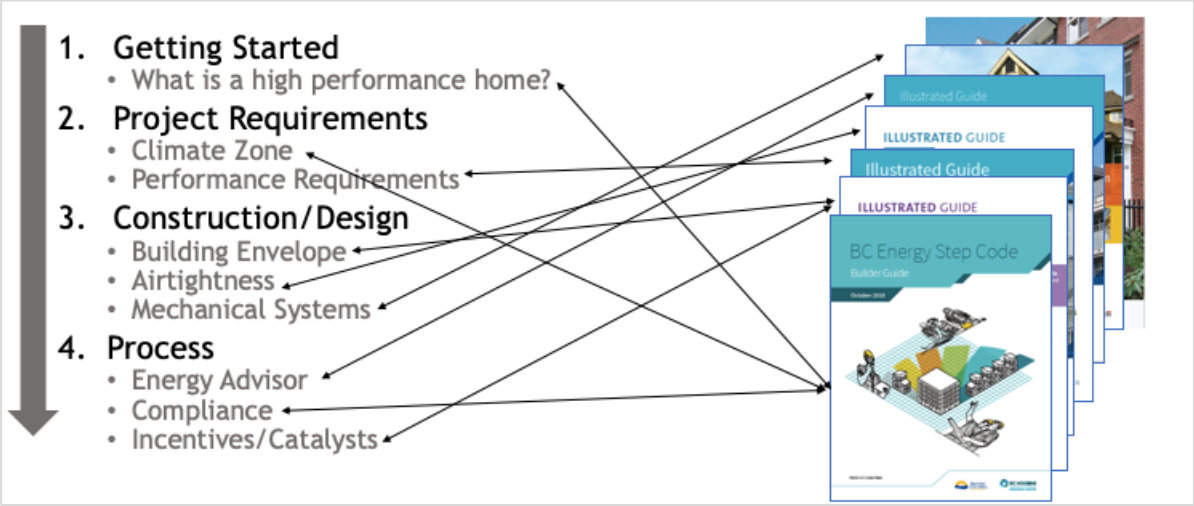

Figure 2 - Exemplification of the Toolkit Linking to Existing Documentation

The links are categorized based on the typical sequence of a project with the intent of minimizing the time and effort to find the desired information. The categories are as follows:

- Getting Started: foundational information on the concepts of net zero energy homes and the BC Energy Step Code;
- My Project Requirements: guidance on the Energy Step Code performance requirements and targets for a specific project, based on location;
- My Construction & Design: specific information pertaining to construction, such as insulation, thermal bridging, assemblies, airtightness, and mechanical systems;
- My Process: helpful links to support the complete process, such as how to find an energy advisor, compliance forms, and incentive/cost information.

What to Include? Voices from the BC Building Community

To better understand which documentation is the most relevant and useful to include in the Toolkit, ZEBx completed a number of interviews within the building community. A total of 18 experienced individuals were interviewed, representing a cross-section of residential

construction stakeholders, including builders, architects, energy advisors, local government officials, and educators.

What is Missing?

As interviews were completed, a number of gaps in existing documentation were identified. These opportunities include, for example, creating a database of approved high-performance building products and creating a listing of skilled trade/builder, among many others. The full list of recommended resources to develop is included in the section Summary of Interview Findings.

Research Approach

To build the Net Zero Energy Ready Residential Building Toolkit, the following steps were completed:

1. Reviewed Existing Documentation
    a. Identified relevant residential green building reports/guides. A full list of documents reviewed in found in Appendix A
    b. Reviewed each document and recorded relevant sections in an Excel spreadsheet, including a short description, page numbers, type, potential audience (builders, designers, energy advisors, owners, local governments), date of publication, publisher, and website address.
2. Sorting & Organizing Documentation
    a. Identified natural steps of a project – “Getting Started”, “Project Requirements”, “Design”, or “Process”.
    b. Sorted the reviewed documentation based on these categories.
3. Conducted Interviews
    a. Identified a list of potential interviewees based on broad cross section of different stakeholders in the green building community and targeting experienced people who have a pulse on the challenges of residential net zero energy ready construction.
    b. Completed interviews and recorded findings in an Excel spreadsheet.
    c. Based on interviews, reviewed additional green building documentation and recorded relevant documentation accordingly.
    d. Identified and summarized any “missing” documentation, i.e., ideas of resources that could be created and that would be useful.
4. Reported Findings
    a. Completed a draft report;

b. Completed an Executive Summary to be used to show the value of the tool and potentially secure future funding to create a publicly available web-based version Toolkit.
c. Completed a full report.

Interviews

Several interviews were completed to better understand the needs of the residential building community with regards to net zero ready residential construction. The goals of the interviews were to identify the roadblocks faced when building net zero energy ready homes, the most useful resources used, and any gaps in the documentation available.

The following general questions were used as a guide:

- "What are the major roadblocks/challenges you are facing with net zero energy ready construction?"
- "Where do you currently find information, what are good resources for you?"
- "What information do you wish was available that would make it easier?"

Summary of Interview Findings

The following table (Table 1) summarizes the key roadblocks to Net Zero Energy Ready (NZER) residential buildings identified during the interviews and the recommended resources to mitigate each challenge. The challenges and recommendations are explained in detail in the sections below.

Table 1 - Summary of Interview Findings

CHALLENGE	#	RECOMMENDATIONS	ACTION
Identifying Approved Construction Methods and Products	1	Appoint City of Vancouver Resource to Answer Questions	CoV to Implement
	2	Create Approved Product Database	To develop
Navigating Zoning Requirements and Relaxations	3	Create Zoning/Relaxation Summary	To develop
Assembling and Coordinating a High-Performance Building Team	4	Create Skilled Builder/Trade Database	To develop
	5	Develop Airtightness Commitment Template	Linked in Toolkit
Technical Requirements for Net Zero Energy Ready Buildings	6	Create a Tips & Tricks for "Hard-to-Find" Air Leakage	To develop

CHALLENGE	#	RECOMMENDATIONS	ACTION
	7	Clarify the Airtightness Failure Resolution Process	To develop
	8	Provide Additional Design Aids	Linked in Toolkit
	9	Short Technical Videos	To develop
Estimating Costs	10	Provide Cost Case Studies	To develop
	11	Provide User-Friendly Costing Estimator	To develop
Achieving Airtightness Requirements	12	Continue Airtightness Training	Linked in Toolkit
Selecting and Installing Mechanical Equipment	13	Build Mechanical Design Capacity	Linked in Toolkit

List of Interviewees

Interviews were completed between mid-May and mid-July 2019, targeting a range of stakeholders involved in net zero energy residential construction. The breakdown of interviewees by category (18 interviews total) is shown in Figure 3 below:

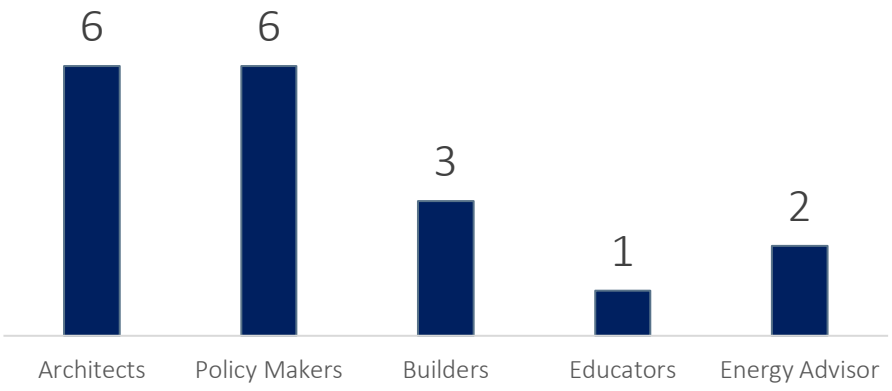

Figure 3 - Breakdown of Interviews by Type of Professional

Detailed Interview Results

The following sub-sections summarize the interviews by similar stakeholder type. The first group includes architects, builders and energy advisors as they are all intimately involved in the construction process. The second group consists of policy makers and educators as they support and legislate construction.

For each group, the most common roadblocks to net zero energy ready homes are identified and listed, ordered based on frequency reported. For each of these challenges, a resource has been identified, and it is noted whether this resource already exists and is included in the Toolkit, or whether the resource should be developed. Finally, for of each group, the list of commonly used resources is listed.

Group 1: Architect, Builders, and Energy Advisor Interviews

The group consisted of six architects, three builders and two energy advisors. The architects and two of the builders were selected based on their project applications to "Nearzero.ca", a City of Vancouver (CoV) initiative to accelerate the construction of high-performance low-rise buildings. The program is sponsored by the CoV and administered by Passive House Canada and ZEBx and targets projects that are either Passive House, Living Building Challenge or Net Zero Energy. It consists of a competitive process where applicants are required to complete a detailed questionnaire about their project and commit to providing data during the project lifecycle.

Challenges and Recommended Resources

1. Challenge – Identifying Approved Construction Methods and Products: Several architects expressed that there is a lack of clarity on accepted construction methods and approved products by the City of Vancouver (CoV), as well as a lack of flexibility in the City's approval or consideration of novel solutions. For example, using structural insulated panels (SIPs), insulated concrete formwork (ICF) and air admittance valves (AAVs) were noted as preferred methods to achieve highly insulated and airtight building envelopes, however, these methods were either rejected or challenged by CoV, leading to lengthy redesign. Furthermore, several commented that commonly used high-performance products, such as certain building tapes, vapour barriers, or insulation types, are not officially endorsed by the City and approval can vary based on the inspector, leading to uncertainty on product selection and approval. Finally, there is confusion about who at the CoV can be contacted to discuss and troubleshoot the issues noted above.

    Recommendation 1 - City Point Person: Appoint a knowledgeable and accessible resource at the City of Vancouver with the authority to answer detailed questions about construction methods and review novel solutions in a timely manner. Publish a short informational resource on approved high-performance building envelope methods, which could be linked on the Residential Toolkit page.

    Recommendation 2 – Product Database: Create and publicly release a list of approved building products database to help designers and builders source them more easily. The database should include links to product information, where to obtain it, regulatory

approval documentation (UL, CSA, Passive House, etc.), and potentially embodied carbon data. It could include approved building components, such as windows/doors/skylights, and approved mechanical systems, such as heat/energy recovery ventilators, recirculating exhaust hoods, and heat pumps. The database could be used as a 2-way communication tool where the building community could also submit new products for review/approval. Finally, it should build on the "Green Buildings Market Forecast" report recently released by the Vancouver Economic Commission.

2. Challenge – Navigating Zoning Requirements and Relaxations: Most architects commented that it is time-consuming and difficult to decipher the zoning requirements and high-performance building relaxations for various municipalities or even for various zonings within the CoV. For example, the thickness of walls, the building area, and the height are often treated differently. Furthermore, it was noted that regulations/relaxations changed several times within a short time period, making it difficult for designers to rely on the benefits of the relaxations in project proposed to their clients.

   Recommendation 3 – Zoning/Relaxation Summary: Create a summary document or diagram of zoning requirements and relaxations for high-performance buildings for each municipality. The document could indicate how each municipality deals with square footage, building depth, height, and wall thickness, for example.

3. Challenge – Assembling and Coordinating a High-Performance Team, Finding Skilled Trades & Builders: The architects mentioned that it is difficult to assemble a skilled team of builders and trades that understand the attention and methods needed for a high-performance residential construction. Also, once the team is assembled, great effort is required to continuously remind them of the care needed to maintain the integrity of the air barrier. Furthermore, it was noted that coordination of the team, including an integrated design process, is much more time-intensive that anticipated and that this additional design cost could be prohibitive to potential clients.

   Recommendation 4 – Skilled Builder/Trade Database: Create a database of high-performance builders and trades to locate them more easily or host a website where they can highlight their projects and the products they use (similar to the interior design application "Houzz Home Renovation and Design"). The database could include project examples, certifications, year of experience, and could be extended to include designers and certified consultants (e.g., for Passive House) and financing institutions. One interviewee noted that it would be valuable to add a "request a call-back" feature, where

a customer looking for a builder could provide their contact details and preferred call-back time in an online form.

Recommendation 5 – Airtightness Commitment Template: Create a one-pager describing the airtightness requirements and commitment needed from the builder/trades that could be used for the bidding process. This resource could also include tips and tricks on how to successfully manage your trades (e.g., appoint an air barrier champion) and could build on the airtightness construction checklist already included in the Toolkit.

4. Challenge – Technical Requirements for Net Zero Energy Ready Buildings: although the Energy Step Code Builder Guide was recognized by most architects as a valuable resource, there is nevertheless concern about how to meet the Step Code airtightness requirements, and a few noted the need for more guidance on design guidelines to meet higher steps.

   Recommendation 6 – Air leakage "Tips & Tricks" : Create a one-pager with "tips and tricks" for hard-to-find sources of air leakage based on industry knowledge and experience. This could include, for example, how to properly close/seal Passive House windows for airtightness testing. A generic checklist for simple leakage has been linked in the Toolkit.

   Recommendation 7 – Airtightness Failure Resolution Process : Provide additional guidance on what happens if the building fails the final airtightness test: e.g., what are the next steps, who is responsible for rectifying the deficiencies.

   Recommendation 8 – Design Aids: Create a one-pager with rule-of-thumb guidelines for window-to-wall ratios and insulation values (or other key values) that can help achieve higher steps of the Step Code. Multiple aids are already included in the Builder Guide and are linked in the Toolkit.

   Recommendation 9 – Short Technical Videos: One builder recommended developing short videos for various building techniques, which a site supervisor, contractor or trade could review on-site before applying the technique.

5. Challenge – Estimating Costs: A few architects noted that it would be helpful to have more guidance on the incremental costs of pursuing high-performance residential homes.

   Recommendation 10 – Cost Case Studies: Assemble a series of case studies representing typical building types/sizes with accurate costing for various building components that can help the design community determine the potential cost of the project. This information can then be communicated to their potential clients. The case studies which are located on the BC Step Code website are linked in the Toolkit. One variation proposed to detailed cost studies would be an online map listing only salient project details, such as

the cost per square foot, the building type (single family residential, 1 storey vs 2 storey, etc.), and category (high-end, normal, affordable housing), a few photos, and the contact information for the project team. This would allow prospective owners to quickly pull-up a wider variety of data points and comparative projects.

Recommendation 11 – Provide User-Friendly Costing Estimator: The Metrics Report, which provides very detailed and Metro Vancouver specific costing, is linked in the Toolkit. To provide more value, develop a user-friendly cost guide that covers more regions in British Columbia.

Resources Commonly Used by Group 1

The following resources were identified as helpful and commonly used by the architects/builders/energy advisors interviewed and have been included in the Toolkit:

- The Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia was referenced by several architects.
- Small Planet Supply, a local supplier of high-performance materials and HVAC products was referenced by almost all architects. It was also noted that there are few or no alternative suppliers in the industry.
- Passive House (PH) Consultants were noted as a great resource for navigating design requirements and sourcing certified products. The Toolkit includes a link to the Passive House member search engine, providing access to PH Consultants/Designers, Tradespeople, and Certifiers.
- Google: most architects noted that they typically search Google to find products and suppliers of materials.

Group 2: Policy Maker & Educator Interviews

Six policy makers and one educator were interviewed, representing regions close to Vancouver and governing bodies in British Columbia.

Challenges and Recommended Resources

1. Challenge – Achieving the Airtightness Requirements: Policy makers raised concerns about the industry's capability of meeting the new airtightness requirements for higher steps of the Step Code. They have been encouraging and incentivizing builders to attend training on airtightness techniques.

   Recommendation 12 – Continue Airtightness Training: Continue to provide training on airtightness techniques. The Toolkit includes several links to airtightness resources within

the Builder Guide, the Illustrated Guide Achieving Airtight Buildings, and the Best Practice Guide Air Sealing, Insulation Retrofits For Single Family Homes, and to the BCIT airtightness training course.

2. Challenge – Selecting and Installing Mechanical Equipment: High-performance mechanical equipment design and installation are major perceived roadblocks. Specifically, concerns about builders' lack of mechanical expertise, therefore oversizing equipment and neglecting proper commissioning, as well as lack of knowledge around ventilation ducting.

   Recommendation 13 – Build Mechanical Design Capacity: A few mechanical design resources have been linked to in the Toolkit from the Builder Guide, the Heat Recovery Ventilation Guide for Houses, and the Thermal Environmental Comfort Association (TECA) training courses. Providing more training would be beneficial to increase the building community's capacity as well as identify where further training is required.

3. Challenge – Understanding Incremental Costs: This group is concerned with understanding the incremental cost of achieving higher steps of the Step Code. BC Housing is currently providing Cost Optimization Workshops which is a good starting point. Costing recommendations were previously listed under the Group 1 section.

Resources Commonly Used by Group 2

The following resources were identified as helpful and commonly used by the policy makers and educators interviewed and have been included in the Toolkit:

- BC Housing website and online document library;
- BC Step Code Design Guide and Builder Guide;
- Municipal website with Step Code pages;
- Community Energy Association (network);
- Home Builder's Association (Canadian and Vancouver).

Draft Toolkit

After reviewing the documentation available on net zero energy ready residential construction and identifying the most relevant information based on stakeholder interviews, a draft Toolkit was developed.

The following table (Table 2) provides the outline of the Toolkit. Each item listed links to a specific section or page within an existing resource. For a more detailed version of this table, please refer to Appendix B which also includes a short description of each item, the reference document, and the page numbers.

Table 2 - Outline of Draft Toolkit

1.0	Getting Started
1.1	**What is a high-performance building?**
	Benefits of High-Performance Buildings
	Principles of High-Performance Buildings
	Common Energy Issues and Concerns
	Considerations when Retrofitting an Existing House
	Glossary of Building Science and Energy Efficiency Terms
1.2	**What is the BC Energy Step Code?**
	Overview of Step Code
	Step Code Council Structure
	How Many Steps Are There?
	What Does Net Zero Energy Ready Mean?
	Step Code Metrics
	Building Form and Exposure
	Energy Step Code Frequently Asked Question (FAQ)
	BC Energy Step Code Technical Training Series
1.3	**What are the different rating systems?**
	BUILTGREEN, ENERGYSTAR, R2000, LEED, Passive House
	What is EnerGuide?
	How to find a Passive House Professional or Tradesperson
1.4	**Examples and Case Studies**
	Step Code Case Studies with Overall Costs and Strategies
2.0	**My Project Requirements**
2.1	**Location**
	Climate Zone Categorization for BC Cities
2.2	**Zone Requirements**

	Step Code Performance Requirements by Zone
3.0	**My Design / Construction**
3.1	**Building Envelope**
3.1.1	***Insulation***
	Enclosure Performance Ranges for Roofs, Walls, Slabs, Glazing, and Airtightness
	What is "Effective" R-value?
	What is "Effective" R-value? Deeper Dive.
	How to Calculate the "Effective" R-value of Tapered Roof Insulation
	Continuity of Insulation - Key Considerations
	Insulating an Existing Home
	Attaching Cladding to Exterior Insulation - High Level
	Attaching Cladding to Exterior Insulation - Deeper Dive
	Insulating an Existing Home
3.1.2	***Thermal Bridging***
	Building Envelope Thermal Bridging Guide v1.2
	Thermal Bridging and Air Barrier/Insulation Continuity
	Thermal Bridging and Comfort
	Videos for the Building Envelope Thermal Bridging Guide
3.1.3	***Assemblies and Details***
	Library of Building Details
	Walls - High Performance Assemblies
	Walls - Examples of R-22+ Wood-Framed Assemblies
	Walls - Other Assemblies for R-22 Walls
	Walls - Assemblies that Are Not R-22
	Walls - Examples of R-22+ Wood-Framed Wall Assemblies – Summary
	Walls - Commonly Accepted Above Grade and Below Grade Assemblies
	Walls - Comparison of Highly Insulated Exterior Wall Assemblies
	Sloped Roof - High Performance Assemblies
	Sloped Roof - High Performance Assemblies - Additional Solutions
	Sloped Roof - High Performance Assemblies - Additional Solutions (Even More!)
	Low-Sloped Roof - High Performance Assemblies
	Low-Sloped Roof - High Performance Roof Assemblies - Additional Solutions
	Below Grade Wall - High Performance Assemblies
	Window - High Performance Assemblies
	FAQ for Windows and Doors
3.2	**Airtightness**
3.2.1	***Airtightness Information***

	Components of Airtightness
	Common Airtightness Deficiencies
	Common Airtightness Deficiencies - Detailed
	Airtightness Testing Procedure
	Testing for Airtightness - The Basics
	Testing for Airtightness - Advanced
	Airtightness Measurement Types
	Coordination and Sequencing of Air Barrier
	Typical Air Leakage Paths
	Checklists for Airtightness
	Retrofitting for Airtightness
	Airtightness Requirements Based on Various Standards
	How to draft proof an existing house?
	Airtightness Training Course
3.2.2	***Airtightness Detailing***
	Detailing: Above Grade Walls Air Barrier Strategies
	Detailing: Roof Air Barrier Strategies
	Detailing: Below Grade Concrete Air Barrier Strategies
	Detailing: Detailing Overview
	Comparison of Air Barrier Strategies
3.2.3	***Airtightness Transitions***
	Transitions: Roof-to-Wall Air Barrier Transition Details
	Transitions: Window and Door Air Barrier Transition Details
	Transitions: Above Grade Wall to Foundation Wall Transition Detail
	Transitions: Foundation Wall to Slab-on-Grade Air Barrier Transition Details
3.3	**Mechanical Systems**
	Mechanical Equipment Selection Examples for All Climate Zones
	Overview of High-Performance HVAC Systems
	Overview of Common Heating and Cooling Systems
	FAQ for Heat Pumps, Gas Furnaces/Boilers/Appliances
	Heat Pumps vs Natural Gas -Which is Better?
	Ventilation Systems
	FAQ for Ventilation Systems: HRVs and Exhaust Fans
	Domestic Hot Water Systems
	FAQ for Domestic Water Heating
	Heat and Energy Recovery Ventilation Concepts
	Heat and Energy Recovery Ventilation System Design and Installation
	Heat and Energy Recovery Ventilation Checklist

	Residential HVAC Training Courses
	High Performance Appliances and Lighting
4.0	**My Process**
4.1	**Energy Advisors**
	How to find an Energy Advisor
	More Resources to find an Energy Advisor
	Search for an Energy Advisor by Postal Code
	Search for an Energy Advisor by City/Municipality
	Support and Information for Energy Advisors
	Technical Bulletin B19-03: Guidelines for Energy Advisors
	Technical Bulletin B19-02: Step 1 in the BC Energy Step Code
	Technical Bulleting B19-01: Complying with Step 1 of the BC Energy Step Code for Part 9 Buildings
4.2	**Builder/Contractor**
	How do you Choose the Right Contractor?
	What is a Program Registered Contractor?
4.3	**Compliance Forms**
	Step Code Compliance Form for Part 9 Buildings
	EnerGuide Rating System - Energy Advisor Requirements
	Instructions for Energy Step Code Compliance Calculator and Report Generator
	What are the Energy-Efficiency Requirements for New Homes in the City of Vancouver?
4.4	**Cost/Incentives/Catalysts**
	Incentive Database for Homes in BC
	Incremental Capital Cost of Building to Step Code – Overview
	Incremental Capital Cost of Building to Step Code – Detailed
	CMHC Incentives on Mortgage Loan Insurance for Energy Efficient Homes
	City of Vancouver Passive House Relaxations - Guidelines for Residences in RS Districts
	City of Vancouver Data Collection Initiative - Nearzero.ca

Summary

In summary, to solve the issue of needing to sort through an overwhelming amount of available and distributed documentation on high-performance residential homes, ZEBx has created a draft resource Toolkit that organizes and simplifies finding relevant information.

The resources in the Toolkit are based on a review of over 30 recent reports, documents, and websites, as well as informational interviews with 18 stakeholders in the residential net zero ready building community.

The Toolkit is organized based on the natural progressing of a project and covers the foundational elements of net zero energy ready homes, specific location-based criteria based on the Energy Step Code, design and construction details and support, and finally the compliance process.

Recommendations

The interviews helped to identify gaps in the existing documentation, and a number of recommendations for new resources are listed in this report, in the section Summary of Interview Findings.

As the Toolkit is currently in a draft format, the next step would be to create a user-friendly visually-appealing online version that is publicly accessible.

Appendix A List of Documents Reviewed

The following table (Table 3) lists all documents that were reviewed as part of the research for the draft Toolkit. Resources in grey were reviewed but are not currently linked in the Toolkit.

Table 3 - List of Documents Reviewed

Document	Publication Date	Publisher	Primary Location
2018 Metrics Research Full Report Update	Sep-18	BC Housing	https://energystepcode.ca/publications/
BC Energy Step Code - A Best Practices Guide for Local Governments	Sep-17	Energy Step Code Council and BC Buildings and Safety Branch	https://energystepcode.ca/for-local-governments/
BC Energy Step Code - Builder Guide	Oct-18	RHD Building Science	https://energystepcode.ca/for-industry/
BC Energy Step Code - Design Guide	Mar-18	HCMA Architecture and Design and Integral Group	https://energystepcode.ca/for-industry/
BC Energy Step Code Website	2019	Energy Step Code Council	https://energystepcode.ca/
BC Gvt Technical Bulletin	Apr-19	BC Buildings Safety and Standards Branch	https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/forms-resources/technical-bulletins
BC Housing Consumer Guide to High Performance Homes	Jan-16	BC Housing	https://www.bchousing.org/research-centre/library/consumer-new-construction/consumer-guide-high-performance-homes&sortType=

Document	Publication Date	Publisher	Primary Location
BC Housing Design and Construction Guidelines	Mar-18	BC Housing	https://www.bchousing.org/partner-services/asset-management-redevelopment/construction-standards
BCIT Airtightness Training	Jun-19	BCIT	https://commons.bcit.ca/zeroenergybuildings/vancouver-airtightness-training-workshop/
Best Practice Guide Air Sealing and Insulation Retrofits - For Single Family Homes	Jan-18	BC Housing and RDH Building Science	https://www.bchousing.org/research-centre/library/residential-design-construction/best-practices-air-sealing-insulation-retrofits&sortType=sortByDate
Building Envelope Thermal Bridging Guide v1.2	Jan-18	Morrison Hershfield Ltd	https://www.bchousing.org/research-centre/library/residential-design-construction/building-envelope-thermal-bridging-guide
Canadian Association of Consulting Energy Advisors (CACAE) website		Canadian Association of Consulting Energy Advisors	http://cacea.ca/
CHMC Website	-	CMHC	https://www.cmhc-schl.gc.ca/en/buying/mortgage-loan-insurance-for-consumers/cmhc-green-home
City of Vancouver Passive House Relaxations - Guidelines for Residences in RS Districts	Jan-19	City of Vancouver	https://vancouver.ca/home-property-development/build-a-passive-house.aspx
Clean BC Better Homes website	Jan-19	CleanBC Better Homes	https://betterhomesbc.ca
Construction Innovation in BC	Dec-15	BC Construction Association	https://www.bccassn.com/resources/reports/construction-innovation-in-bc
Guide for Designing Energy Efficient Building Enclosures	Mar-13	FPInnovations	https://rdh.com/wp-content/uploads/2014/07/Guide-for-Designing-Energy-Efficient-Building-Enclosures.pdf

Document	Publication Date	Publisher	Primary Location
Guide to Low Thermal Energy Demand for Large Buildings	Apr-18	BC Housing	https://energystepcode.ca/for-industry/
Heat recovery ventilation guide for houses	Jan-15	BC Housing, Home Owner Protection Office	https://www.bchousing.org/research-centre/library/residential-design-construction/heat-recovery-ventilation-guide-houses&sortType=sortByDate
http://nearzero.ca/	Jan-19	City of Vancouver	http://nearzero.ca/
Illustrated Guide - Achieving Airtight Buildings - Appendix A	Sep-17	BC Housing	https://www.bchousing.org/research-centre/library/residential-design-construction/achieving-airtight-buildings-appendix-A&sortType=sortByDate
Illustrated Guide - Energy Efficiency Requirements for Houses in British Columbia (Zone 4 Lower Mainland and Southern Vancouver Island)	~2014	Home Protection Office, Innes Hood	https://www.bchousing.org/research-centre/library/residential-design-construction/ig-energy-efficiency-houses-climate-zone-4-lowermainland&sortType=sortByDate
Illustrated Guide Achieving Airtight Buildings	Sep-17	BC Housing	https://www.bchousing.org/research-centre/library/residential-design-construction/achieving-airtight-buildings
Illustrated Guide Energy Efficiency Requirements for Houses in BC - Zones 5 to 7A	Jan-14	Home Protection Office	https://www.bchousing.org/research-centre/library/residential-design-construction/ig-energy-efficiency-houses-climate-zone-5-7a&sortType=sortByDate
Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia	Nov-17	BC Housing, RDH	https://www.bchousing.org/research-centre/library/residential-design-construction/ig-R22-effective-walls-residential-construction
Illustrated Guide R30+ Effective Vaulted & Flat Roofs in		BC Housing, RDH, MH	https://www.bchousing.org/research-centre/library/residential-design-construction/ig-r30-vaulted-flat-roofs&sortType=

Document	Publication Date	Publisher	Primary Location
Residential Construction in British Columbia			
Instruction Manual: BC Energy Compliance Report for (some) Part 9 Buildings	Dec-18	Energy Step Code Council	https://energystepcode.ca/compliance-tools-part9/
Lessons from the BC Energy Step Code	Jun-19	BC Hydro	https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/reports/bcenergystepcode_lessons_learned_final.pdf
Local Gov Peer Network Sharepoint Access	-	BC Hydro	Private sharepoint
NRCan Home Improvement Website	-	NRCan	http://oee.nrcan.gc.ca/residential/personal/home-improvement/service/contact-advisors.cfm
NRCAN Website Keeping The Heat In - Chapter 4: Comprehensive air leakage control	Dec-16	NRCan	https://www.nrcan.gc.ca/energy/efficiency/housing/home-improvements/keeping-the-heat-in/comprehensive-air-leakage-control/15635
Passive Design Toolkit for Homes	Jul-09	BC Construction Association	https://www.toolkit.bc.ca/resource/passive-design-toolkit
Passive House Member Search	Jan-19	International Passive House Association	
Procuring Innovation in Construction a review of models, processes and practices	Jan-17	BC Construction Association	https://www.bccassn.com/resources/reports/procuring-innovation-in-construction
TECA Training Courses	Jan-19	Thermal Environmental	TECA Training Courses

Document	Publication Date	Publisher	Primary Location
		Comfort Association	

Appendix B - Draft Toolkit – Detailed

The following table (Table 4) is a detailed version of the draft Toolkit, including a short description of each resource, the page number and the reference document.

Table 4 - Detailed Version of Draft Toolkit

	Resource	Short Description	Pages	Document
1.0	Getting Started			
1.1	**What is a high-performance building?**			
	Benefits of High-Performance Buildings	How do high performance buildings affect costs, greenhouse gas emissions, and climate adaption?	p.6	BC Energy Step Code - Builder Guide
	Principles of High-Performance Buildings	Description of the characteristics of high-performance buildings: air tightness, thermal performance, solar control, building form, solar orientation, enclosure impact, windows/shading, detailing/insulation, enclosure durability, thermal comfort.	p.25-36	BC Energy Step Code - Builder Guide
	Common Energy Issues and Concerns	FAQ page providing information on general energy concerns regarding home improvements, energy efficiency, cost effectiveness, home comfort, and moisture/condensation.	all	Clean BC Better Homes website
	Considerations when Retrofitting an Existing House	FAQ page with information on the "house as a system" concept for retrofits.	all	Clean BC Better Homes website
	Glossary of Building Science and Energy Efficiency Terms	List of commonly used terms with definitions	all	Clean BC Better Homes website
1.2	**What is the BC Energy Step Code?**			
	Overview of Step Code	Overview of the Step Code: its relation to the BC Building Code, its adoption timeline, its major strategies.	p.7	Lessons from the BC Energy Step Code
	Step Code Council Structure	One-pager outlining how the Step Code Council is structured, its subcommittees, and its peer learning networks.	p. 9	Lessons from the BC Energy Step Code

	Resource	Short Description	Pages	Document
	How Many Steps Are There?	Table showing how many Steps there are for different categories of buildings, upper vs lower steps.	p.15	BC Energy Step Code - A Best Practices Guide for Local Governments
	What does Net Zero Energy Ready mean?	Graphical representation of the Step Code for single-family homes, including Step 5.	p.6/28	Green Buildings Market Forecast - Demand for Market Products
	Step Code Metrics	Overview of the Step Code performance requirements: air tightness, equipment and systems, building enclosure, including TEUI, MEUI and TEDI.	p.11-15	BC Energy Step Code - Builder Guide
	Building Form and Exposure	Effective visuals showing how the building form influences the thermal energy demand intensity.	p.30	BC Energy Step Code - Builder Guide
	Energy Step Code Frequently Asked Question (FAQ)	A detailed list of FAQs on the Energy Step Code website.	All	BC Energy Step Code Website
	BC Energy Step Code Technical Training Series	Four detailed videos introducing the Step Code, Part 3 and Part 9 requirements, and enforcement.	All	BC Energy Step Code Website
1.3	**What are the different high-performance home rating systems?**			
	BUILTGREEN, ENERGYSTAR, R2000, LEED, PassiveHouse	Overview and links to detailed information about the various rating systems.	All	EfficiencyBC
	What is EnerGuide?	FAQ page providing information on EnerGuide.	All	Clean BC Better Homes website
	How to find a Passive House Professional or Tradesperson	Link to an online database of certified Passive House designers, consultants, tradespeople, certifiers, manufacturers.	All	Passive House Member Search
1.4	**Examples and Case Studies**			

	Resource	Short Description	Pages	Document
	Step Code Case Studies with Overall Costs and Strategies	A series of five case studies with overall project costs, percent increase over traditional cost, and overview of design strategies.	all	BC Step Code Case Studies
2.0	My Project Requirements			
2.1	**Location**			
	Climate Zone Categorization for BC Cities	Map and summary table of BC cities by climate zone.	p.37-38	BC Energy Step Code - Builder Guide
2.1	**Zone Requirements**			
	Step Code Performance Requirements by Zone	Tables for each climate zone showing the requirements for each step: airtightness, equipment and systems (MEUI and TEUI) and building enclosure (MEUI).	p.16-21	BC Energy Step Code - Builder Guide
3.0	My Design / Construction			
3.1	**Building Envelope**			
3.1.1	***Insulation***			
	Enclosure Performance Ranges for Roofs, Walls, Slabs, Glazing, and Airtightness	Graphics for each climate zone showing the required insulation, u-value, and airtightness of various parts of the building assembly.	p.39-44	BC Energy Step Code - Builder Guide
	What is "Effective" R-value?	One-pager describing effective R-value.	p.54	BC Energy Step Code - Builder Guide
	What is "Effective" R-value? Deeper Dive.	Additional information on effective R-value calculation, the calculation requirements, thermal modelling, and material thermal properties.	p. 6-8	Illustrated Guide R22+ Effective Walls in Residential

	Resource	Short Description	Pages	Document
				Construction in British Columbia
	How to Calculate the "Effective" R-value of Tapered Roof Insulation	A description of how to calculate the R-value of tapered insulation, including tables with R-value calculation results.	p.3-4	Illustrated Guide R30+ Effective Vaulted & Flat Roofs in Residential Construction in British Columbia
	Continuity of Insulation - Key Considerations	Illustrations of definitions such as nominal insulation vs effective insulation, typical problem areas for insulation continuity.	p.6-8	Illustrated Guide Energy Efficiency Requirements for Houses in BC - Zones 5 to 7A
	Attaching Cladding to Exterior Insulation - High Level	A one-pager describing the considerations of attaching cladding to exterior insulation, including clip type, thermal performance, and diagrams.	p.13	Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia
	Attaching Cladding to Exterior Insulation - Deeper Dive	A detailed discussion on cladding support options, structural considerations such as weight, strapping, drain mat, screws, backup wall and fastener embedment, deflection, installation methods, and fastener tables.	p.19-26	Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia
	Insulating an Existing Home	An FAQ with general information on existing home insulation.	all	Clean BC Better Homes website
3.1.2	***Thermal Bridging***			
	Building Envelope Thermal Bridging Guide v1.2	The go-to guide on thermal bridging in BC, including details on how to calculate the effective insulation value.	All	Building Envelope Thermal Bridging Guide v1.2

	Resource	Short Description	Pages	Document
	Thermal Bridging and Air Barrier/Insulation Continuity	Information on how thermal bridging is related to the air barrier and insulation continuity.	p.34	BC Energy Step Code - Builder Guide
	Thermal Bridging and Comfort	Information on how thermal bridging is related to thermal comfort and condensation.	p.36	BC Energy Step Code - Builder Guide
	Videos for the Building Envelope Thermal Bridging Guide	Four short videos that explain how to use the Building Envelope Thermal Bridging Guide	All	Building Envelope Thermal Bridging Guide v1.2
3.1.3	***Assemblies and Details***			
	Library of Building Details	Table of contents linking to details/diagrams for windows, sloped roofs, low-sloped roofs, rim joist, and below-grade.	p.115-145	BC Energy Step Code - Builder Guide
	Walls - High Performance Assemblies	Diagram showing the R-value range for four common wall assemblies, information on air barriers, insulation, and alternative arrangements.	p.55-64	BC Energy Step Code - Builder Guide
	Walls - Examples of R-22+ Wood-Framed Assemblies	Detailed diagrams for four typical wall assemblies that can meet R-22 insulation requirements, including key considerations for each component of the wall.	p.27-35, p.42-45	Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia
	Walls - Other Assemblies for R-22 Walls	Overview and short description of six wall types that can achieve R-22 effective insulation value.	p.50-52	Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia
	Walls - Assemblies that Are Not R-22	A series of diagrams showing typical wall assemblies that will not achieve R-22 insulation values.	p.46-47	Illustrated Guide R22+ Effective Walls in Residential Construction in British Columbia
	Walls - Examples of R-22+ Wood-Framed Wall Assemblies - Summary	Summary diagrams for typical wall assemblies that can meet R-22 insulation requirements.	p.48-49	Illustrated Guide R22+ Effective Walls in Residential

	Resource	Short Description	Pages	Document
				Construction in British Columbia
	Walls - Commonly Accepted Above Grade and Below Grade Assemblies	Diagram and descriptive table for commonly accepted wall assemblies for climate zones 5-7a.	p.10-11	Illustrated Guide Energy Efficiency Requirements for Houses in BC - Zones 5 to 7A
	Walls - Comparison of Highly Insulated Exterior Wall Assemblies	Comparison of the benefits and limitations of four common wall assemblies	p.123/242	Guide for Designing Energy Efficient Building Enclosures
	Sloped Roof - High Performance Assemblies	Diagram showing the R-value range for three common sloped roof types, information on air barriers, insulation, and alternative arrangements.	p.65-71	BC Energy Step Code - Builder Guide
	Sloped Roof - High Performance Assemblies - Additional Solutions	Additional diagrams showing two common sloped roof types, information on air barriers, insulation, vapour control, and design considerations.	p.5-8	Illustrated Guide R30+ Effective Vaulted & Flat Roofs in Residential Construction in British Columbia
	Sloped Roof - High Performance Assemblies - Additional Solutions (Even More!)	Additional diagrams showing three more common sloped roof types.	p.25	Illustrated Guide R30+ Effective Vaulted & Flat Roofs in Residential Construction in British Columbia
	Low-Sloped Roof - High Performance Assemblies	Diagram showing the R-value range for 4 common low-sloped roof types, information on air barriers, insulation, and alternative arrangements.	p.72-78	BC Energy Step Code - Builder Guide
	Low-Sloped Roof - High Performance Roof Assemblies - Additional Solutions	Additional diagrams showing five common low-sloped roof types, information on air barriers, insulation, vapour control, and design considerations.	p.9-18	Illustrated Guide R30+ Effective Vaulted & Flat Roofs in Residential

	Resource	Short Description	Pages	Document
				Construction in British Columbia
	Below Grade Wall - High Performance Assemblies	Diagram showing the R-value range for four common below grade assemblies, information on air barriers, insulation, and alternative arrangements.	p.79-85	BC Energy Step Code - Builder Guide
	Window - High Performance Assemblies	Diagram showing the R-value range for 4 common window assemblies, information on energy performance, window frame material, airtightness, insulating glass units, solar heat gain and low-e coatings, installation method, and glazed and opaque doors.	p.86-90	BC Energy Step Code - Builder Guide
	FAQ for Windows and Doors	An FAQ with general information on window/door types and ENERGY STAR.	all	Clean BC Better Homes website
3.2	**Airtightness**			
3.2.1	***Airtightness Information***			
	Components of Airtightness	Overview of air permeability, continuity, durability, stiffness, and general airtightness strategy.	p.91-93	BC Energy Step Code - Builder Guide
	Common Airtightness Deficiencies	Overview of common deficiencies and a proposed approach to quality control.	p.102	BC Energy Step Code - Builder Guide
	Common Airtightness Deficiencies - Detailed	A more in-depth review of how/where to find air leakage, including a room by room checklist.	all	NRCAN Website Keeping The Heat In - Chapter 4: Comprehensive air leakage control
	Airtightness Testing Procedure	A one-pager describing the various steps of air testing a Part 9 building, including the test standard.	p.10	BC Energy Step Code - Builder Guide
	Testing for Airtightness - The Basics	Overview of airtightness testing: whole-building, infrared, smoke pencils, visual inspection.	p.12-13	Best Practice Guide Air Sealing and Insulation Retrofits - For Single Family Homes
	Testing for Airtightness - Advanced	Detailed description of qualitative vs quantitative testing, fan-based measurements, test conditions, test boundary, preparing openings, fan requirements, conducting the test, analysis, reporting and alternative methods.	p.16-21/29	Illustrated Guide Achieving Airtight Buildings

	Resource	Short Description	Pages	Document
	Airtightness Measurement Types	Diagrams and descriptions of airtightness metrics: air leakage rate, normalized rate, air change rate, leakage area.	p.5/29	Illustrated Guide Achieving Airtight Buildings
	Coordination and Sequencing of Air Barrier	One-pager describing a step by step sequence based on building activities: framing, openings, penetrations, and flashings.	p.15/29	Illustrated Guide Achieving Airtight Buildings
	Typical Air Leakage Paths	A series of diagrams illustrating typical air leakage paths.	p.13-17	Illustrated Guide Energy Efficiency Requirements for Houses in BC - Zones 5 to 7A
	Checklists for Airtightness	Comprehensive forms for air barrier design, construction, testing, and reporting	p. 23-25/29	Illustrated Guide Achieving Airtight Buildings
	Retrofitting for Airtightness	List of airtightness retrofit procedures, table of content linked to diagrams/explanations for each procedure.	p.16-17	Best Practice Guide Air Sealing and Insulation Retrofits - For Single Family Homes
	Airtightness Requirements Based on Various Standards	Table with airtightness requirements and reference test standard based on different rating standards/codes used in BC.	All	Illustrated Guide - Achieving Airtight Buildings - Appendix A
	How to draft proof an existing house?	An FAQ with general information on existing home draft proofing.	All	Clean BC Better Homes website
	Airtightness Training Course	A link to a full-day hands-on training course on airtightness delivered by Small Planet Supply in partnership with the BC Institute of Technology.	all	BCIT Airtightness Training
3.2.2	***Airtightness Detailing***			
	Detailing: Above Grade Walls Air Barrier Strategies	Diagrams and descriptions of both exterior and interior air barrier systems.	p.94-96	BC Energy Step Code - Builder Guide
	Detailing: Roof Air Barrier Strategies	Diagrams and descriptions of roof air barrier systems, e.g., sheathing membrane, sealed polyethylene, and sealed interior sheathing,	p.97	BC Energy Step Code - Builder Guide

	Resource	Short Description	Pages	Document
	Detailing: Below Grade Concrete Air Barrier Strategies	Diagrams and descriptions of roof air barrier systems, e.g., sheathing membrane, sealed polyethylene, and sealed interior sheathing,	p.98	BC Energy Step Code - Builder Guide
	Detailing: Detailing Overview	Overview and diagram outlining the key aspects of detailing for airtight construction.	p.99	BC Energy Step Code - Builder Guide
	Comparison of Air Barrier Strategies	A concise comparison of benefits and limitations of eight air barrier strategies, including sealed polyethylene, airtight drywall, spray foam, sealed exterior sheeting and more.	p.65/242	Guide for Designing Energy Efficient Building Enclosures
3.2.3	***Airtightness Transitions***			
	Transitions: Roof-to-Wall Air Barrier Transition Details	Diagrams and descriptions of typical roof-to-wall transitions, including parapet and sloped roof construction.	p.102-104	BC Energy Step Code - Builder Guide
	Transitions: Window and Door Air Barrier Transition Details	Diagrams and descriptions of two common window and door transitions: back-dam and backer rod with sealant.	p.104	BC Energy Step Code - Builder Guide
	Transitions: Above Grade Wall to Foundation Wall Transition Detail	Diagrams and descriptions of three common transitions: taped membrane, spray foam, membrane pre-strip.	p.105	BC Energy Step Code - Builder Guide
	Transitions: Foundation Wall to Slab-on-Grade Air Barrier Transition Details	Diagrams and descriptions of three common transitions: taped/sealed membrane, slab sealant, taped insulation.	p.106	BC Energy Step Code - Builder Guide
3.3	**Mechanical Systems**			
	Mechanical Equipment Selection Examples for All Climate Zones	Table for each climate zone in BC with examples of mechanical systems to choose based on the Step of the Step Code to be achieved.	p.47-52	BC Energy Step Code - Builder Guide

	Resource	Short Description	Pages	Document
	Overview of High-Performance HVAC Systems	An overview of HVAC systems, sizing of equipment, and installation and commissioning.	p.107-108	BC Energy Step Code - Builder Guide
	Overview of Common Heating and Cooling Systems	An overview of gas furnaces, electric baseboards, hydronic systems, and heat pumps.	p.109-110	BC Energy Step Code - Builder Guide
	FAQ for Heat Pumps, Gas Furnaces/Boilers/Appliances	An FAQ with general information on HVAC systems	All	Clean BC Better Homes website
	Heat Pumps vs Natural Gas -Which is Better?	A short article comparing the pros/cons of electric heat pumps vs natural gas heating.	All	Pembina Website
	Ventilation Systems	An overview of ventilation options: dedicated air inlet and exhaust fan, makeup air systems, ventilation heat recovery.	p.111-112	BC Energy Step Code - Builder Guide
	FAQ for Ventilation Systems: HRVs and Exhaust Fans	An FAQ with general information on HRVs and kitchen/washroom exhaust.	all	Clean BC Better Homes website
	Domestic Hot Water Systems	A one-pager on domestic hot water systems options: tank-type, tankless, and drain water heat recovery.	p.113	BC Energy Step Code - Builder Guide
	FAQ for Domestic Water Heating	An FAQ with general information on water heating technologies.	All	Clean BC Better Homes website
	Heat and Energy Recovery Ventilation Concepts	Detailed information on HRV/ERV components, operation, benefits, energy and cost savings	p.14/59 - 17/59	Heat recovery ventilation guide for houses
	Heat and Energy Recovery Ventilation System Design and Installation	Step-by-step overview of design considerations, including code requirements, system configuration selection, HRV/ERV selection, layout and sizing.	p.21/59- 30/59	Heat recovery ventilation guide for houses
	Heat and Energy Recovery Ventilation Checklist	Checklists for HRV/ERV design and installation.	p.32-34/59	Heat recovery ventilation guide for houses

	Resource	Short Description	Pages	Document
	Residential HVAC Training Courses	Training courses offered by the Thermal Environmental Comfort Association (TECA) on forced air guidelines, heat loss / heat gain, heat recovery ventilation design and installation, hydronic system design, principles of moving air, and ventilation guidelines.	all	TECA Training Courses
4.0	**My Process**			
4.1	**Energy Advisors**			
	How to find an Energy Advisor	Link to the BC Step Code website with an overview of the role of the Energy Advisor (EA) and several links to find an EA near you.	All	BC Energy Step Code Website
	More Resources to find an Energy Advisor	Link to the CleanBC Better Homes website with a search database to find an Energy Advisor near you.	All	Clean BC Better Homes website
	Search for an Energy Advisor by Postal Code	Link to the NRCan website where you can find an Energy Advisor by postal code.	All	NRCan Home Improvement Website
	Search for an Energy Advisor by City/Municipality	Link to the Clean BC Better Homes website, where you can find Energy Advisors by location.	All	Clean BC Better Homes website
	Support and Information for Energy Advisors	Link to the Canadian Association of Consulting Energy Advisors (CACAE) website.	All	Canadian Association of Consulting Energy Advisors (CACAE) website
	Technical Bulletin B19-03: Guidelines for Energy Advisors	Bulletin from the BC Government on setting Airtightness Values for Energy Modelling of Part 9 Buildings for Compliance with the BC Energy Step Code (PDF). Information on Energuide Rating System modelling and air tightness requirements and decisions paths.	All	BC Gvt Technical Bulletin
	Technical Bulletin B19-02: Step 1 in the BC Energy Step Code	Bulletin from the BC Government on Airtightness, Enhanced Compliance and Compliance Paths (PDF) and information on the differences between ERS path and 9.36.5 path	All	BC Gvt Technical Bulletin
	Technical Bulleting B19-01: Complying with Step	Bulletin from the BC Government with basic information on the Step Code, requirements for permit application and building completion, info on air tightness.	All	BC Gvt Technical Bulletin

	Resource	Short Description	Pages	Document
	1 of the BC Energy Step Code for Part 9 Buildings			
4.2	**Contractors/Builders**			
	How do you choose the right contractor?	FAQs and tips and tricks on selecting a contractor.	All	Clean BC Better Homes website
	What is a Program Registered Contractor?	Information and directory on program registered insulation contractors.	All	Clean BC Better Homes website
4.3	**Compliance Forms**			
	Step Code Compliance Form for Part 9 Buildings	Website with all compliance forms, including Excel tools.	All	BC Energy Step Code Website
	EnerGuide Rating System - Energy Advisor Requirements	Short description of what documents energy advisors need to adhere to.	p.6	Instruction Manual: BC Energy Compliance Report for (some) Part 9 Buildings
	Instructions for Energy Step Code Compliance Calculator and Report Generator	Instructions on how to complete various sections of the Step Code Excel Compliance tool.	p.6-17	Instruction Manual: BC Energy Compliance Report for (some) Part 9 Buildings
	What are the Energy-Efficiency Requirements for New Homes in the City of Vancouver?	Website for residential buildings under 6 stories, with details on the "new homes energy checklist", building requirements (envelope, mechanical, reporting and documentation), and floor area exclusions.	All	City of Vancouver Website: Energy-efficiency requirements and resources for new homes up to 6 storeys
4.4	**Cost/Incentives/Catalysts**			

	Resource	Short Description	Pages	Document
	Incentive Database for Homes in BC	Link to the CleanBC Better Homes rebate program - use the search functions to find all applicable rebates.	All	Clean BC Better Homes website
	Incremental Capital Cost of Building to Step Code - Overview	Description of incremental cap cost and table showing % increase based on building type and climate zone.	p.47-48/129	2018 Metrics Research Full Report Update
	Incremental Capital Cost of Building to Step Code - Detailed	Table with incremental capital cost for different typical energy conservation measure combinations, by climate zone and by Step.	p.104-107/129	2018 Metrics Research Full Report Update
	CMHC Incentives on Mortgage Loan Insurance for Energy Efficient Homes	Incentive information from CMHC for energy efficient homes	All	CHMC Website
	City of Vancouver Passive House Relaxations - Guidelines for Residences in RS Districts	City of Vancouver - Passive House relaxations provide a compelling argument to pursue the certification.	All	City of Vancouver Passive House Relaxations - Guidelines for Residences in RS Districts
	City of Vancouver Data Collection Initiative – Nearzero.ca	Initiative to collect data from residential low-carbon/energy construction in the City of Vancouver, including financial incentives.	All	http://nearzero.ca/