Enabling High-Performance Gentle Density:
A Practical Guide for Housing Professionals

small housing

Prepared by
Pinna Sustainability

Land Acknowledgement

As this guide is intended to address all of the area now known as British Columbia, Small Housing BC would like to acknowledge the many First Nations whose traditional and unceded territories are affected by this work. Without the stewardship of these First Nations, overseeing and protecting these lands since time immemorial, we would not be able to enjoy the benefits of working and living as we do now. We are grateful for this stewardship and are committed to working with First Nations to continue to ensure the lands and waters around our homes are protected.

About Small Housing

At the heart of Small Housing's vision is a simple concept - affordable and high-quality housing, accessible to all and built in appealing ways that strengthen communities. We recognize that the old approach to housing is not sustainable, and we work with builders, trades, governments, banks, and communities themselves to ensure that future generations of Canadians will have access to beautiful and resilient homes in strong, growing communities.

Acknowledgements

This guide is built on insights from many professionals in these fields and data from thousands of recent construction projects across British Columbia. Small Housing BC, Pinna Sustainability Inc., and Bernhardt Contracting Ltd. worked collaboratively to develop this guide, supported by graphic design from Mika Creative. We are incredibly grateful to the individuals and organizations who generously supported us in preparing this resource. It wouldn't have been possible without them.

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Unlocking the Potential of Gentle Density in a Changing Landscape

Gentle density housing (GDH) is a powerful way to create more housing options in our neighbourhoods without changing their unique feel. Adding laneway homes, duplexes, and other smaller homes to existing neighbourhoods isn't a new idea - but with our population growing much faster than our housing supply, it's never been more urgent. It's also essential that new homes support both the needs of their residents and their neighbourhoods. Our provincial government has set ambitious, crucial goals for greener, more resilient homes, leading to more low carbon systems and better building methods. These changes are important and welcome but also bring some challenges for the construction industry, especially for those building high performance gentle density homes.

Key considerations that will emerge throughout this guide include:

- **Lot size -** GDH generally uses most of the available lot space, so setback requirements can add tough challenges.
- **Unit size -** Units in GDH are efficiently sized, but adding certain high performance features (such as double-stud walls) can cut down on the available space.
- **Electrical loads** - Builds with multiple units face increased calculated electrical loads which can require costly system upgrades, if no power efficient design strategies are used.
- **Aesthetics** - Visual appeal of a home is important, and keeping builds efficient can't come at the cost of making our neighbourhoods bland.
- **Air Barrier Integrity -** High performance GDH often uses high R-value assemblies. In these cases, the air barrier system plays a particularly critical role in keeping out moisture and preventing mold and rot over time.

Each site is different, and any challenge can be solved with proper care and collaboration between those involved in the building process. That's what this guide is all about.

__Photo:__ the "Bird's Wing" passivehaus project, a great real world example of high-performance gentle density housing that utilizes many of the best practices in this guide.

Credit: OneSeed Architecture

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Introduction

What Does High Performance Mean?

In this guide, we define *high performance* as meeting the upper steps of the BC Energy Step Code— Step 4 or 5 for Part 9 buildings. The BC Energy Step Code sets energy efficiency standards for homes, and homes that reach Step 4 or 5 are built to be more energy-efficient, comfortable, and climate-resilient, using high-efficiency systems, better insulation, and airtight construction.

Understanding the Performance Path

The BC Energy Step Code uses a **performance-based** approach[1], meaning the home is evaluated as a whole system—not just by individual components like insulation or window type.

This gives design teams and builders flexibility. For example:

- A home with many large windows might offset heat loss with extra insulation elsewhere.
- Exceptional airtightness might reduce the need for high insulation R-values.

Performance Path Options

WINDOWS		INSULATION		AIR TIGHTNESS	
Efficient	+	High (R24)	+	Average	✓
Inefficient	+	High (R24)	+	Good	✓
Inefficient	+	Low (R18)	+	Average	✗
Efficient	+	High (R24)	+	Good	✓ +

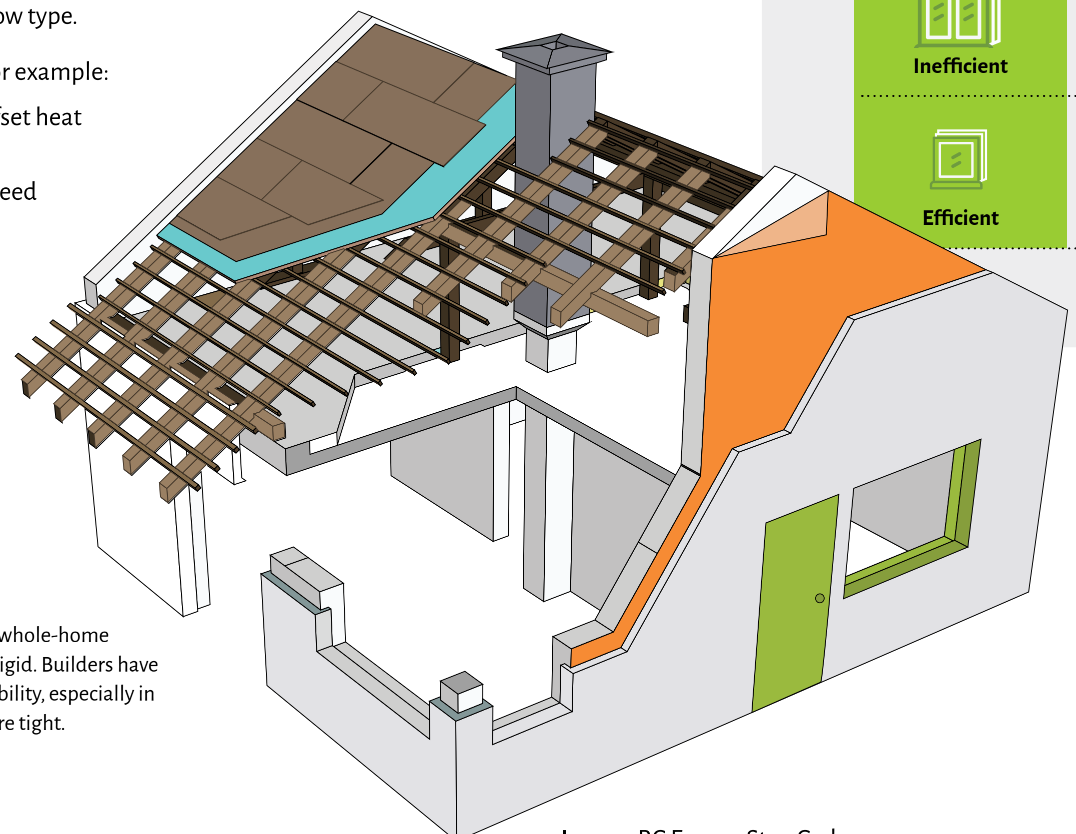


Image: BC Energy Step Code

1 While a **prescriptive** approach—which doesn't involve whole-home testing—is sometimes available to meet Step 3, it is quite rigid. Builders have more commonly used the performance path for its adaptability, especially in compact, gentle density projects where space and layout are tight.

Everyone Has a Role to Play

Delivering high-performance gentle density housing takes collaboration and open communication across the entire building industry. Each player brings a critical piece to the puzzle:

- **Local Authorities (planners, plan checkers and inspectors)** shape zoning, permitting, and inspections that enable performance-focused small-scale housing.
- **Design teams**, which include building designers, architects**,** and other participants in the design process, create homes that meet energy targets through early collaboration, thoughtful layout, envelope detailing, and system integration.
- **Builders and trades** bring designs to life with precision—executing air barrier systems, insulation, and sequencing to meet standards.
- **Energy advisors (EAs) /modellers** analyze designs and guide teams toward meeting performance goals.
- **Mechanical contractors** size, install, and commission efficient systems that fit tight spaces and meet comfort needs.
- **Homeowners** benefit from better homes—and help drive demand for high-performance gentle density in their communities.

This guide offers practical insights for three of these groups: Local Authorities, Design Teams and Mechanical Contractors. Additional resources applicable to each group are also in the appendix. This guide offers recommendations and best practices for high-performance gentle density housing; it is not a regulatory document, and practitioners are responsible for understanding and complying with the specific requirements relevant to their roles and projects.

While you'll find the most value in the section related to your area of work, remember that building is a team effort! We encourage everyone to read all sections to see how you can support your colleagues and help complete projects faster, more affordably, and with higher quality.

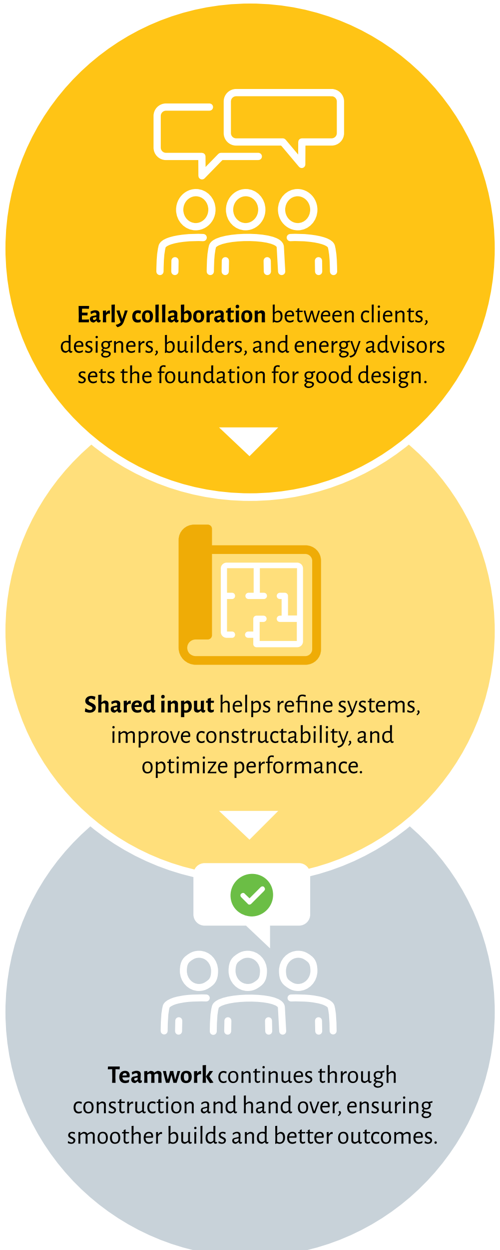
Working Together from the Start

High-performance gentle density homes are most successful when the key people involved—design teams, builders, mechanical contractors, energy advisors, and clients—work together early. Approaching design as a shared, iterative process helps unlock smarter solutions. It ensures mechanical systems, constructibility, and long-term performance are considered from day one—reducing revisions, delays, and stress down the line.

Why it matters:

Early collaboration gets the right people at the table before construction begins. While the conventional build process spends time and money resolving issues as they arise on-site, a collaborative approach addresses concerns in advance. A few well-timed meetings can lead to better permit submissions, smoother builds, quicker timelines, and long-term savings.

The most successful gentle density projects maintain that spirit of teamwork from start to finish.



Recommendations for Local Authorities

Building high-performance GDH requires strong collaboration across local government departments and industry. This guide focuses on three key local authority roles that shape the success of these projects:

- **Planners** who shape the zoning and policy framework that enable gentle density.
- **Plan checkers** who ensure designs meet building codes and performance standards.
- **Inspectors** who verify that construction aligns with approved plans, codes, and quality benchmarks.

We also provide some guidance for **managers** and other local authorities, whose work influences each of the roles above. This section offers practical guidance for each role, along with recommendations to streamline the permitting process from early-stage planning to final occupancy.

You'll find insights on:

- Zoning and design that support gentle density success
- Performance-conscious design guidelines
- Approving high-performance housing
- Managing departmental capacity constraints

Whether you're reviewing plans, inspecting and approving construction, or writing policy, this section is designed to support and clarify how to support high-performance housing in your community.

Zoning and Design that Support Gentle Density Success

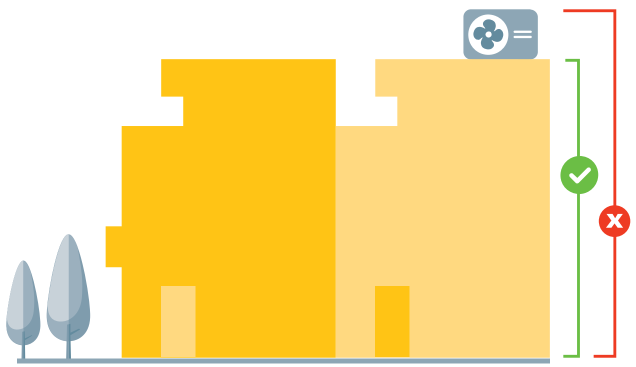
Height, setbacks, parking, and noise requirements are the biggest zoning-based restrictions faced by designers of high-performance GDH. Local authorities can play a role in enabling better housing outcomes by reviewing how these bylaws affect small-scale builds. Here are some practical ways zoning can better support high-performance housing:

Rethink Height Restrictions

Avoid special height restrictions for infill homes—especially gentle density that penalize high-performance GDH designs. For example, mechanical and electrical equipment (like heat pumps or ventilation units) may need to be placed on rooftops.

Recommendation: Avoid the requirement for stepped building forms to comply with sloping max building height requirements.

Recommendation: Consider exemptions or relaxed height limits for rooftop equipment on gentle density projects.[2]

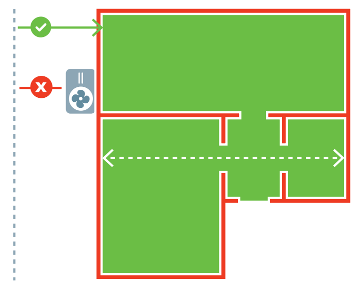


Use Interior Floor Area for Calculations

High-performance homes often use thicker exterior walls (e.g., double-stud) to improve insulation. But if zoning bylaws measure floor area from the outside of the walls, these designs are penalized — reducing usable interior space.

Recommendation: Base floor area calculations on interior dimensions. This encourages better building envelopes without compromising livable space.

Alternative: Exemptions to floor area restrictions, such as [those implemented by City of Vancouver](), are another way to avoid penalizing high performance builds.

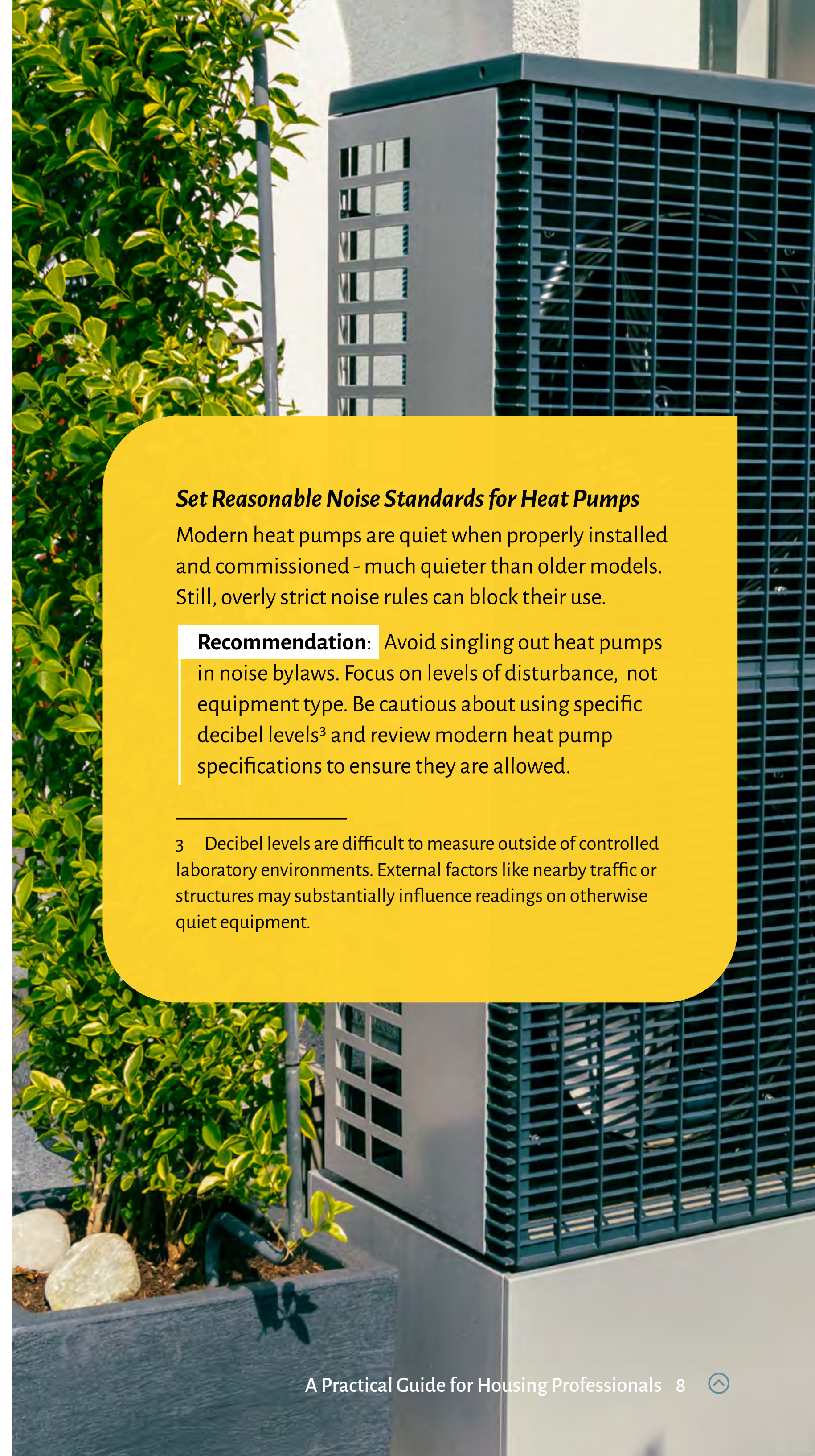


Provide Flexibility with Setbacks

Setbacks can limit the placement of thicker walls, mechanical systems, or shading devices.

Priority Recommendation: Define setbacks as the distance between the lot line and interior liveable square footage, but also consider the importance of consistency with neighbouring AHJs.

Recommendation: Ensure that setback exemptions allow for high-performance features like heat pumps.



Set Reasonable Noise Standards for Heat Pumps

Modern heat pumps are quiet when properly installed and commissioned - much quieter than older models. Still, overly strict noise rules can block their use.

Recommendation: Avoid singling out heat pumps in noise bylaws. Focus on levels of disturbance, not equipment type. Be cautious about using specific decibel levels[3] and review modern heat pump specifications to ensure they are allowed.

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2 For example, the City of Vancouver provides up to a 1.0m conditional height bonus to certain builds which meet the Passive House standard.

3 Decibel levels are difficult to measure outside of controlled laboratory environments. External factors like nearby traffic or structures may substantially influence readings on otherwise quiet equipment.

Performance-Conscious Design Guidelines

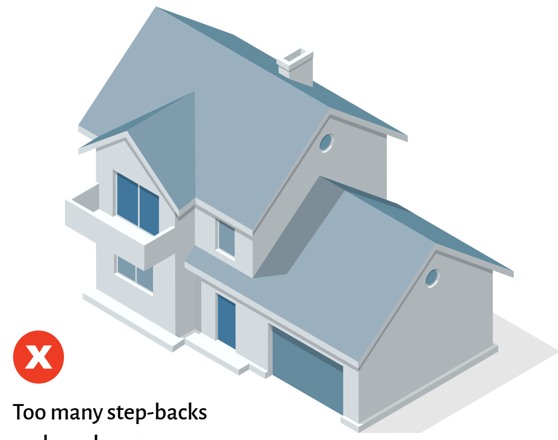
Design guidelines should champion, not prohibit, high-efficiency buildings. Character and efficiency can go hand-in-hand!

Avoid Envelope Disruption

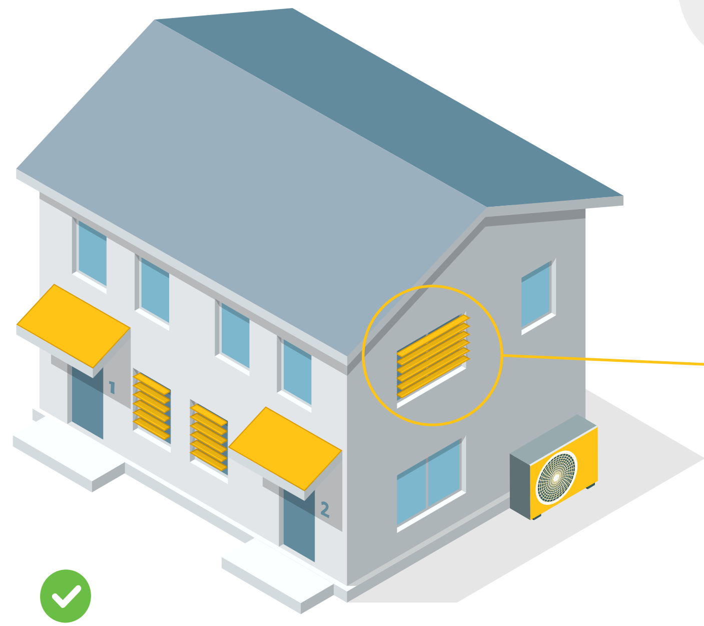
GDH projects can occasionally straddle the Part 3/Part 9 line, making guidance on both types of buildings relevant. Features like numerous step-backs or corners break the continuous building envelope, making efficiency harder to achieve. Design interest doesn't have to come at the cost of performance.

Recommendations:

- **Encourage simple, compact forms** and provide examples within form and character guidelines (or other similar documents). If step-backs are required, limit them to a single transition between floors.
- **Favour elements like porches, awnings, or pergolas**. These add character and shape without impacting the continuous envelope.
- **Discourage overhangs** in the building envelope that do not serve a clear passive design function, since they complicate air barrier system continuity and increase thermal bridging - both highly impactful components of building performance.



Too many step-backs and overhangs.



Simple, compact forms and passive shading devices.

Examples of Problematic Language in Form and Character Guidelines:

"Façades should include a variety of projections and recesses to create visual interest and avoid monotony."

"New developments should echo the architectural rhythm of adjacent buildings through stepped massing and articulated volumes."

These aren't bad things necessarily, but they are likely to drive designers away from choices that add visual interest without compromising energy efficiency.

Encourage Solar Strategies

Proper siting and orientation improve passive solar gain and reduce energy demand.

Recommendation: Support guidelines that prioritize solar access and encourage passive shading devices and encourage new developments to consider these, even if formal guidelines don't yet exist in your jurisdiction.

Approving High-Performance Gentle Density Housing

Modern homes are complex systems and reviewing them in a timely manner can be challenging. Local authorities also face unique pressures to approve projects and act as unpaid project managers. To address these challenges:

Look for Outliers to Deal with Variations in Design Choices

The performance-based approach of the BC Energy Step Code brings welcome flexibility for design teams and their clients, but it also means local authorities may see a lot of variety in homes built in their areas.

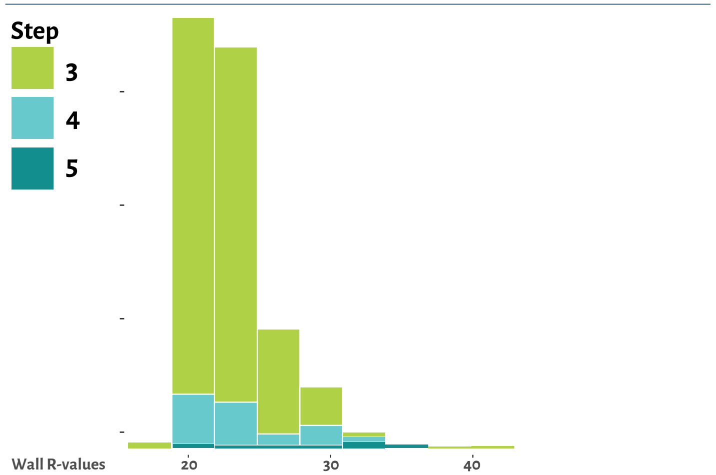


Figure 1 shows a range of wall R-values used in a set of gentle density (<1500 sq ft or MURB) projects since 2020[4]. The data shows that there is a wide range of wall R-values used, even in projects that reach the same step level. The result is that it can be hard or impossible to know if a building will be good enough based just by focusing on one measure like R-value. Instead, we encourage local authorities to observe trends and watch for outliers in multiple variables that warrant closer inspection.

4 Data from Bernhardt Contracting LLC represents figures from new housing projects on which Bernhardt Contracting has advised.

Recommendation: Expect some variation across projects. Track trends and look for projects with outliers in multiple areas such as:

- R-Values
- Window to wall ratio
- Window area
- Wall surface area
- TEDI
- MEUI
- NLA/NLR (Air tightness)

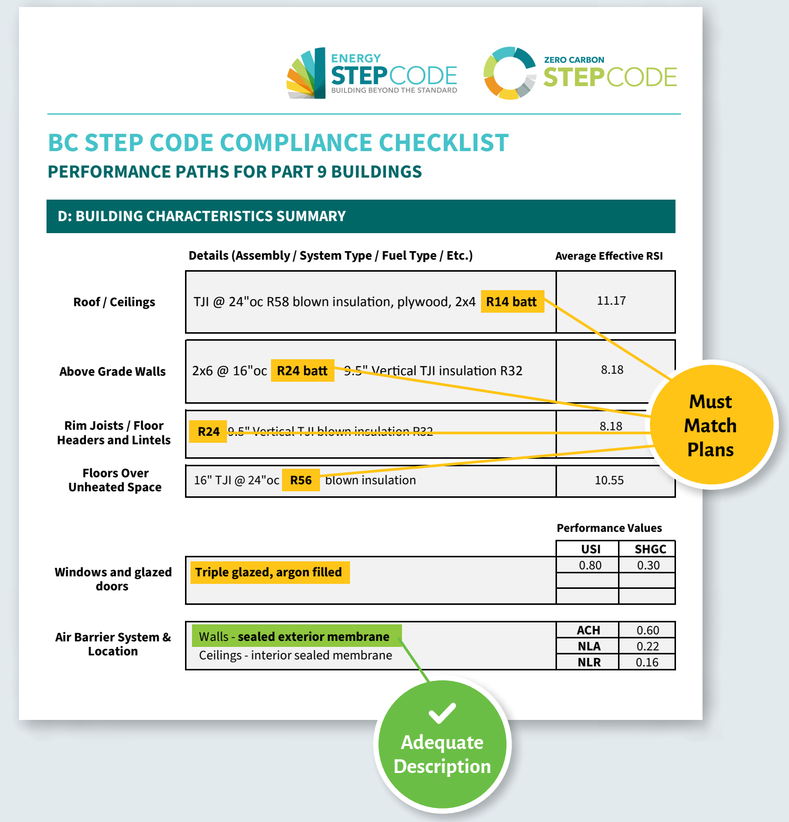
Utilize the BC Energy Step Code Checklist Guide

Beyond looking at outliers for clues, the best point of reference for local authorities is a complete BC Step Code Compliance Checklist, which considers the holistic performance of the building. The Checklist has both a base and a detailed report found on the 'Pre-Con Checklist' and 'Pre-Con HOT2000 details' tabs respectively. In most cases, the base report (see example below), together with other more basic design documents, should contain all the information required to verify a building's energy performance is compliant. In other cases (like those where values appear to be outliers), the detailed report can provide more context to how the energy modeler has built their model.

As an additional benefit, the Checklist has publicly available guides to support builders in completing it and to support officials in interpreting its outputs.

Building departments can ensure that they are clear in communicating what they need to see from builders. The best method for this is to assemble publicly available checklists that clearly detail what documents are required to support applications.

Recommendation: Request both the base (Pre-Con Checklist) and detailed report (Pre-Con HOT2000 details) from the BC Step Code Compliance Checklist.



Understand CSA F280 Calculations

The BC Building Code requires that new Part 9 builds present CSA F280 calculations that estimate the heating and cooling requirements for each room and/or unit in the building[5]. This helps assure plan checkers and inspectors that adequate heating and cooling capacity has been considered and designed for each unit. The BC Energy Step Code and Zero Carbon Step Code Handbook for Building Officials from BOABC is a great resource for local authorities to reference and includes examples of how to interpret the CSA F280.

Reports on CSA F280 calculations are often not requested by building departments. This omission often leads to poor performing mechanical systems and difficulties down the line for occupants.

Recommendation: Plan checkers can look for common/glaring problems on CSA F280 calculation reports, such as:

- Do the room sizes on the report match those in the plans?
- Are the heating and cooling loads different between units/builds?

Recommendation: On site, inspectors can also make use of the room-by-room reports by:

- Verifying that **documents substantially match the building** (e.g., same number and size of rooms).
- Verifying that any **heating or cooling equipment has a sufficient capacity to** comfortably cover the total heating/cooling loads in the report (see example on right). For example, inspectors should reject a heating system which shows a maximum heating or cooling capacity of 30,000 BTUs if the CSA F280 calculations demonstrate a need for 40,000 BTUs.

5 Although HOT2000 is commonly preferred by Energy Advisors, officials should note that it is NOT a substitute for a CSA F280 submission and CANNOT be used for the sizing of mechanical equipment

CSA F280 calculations are prepared according to a rigid methodology. A drawback is that it does not allow modelers to properly consider future changes in climate loads. This further increases the importance of ensuring sufficient cooling capacity (above and beyond what the CSAF280 states is required) will be installed.

Equipment label:

Equipment serial number indicates: **Nominal Cooling Capacity**

036 = 36,000 BTUs

36,000 BTUs are:

Sufficient for main house

Insufficient for combined house & suite

Energy Assessment:

wrightsoft **Load Short Form: Entire House**

HEATING EQUIPMENT	COOLING EQUIPMENT
Make Generic	Make Generic
Trade	Trade
Model SEER 16.0, HSPF 8	Cond SEER 16.0, HSPF 8
AHRI ref	Coil
Efficiency	AHRI ref
Heating input	Efficiency
Heating output	Sensible cooling
Temperature rise	Latent cooling
Actual air flow	Total cooling
Air flow factor	Actual air flow
Static pressure	Air flow factor
Space thermostat	Static pressure
Capacity balance point = 18 °F	Load sensible heat ratio

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
Secondary Suite	-	4500	-	-	-
Main Home	-	34800	-	-	-
Other equip loads		-	-		
Equip. @ 0.80 RSM			-		
Latent cooling			-		
TOTALS	-	39300	-	-	-

Aim for Consistency

Other small practices can help local authorities receive consistent and accurate information from builders.

Priority Recommendation: Wherever possible, local authorities should try to align their documentation requirements with other neighbouring jurisdictions to reduce the time builders must spend determining requirements specific to each location. This further supports using the standard BC Step Code Compliance Checklist, and refraining from modifying it.

Recommendation: Local authority checklists are encouraged to emphasize the need for factual consistency between various aspects of the drawing packages, particularly with respect to the Compliance Checklist and drawings. For example, heated areas in energy reports should exactly match what is shown in drawings. Failure to reject proposals that do not meet this basic requirement will result in additional confusion for officials, especially inspectors who will be left to reconcile differences in multiple documents *and* any differences in the on-site product.

Managing Departmental Capacity

Local authorities face unique pressures. High application volumes, the need to avoid delays, and the pressure to guide builders through fixes can really strain department capacity. To mitigate this, departments can reduce the amount of information they must sift through and reduce the number of pitfalls for design teams and builders.

Streamlining Your Process

Priority Recommendation: Keep energy performance document requirements lean. To receive a building permit, limit required documents to just two: the BC Step Code Compliance Checklist and room-by-room CSA F280 calculations. Other details—like heat pump model numbers[6], or Energuide labels—often aren't available until later in the build process.

We strongly recommend AHJs do **not** request HOT2000 full house reports. The tool is no longer updated and any information it would contain should be available through the detailed report of the Compliance Checklist.

Recommendation: Advocate for flexibility. Support exemptions (like for height or setback rules) that give design teams room to meet performance goals without triggering redesigns and advocate for policies that allow greater delegated authority in the department.

Recommendation: Streamline approvals in special zones. For areas with special ordinances (like Development Permit Areas), consider exempting high-performance gentle density homes or delegate these projects to staff, bypassing council approval. This small step reduces delays and workload. Ultimately, an Official Community Plan (OCP) that effectively aligns zoning regulations with broader objectives can eliminate the need for the development permit process entirely.

6 We think there is value in requesting heat pump models as an optional, preferably incentivized detail during permitting, since it encourages builders to collaborate with mechanical contractors sooner. However, making this a hard requirement is likely to cause delays and frustrations.

Focus on Problem Areas

While every project is unique, building departments can streamline reviews by focusing on common, high-impact issues.

Recommendations for Plan Checkers:

- **Check external system siting.** Heat pumps and Pad Mounted Transformers (PMTs) can be hard to place on small lots. Flag potential issues early—especially around setbacks, noise, and fire access—and ensure inspectors are aware.
- **Be sure your team is aware of evolving regulations** around utilities as Bill 44 has implications for previous practices need to be revised.
- **Get to know Energy Advisors**. If an advisor consistently provides results that seem lower than comparable builds, take a closer look. Also be wary of design teams or builders who frequently switch advisors, as this can lead to miscommunication or inconsistencies.
- **Seek out training on energy modeling.** Your jurisdiction may be willing to host this, or you can refer to this video guide to the BC Step Code Checklist. The best information for plan checkers starts around 1 hour, 40 minutes. This document also provides instructions for proper completion of the checklist.

Recommendations for Inspectors (and Plan Checkers On-Site):

- **Observe general workmanship**. On-site observations about overall work quality can signal how closely to scrutinize key assemblies. Issues like poor foundation insulation or framing (e.g., assemblies not matching plans) suggest later work needs closer inspection.
- **Match R-values and assemblies**. Confirm that assemblies and R-values match the BC Energy Step Code Compliance Checklist—not just the plans. Trades often overlook the energy report, leading to incorrect construction.
- **Verify windows.** Confirm sizes, locations, and counts match the approved plans and that performance labels are present. Variations can significantly affect performance and require a revised energy report. Ensure the energy report is available on-site.

- ***Be especially thorough with builds designed within 5% of envelope or mechanical performance criteria, as small changes can cause failure.***
- **Be aware of unique issues with secondary suites.** Confirm that each suite has independent temperature control and complies with legal requirements. Watch for builds that appear to include multiple suites where only one is permitted—these may be unpermitted and often lack proper ventilation and controls, which can negatively impact both performance and code compliance.

Working with Energy Advisors

The sections above have highlighted the key energy performance documents to check and some important values on them. Many have to do with ensuring common sense and consistency, however to confidently perform due diligence, plan checkers should also be aware of common Energy Advisor assumptions or misconceptions. These often show up as unexpected values or missing items on energy reports and result in the need for further conversation with the project EA.

Recommendations for all Part 9 buildings:

- As above, **we recommend that AHJs request the detailed report** (Pre-Con HOT 2000 details tab) from the Compliance Checklist in submission package. It provides detailed inputs, window specifics, and system selections. In all cases, ensure submissions match building plans.
- **Watch for red flags.**
  - **Inconsistencies** between the energy model and plans (e.g., heated floor area).
  - **Unrealistic performance**—e.g., a Step 4 home with minimal insulation (R20) in a cold climate like Fort St. John. Check model details: Is the proposed air barrier performance consistent with the builder's experience level? Are windows missing? This might explain it.
  - **Identical results** for noticeably different units (e.g., different orientation or glazing). This may indicate overuse of "copy-paste."
- **Know what EAs can and can't confirm.**
  - EAs estimate mechanical system performance—they don't select model numbers.
  - EAs know window size, number, placement, and performance—not specific manufacturers.
  - EAs estimate air barrier system performance—they don't select specific construction techniques.
- **Build relationships** with a few different Energy Advisors in your region. They can be a great resource for confirming if something looks typical or flag when something doesn't.

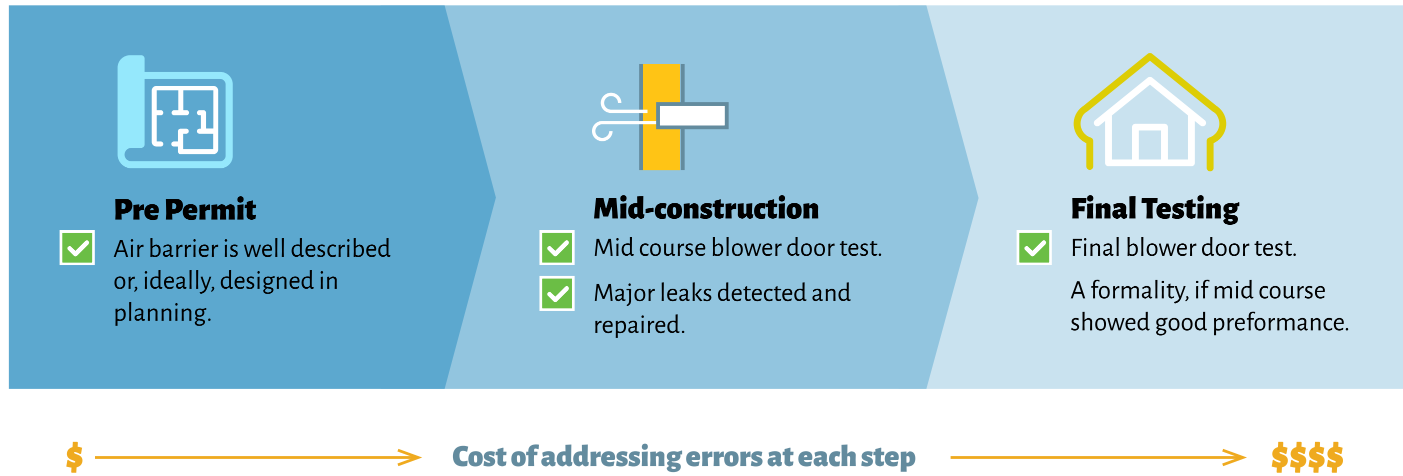
Understanding Challenges to High Performance Building Techniques

Air Barrier System Testing - A Phased Approach:

Air barrier system quality should be evaluated throughout the project, either directly or indirectly. The most critical point, however, is a mid-construction test. A mid-course blower door test is a clear best practice, giving builders a chance to find and fix issues *before* insulation, drywall, and final testing. Builders should aim for the final test to be a mere formality. Failing at this stage is typically expensive, with very limited options for fixes.

Recommendation: Incentivize and encourage mid-course blower door tests, especially for less experienced builders and builds whose energy models suggest they will be close to step code thresholds.

Recommendation: Officials can **keep data from all stages** (pre-permit, mid-construction, and final test) for their own analysis.



Supporting Increased Care with Heat Pump Installations

Heat pump systems in well-insulated buildings are increasingly common; however, many designers, architects, and builders were trained on fossil fuel based systems suited to less airtight envelopes, which can sometimes result in unintended design challenges. Proper heat pump setup is crucial, but building officials should know that good design, installation, and commissioning (including ducting) remain a key challenge. Currently, BC has few or no formal training requirements for mechanical contractors, who typically size heat pumps, install ducts, and commission units.

Supporting increased care in these contexts therefore means encouraging:

- Earlier and higher-quality design submissions
- CSA F280 load calculations and duct designs are completed by qualified professionals, and
- That noise, electrical capacity, and maintenance access issues are addressed before installation.

Authorities have a key role to play in setting expectations, offering clear guidance, and incentivizing professional training to raise the quality of installations in GDH and beyond.

Recommendations for all AHJs: Authorities should consider:

- Requiring specific permits for mechanical systems.
- Offering incentives for early submission of mechanical system designs by trained professionals.
- Collaborating with Technical Safety BC (TSBC) by ensuring permits have been properly obtained and by incentivizing those performing HVAC work in their jurisdiction to register and use TSBC educational resources.

Recommendations for AHJs with delegated authority from TSBC:

Authorities should consider:

- Requiring or incentivizing early electrical load calculations (including CSA F280 heat loss/heat gain calculations) and coordination with utilities, while promoting education and adoption of load management strategies to minimize the cost of electrical service, panel size, and grid demand.
- Providing clear guidance on code-compliant routing and leak detection for refrigerant lines. Refrigerant line lengths and placements matter with new A2L refrigerants, which are mildly more flammable, becoming the norm.
- Requiring duct design drawings and post-installation airflow testing for projects with constrained ceiling heights that make appropriate ducting more challenging and efficiency problems more likely. In this context, multi-zone or short ducted mini-split systems can work well but require careful sizing to avoid oversizing and its effects like short cycling.
- Prioritizing locating outdoor and indoor heat pump units in easily serviceable locations, wherever possible, since poor access can lead to skipped commissioning and reduced system life.
- Establishing uniform permitting requirements for all HVAC to ensure that heat pumps face no additional barriers to adoption while maintaining consistent safety and installation standards.

Recommendations for Design Teams

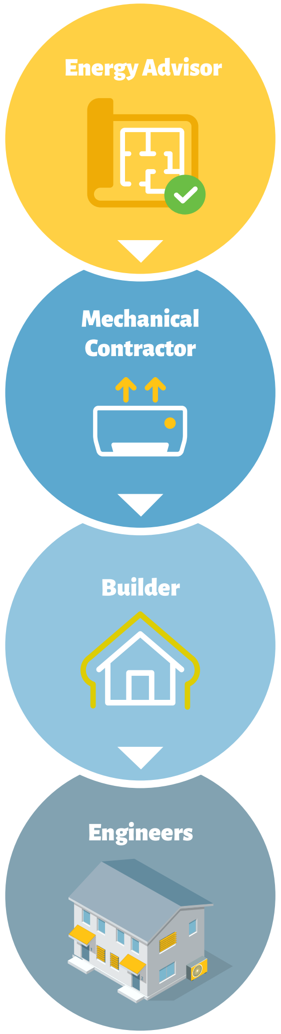
High-performance, gentle density housing starts with smart design. From orientation to envelope, design sets the foundation for homes that are beautiful and functional, while also being energy-efficient, cost-effective, and a good fit for the community.

In this section, you'll find insights on:

- Working Together for Better Design
- Maximizing Performance through Form
- Designing the Building Envelope & Air Barrier
- Communicating Construction Sequencing
- Considering High-Performance Systems in Design
- Managing High Electrical Loads
- Hand-off to Homeowners

Working Together for Better Design

When starting a new GDH design, it's important for design teams to engage key collaborators early in the process. The following list outlines who to meet with and why their input matters in these initial conversations. Whether the designer or the builder is assembling the team, it is essential to meet with these key partners before beginning major design work.



1. **Energy Advisor:** Collaborating with Energy Advisors at the outset of the design process aligns the building design with the project's efficiency goals. Collaborating with your Energy Advisor ensures their Step Code Compliance Checklist aligns with the tender drawings and vice versa, streamlining permit approvals down the road. Qualified EAs can provide high-level location-specific guidance on performance, even before a full schematic design is complete.

2. **Mechanical Contractor:** On a compact lot, it is especially important to collaborate early with the mechanical contractor to ensure the building design and lot layout accommodate key systems—like HRVs, ERVs, ductwork, and heating and cooling appliances—in a way that's both efficient and visually integrated. This is a great way to avoid poor performance and ugly bulkheads in the final design.

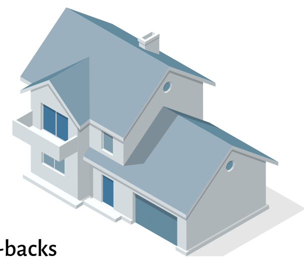
3. **Builder:** Collaborative meetings with the builder can improve their understanding of construction sequencing for key elements, like the air barrier system. It also helps you, as the design team, understand your team's existing expertise.

4. **Engineers:** For homes with complex or unusual designs that exceed the scope of Part 9 structural design, structural engineers must be involved to ensure the structural safety of the home is made a priority. Envelope designers may also be required in these cases.

Maximizing Performance through Form

A building's shape (form factor) has a big impact on energy performance—often more than insulation values alone. Compact and simple forms reduce the number of complex junctions and minimize the skill level required to achieve effective air tightness. Simple forms also reduce surface area relative to volume, resulting in less heat loss. By experimenting with simple forms, you can unlock better energy efficiency outcomes without needing expensive or speciality appliances or systems.

Recommendation: Prioritize simple, compact building forms to improve performance without relying on costly systems, specialty equipment, or envelope consultants.



Too many step-backs and overhangs.

Simple, compact forms.

Good form factor, or a more compact building shape, has a big impact on performance.

Designing the Building Envelope & Air Barrier System

Like the form factor, the building envelope is a key driver of performance in gentle density homes. A well-designed envelope improves comfort, reduces energy use, and supports long-term durability.

Choose the Right Wall Assembly

High-performance envelopes can be tricky to draw and detail—especially with evolving code requirements.

Recommendation: BC Housing's [Illustrated Guide to R22+ Effective Walls in Residential Construction]() compares assemblies by cost, constructability, airtightness, durability, and other factors. Choose an assembly that fits your project and team skill level. Note that there are also assembly options beyond what is included in this guide.

Recommendation: Use envelope material suppliers as a resource for technical questions around envelope details.

Tip: Window selection has a large impact on TEDI. Size is important, but so is the choice of triple or double-pane glazing, low-e coatings, and frames with less thermal bridging (vinyl, fiberglass, thermally broken aluminum).

Design for Airtightness

When it comes to performance, the air barrier system is one of the most important elements. It limits air leakage between the conditioned interior and the outdoors, improving heating and cooling efficiency.

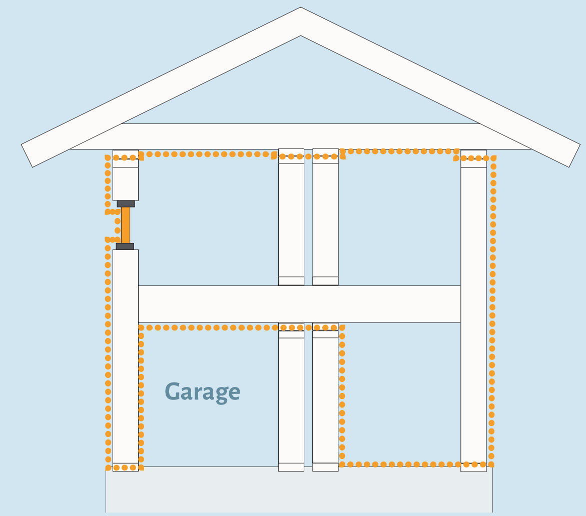
Recommendation: Set an airtightness target early in the design process with your Energy Advisor. This will help determine the best wall assembly to use.

Recommendation: Teams that are less familiar with high-performance construction should use exterior air barriers (just behind the cladding) where possible—they're resistant to damage and often easier to seal well.

Recommendation: Ambitious teams may want to consider external insulation assemblies with internal service cavities[7], which hold advantages for reducing air barrier system penetrations.

Recommendation: Focus on the details. Mark the air barrier system as a continuous line and provide details to builders anywhere where the line is interrupted. Air leaks from small gaps like hose bibs, electrical outlets, and around windows, so air tightness is closely tied with installation quality and attention to detail. Spending time on site with framers is an irreplaceable way to gain an understanding of the pain points.

Tip: Most builders can hit airtightness targets using readily-available materials and careful seam sealing, especially around windows and penetrations, without the need for expensive materials.



7 See page 14 of the Illustrated Guide to R22+ Effective Walls in Residential Construction.

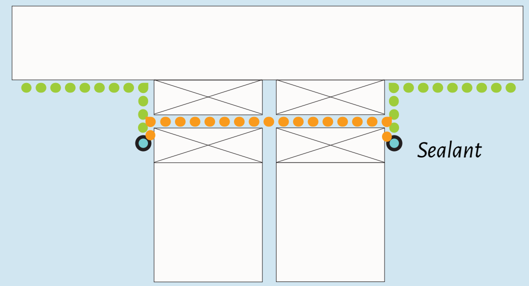
More Ways Design Teams Can Improve Airtightness

Recommendations:

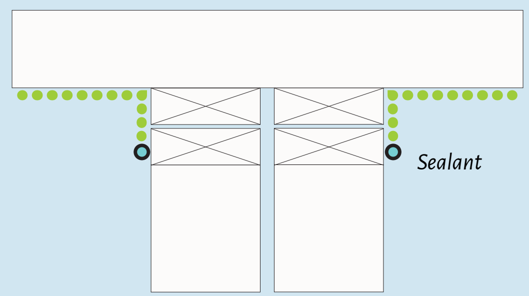
- Install certain air barrier elements during framing (for example, the membranes that wrap the top plates should ideally be installed before the roof trusses).
- Reduce penetrations by selecting specialized appliances (for example, ventless dryers or an HRV[8] in place of bath fans).
- Identify and draw unique or challenging details – design teamss need to understand how the foundation, wall, and ceiling air barriers connect to make a continuous air barrier system and detail any challenging areas to assist those on-site.
- Keep details simple. Avoid designs that require specialized materials. Consider the skill level required to construct the air barrier system when detailing the design and construction sequencing.

Multi-family GDH (like duplexes and multi-plexes) require airtight party walls to achieve net-zero targets. It is important to think about the party-wall-to-exterior-wall detail, and draw it out for those on-site.

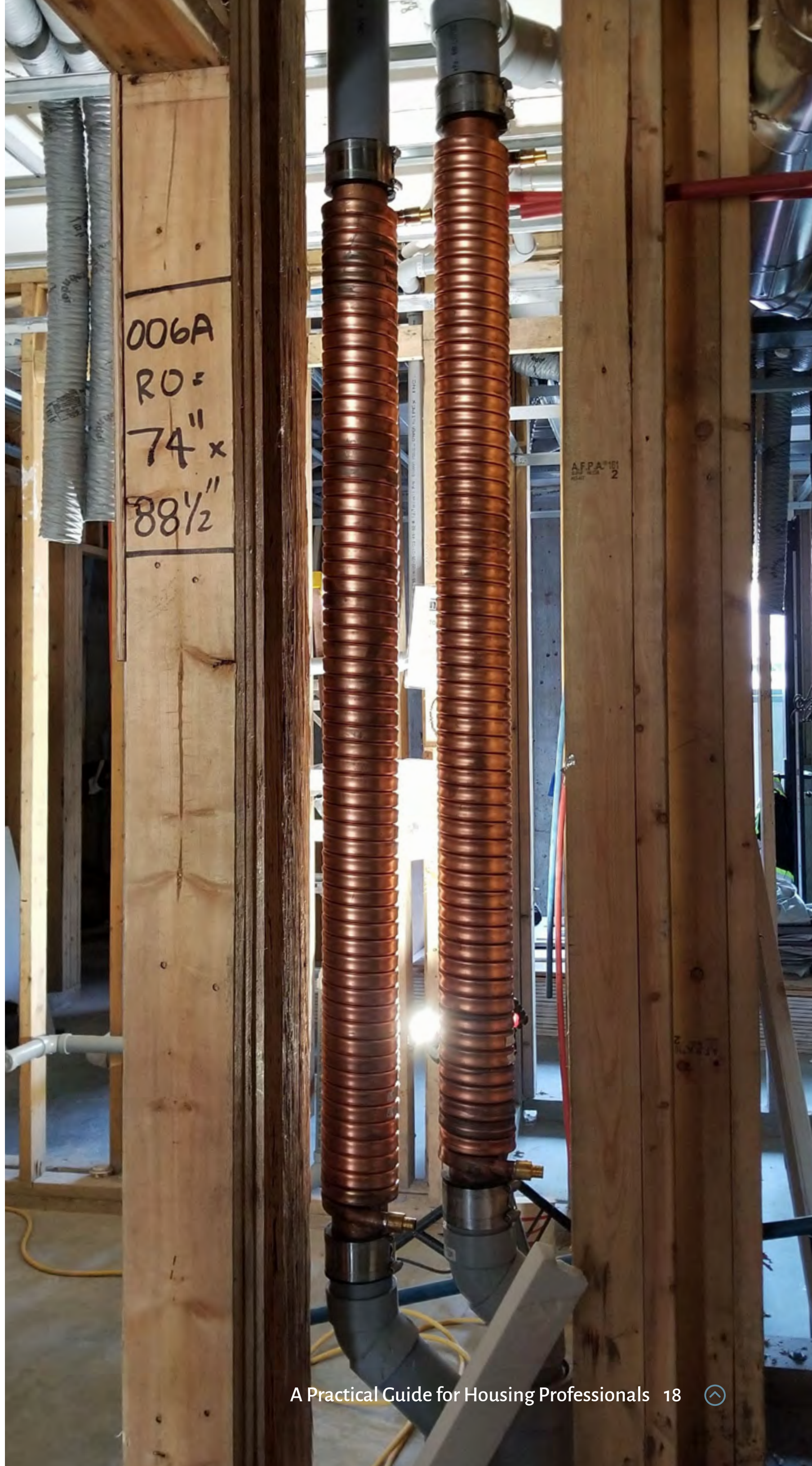
Pre-Strip *- Ensure a continuous air barrier system by laying a pre-strip and applying seam sealing between air barrier materials on both sides.*



No Pre-Strip *- Ignoring the pre strip breaks the continuity of the air barrier and reduces air tightness.*



8 HRV's do require penetrations in the air barrier system, but these penetrations are easily sealed, and the units themselves are easily blocked for testing.



Considering Construction Sequencing

Establishing a clear air barrier system installation plan—and communicating it effectively to builders—prevents on-site missteps and helps ensure performance targets are met. Given the importance of air tightness to performance results, we think it is worth the effort for design teams to support builders in this way, especially if a design features uncommon or unusual junctions.

Recommendations:
Collaborate early with builders to address design challenges, ensure any challenging details or transitions are discussed, and confirm feasibility.

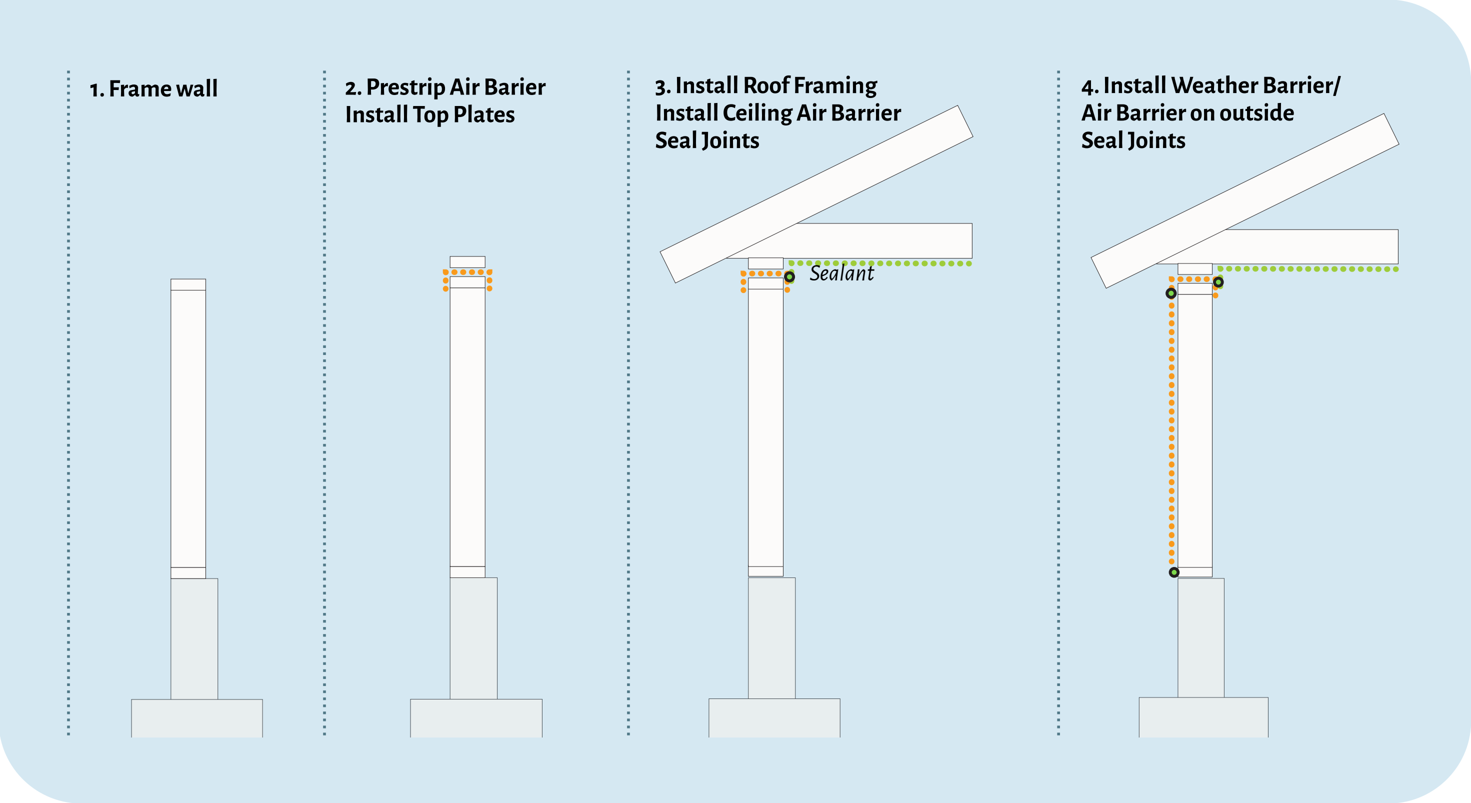
- **Provide detailed drawings** of key air barrier system junctions and wall assemblies to guide correct installation (for common assemblies, you can reference existing guides like this one).
- **Assign a designated on-site 'air boss'** – someone with a solid understanding of the air barrier system construction sequencing – to oversee installation.

For complex assemblies, design teams may consider other ways to ensure proper on-site air barrier system installation.

Recommendation: Supply builders with step-by-step construction instructions using annotated 3D images to explain the air barrier system sequencing. For more complex assemblies, consider a builder's perspective when creating the details required for permit application materials.

Recommendation: Engage with builders as early as possible to get their input on their team's (and subcontractor's) skills and to flag assemblies that may present a challenge.

Step-by-step instructions communicating the build sequence for an assembly option at the roof-to-wall air barrier junction.



Tip: Make sure that files are optimized for mobile viewing and small enough to be downloaded easily, to support real-time access on site.

Tip: Work with a building envelope consultant to detail complex junctions and/or verify any 3D installation instructions.

Considering High-Performance Systems in Design

There's a wide range of high-performance mechanical systems, each with different considerations for installation and siting, which can be complicated by the tight layouts and compact lots typical of GDH.

Account for System Requirements

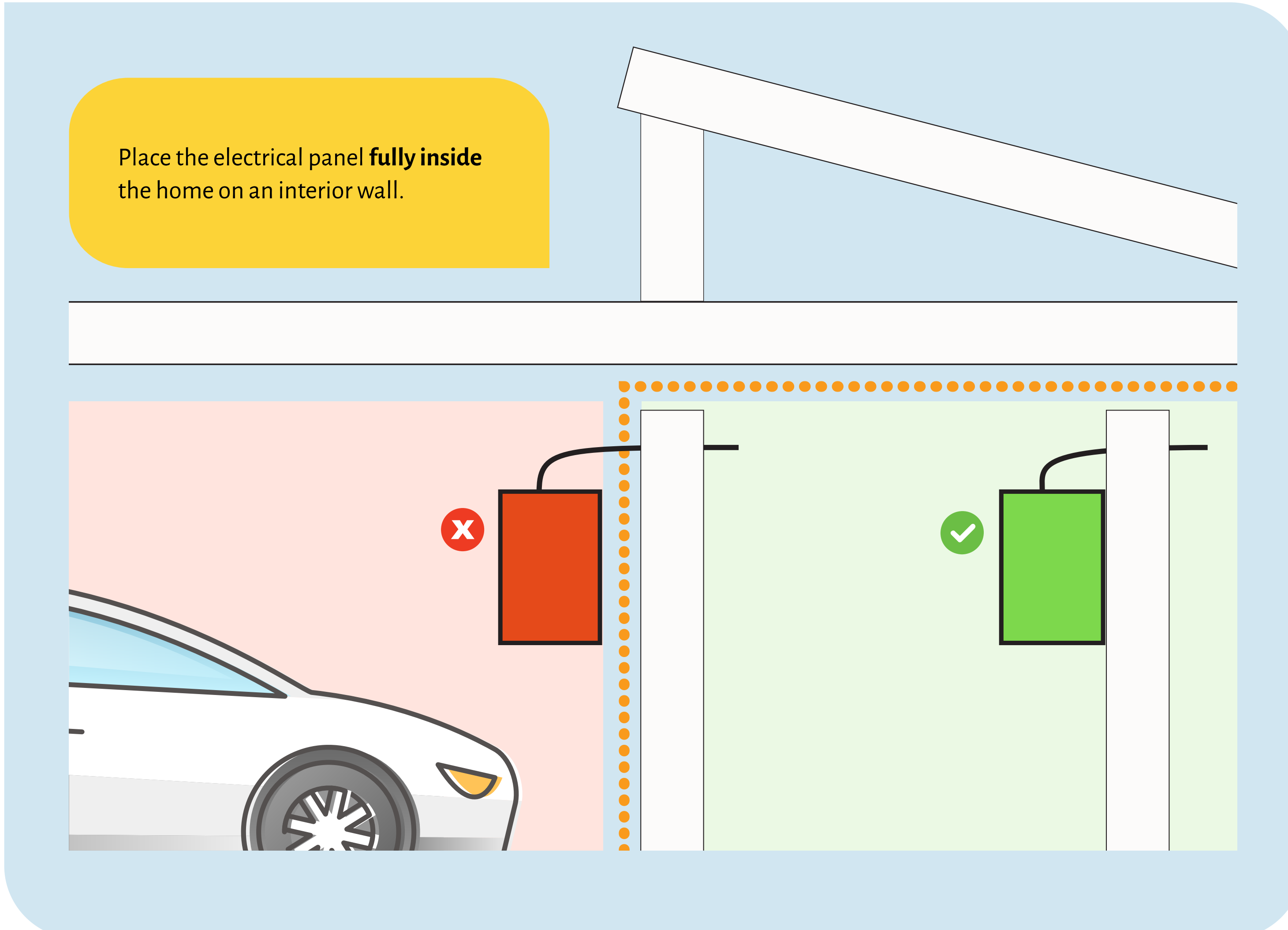
For example, electric hot water tanks are bulkier and heavier than tankless gas systems, requiring a larger mechanical room—ideally on the ground floor with a wide doorway for an easy install. On the plus side, electric tanks are often simpler to maintain and don't require venting or gas lines, which can make installation more straightforward in many buildings.

> **Recommendation:** Coordinate early with mechanical contractors to make sure the equipment fits without needing major design changes.

Design for Airtightness in System Siting

Electrical panels can be a common source of air leaks. Panels installed in garages or exterior walls require extra sealing around every wire, making the job more complex.

> **Recommendation:** Keep all mechanical systems within the thermal envelope and air barrier system to help maintain airtightness.



Adapt High-Performance System Selection and Siting for Compact Size Constraints

While *Heat Recovery Ventilation* (HRV) systems aren't always required[9] by the BC Building Code, they're commonly used to boost energy efficiency – like heat pumps. System clearance requirements can clash with local bylaw restrictions, complicating siting on compact lots.

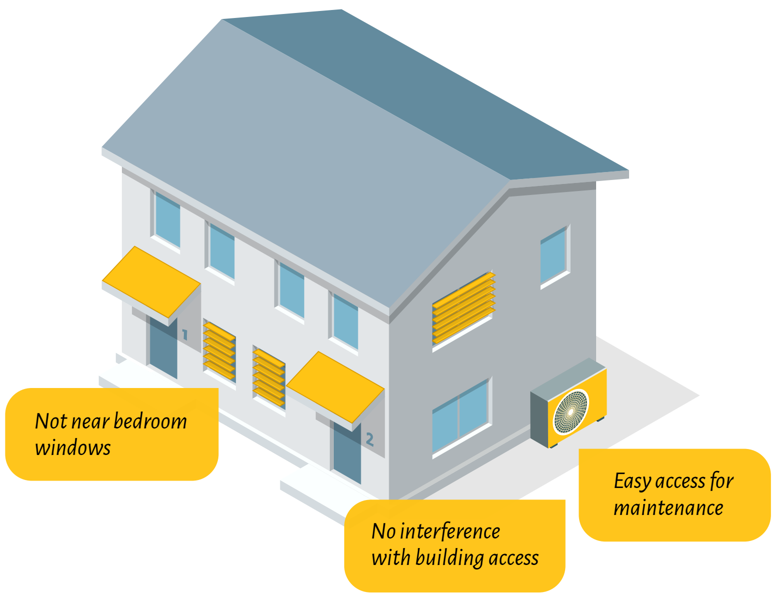
Recommendations:

- **Use compact HRVs and heat pumps** where possible. Smaller units offer flexibility for placement in tight layouts but may have different installation requirements than larger/ older models – making specification reviews essential.
- **Get creative with equipment placement.** Consider rooftops, under outdoor stairs, or the front yard for outdoor heat pump siting - so long as the unit can still be accessed readily for maintenance.
- **Use newer heat pumps without outdoor units** In jurisdictions with especially restrictive siting rules around noise concerns or visual preferences.

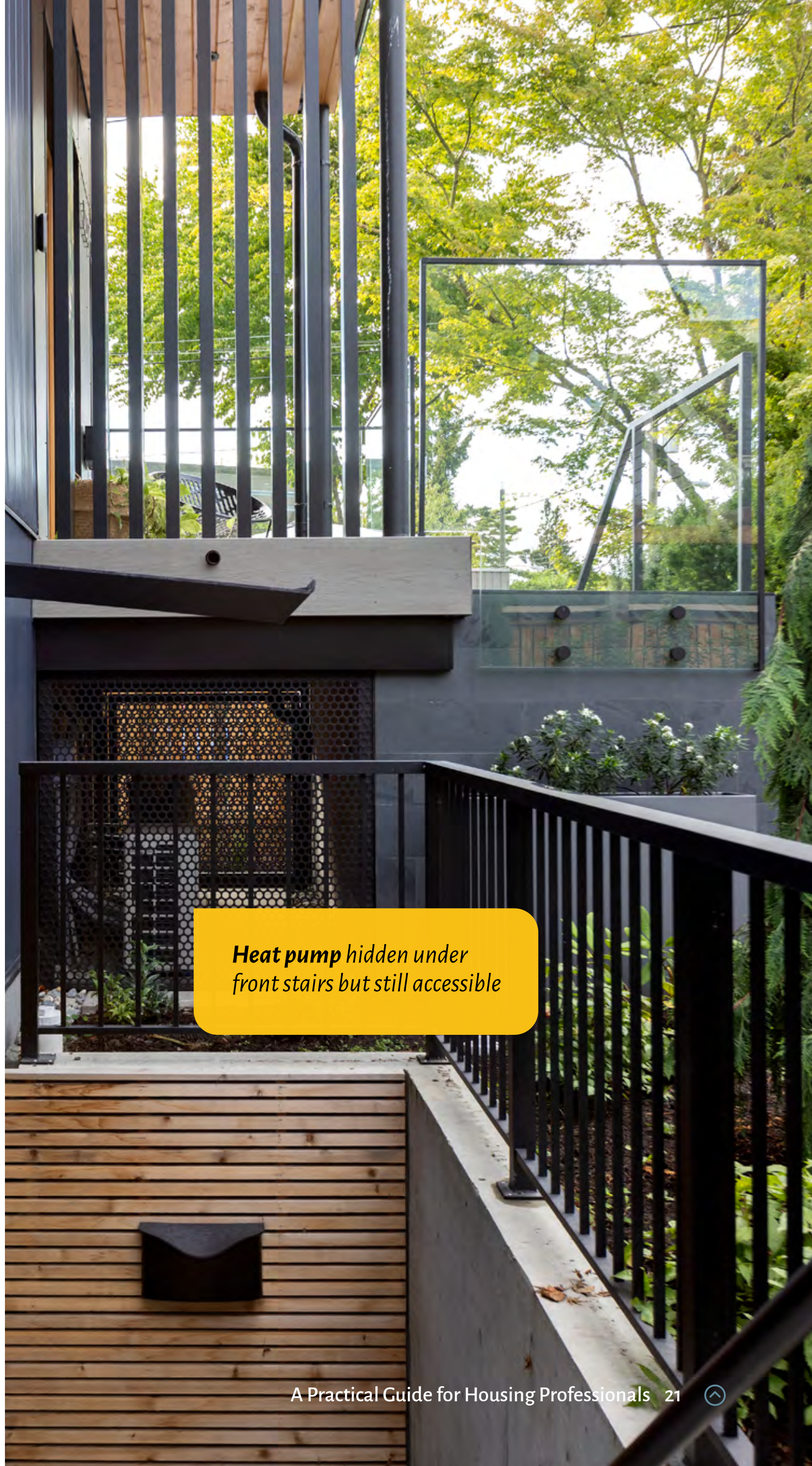
More Considerations for Design Teams When Siting Outdoor Heat Pumps

Recommendations:

- **Plan for easy access** to units for future maintenance.
- **Be mindful when siting outdoor heat pumps** that they don't cause damage or interfere with building access or use as a result of ice buildup from condensate drips.
- **Call the AHJ early** to identify noise bylaws, fire access requirements, setbacks, and drainage requirements that may limit where systems can be placed. An early call can clarify these restrictions and while newer units are quiet, avoid placing systems near bedroom windows, tight property lines, or other areas where even low noise levels can be disruptive.
- **Consider noise for indoor occupants.** Modern heat pumps are much quieter than their older counterpoints. Still, avoid placing outdoor units directly underneath windows or consider taking other noise abatement steps like sound insulation.



9 When utilizing a performance-based approach. If following a prescriptive approach for Step 3 construction, HRVs ARE required.



Managing High Electrical Loads

While energy-efficient homes reduce overall consumption, all-electric setups—with the potential for multiple high-draw appliances running at once—can strain infrastructure. Peak demand becomes a key concern, and in some cases, upgrades to the utility connection may be needed.

Fully electric homes with a secondary suite and EV charging can *usually* run on a 200amp service (you must do electrical load calculations to be certain). However, luxury loads or more than 2 units on a property can push the total load into a more expensive service, like 400-amp. BC Hydro recently introduced the 320 amp service, which can also be a good in-between alternative as well. In some cases, a *pad-mounted transformer (PMT)* may be required to handle the increased load. PMTs may exacerbate already-challenging siting decisions for designers and thus are best avoided wherever possible. Here are a series of more strategies that design teams can use to reduce the risk of costly utility upgrades:

Utilize Specialized High-Performance Appliances

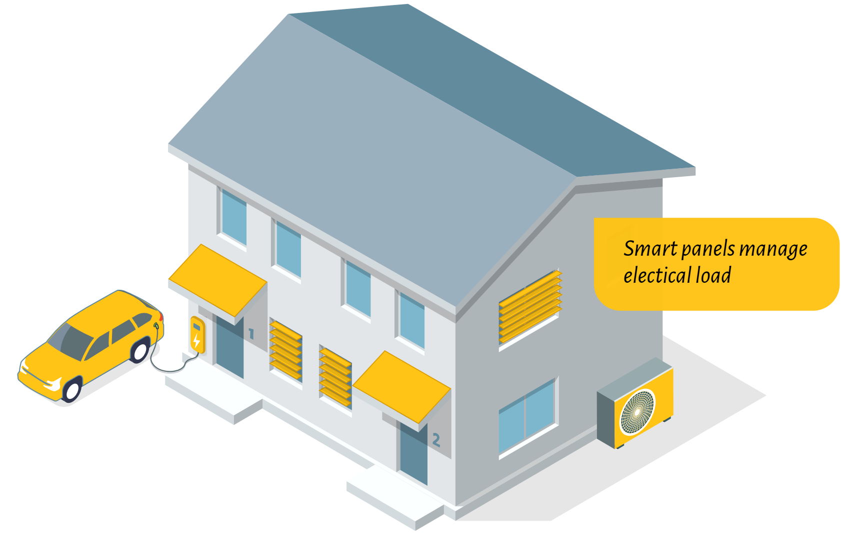
Recommendation: Specifying low-load appliances, such as ventless or heat pump dryers, can significantly reduce the total electrical demand. In many cases, this can mean the difference between staying within a 200-amp service or needing an upgrade.

Utilize Load Management Strategies

Recommendation: Load management systems such as load splitters, circuit pauses and smart panels for EV charging can reduce the total electrical load by up to 40 amps per unit–a significant gain for multi-unit GDH.

Monitoring tools can reduce peak demand by:

- Temporarily switching off the EV plug when other high-load appliances (e.g. oven, laundry) are in use.
- Monitoring the panel and only allowing EV charging when capacity is available.



Coordinate Early with Your Local Utility

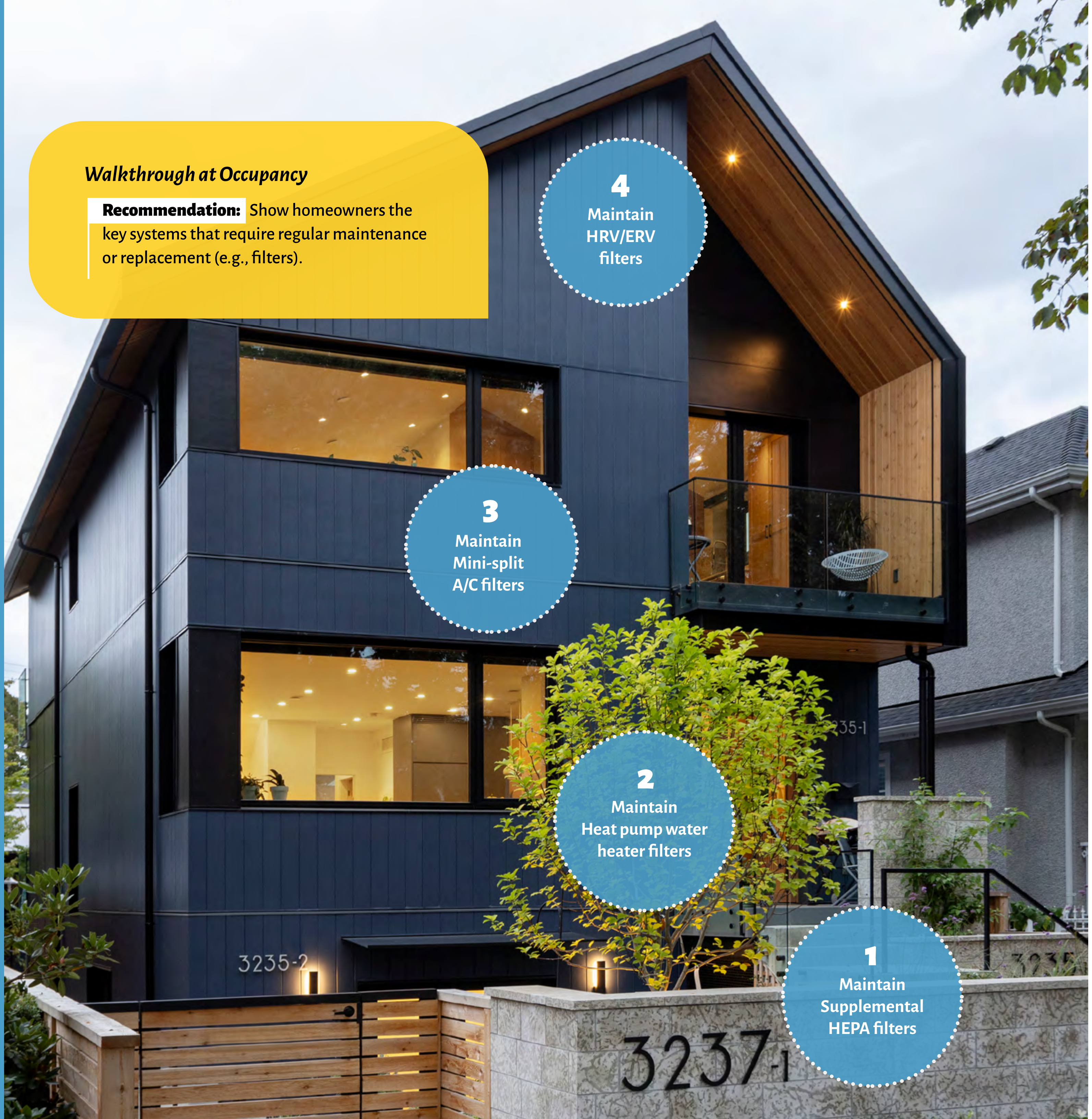
Clearly establishing that the proper electrical infrastructure is in place is one of the first things which must be done before designs are completed. This is commonly done by builders, but because it impacts design teams directly, they must also ensure it has been done.

Priority Recommendation: Engage your local utility early in the design process to clarify the project's electrical requirements.

Recommendation: Request a pre-clearance letter confirming a PMT is not required to streamline later approvals.

Walkthrough at Occupancy

Recommendation: Show homeowners the key systems that require regular maintenance or replacement (e.g., filters).



Hand-off to Homeowners

To help ensure long-term performance, comfort, and durability, homeowners need to understand how to operate and maintain the high-performance systems in their home. Though the task commonly falls to builders, the hand-off process is substantially improved when everyone from the Integrated Design Process contributes to this step.

Post-Occupancy Maintenance

Recommendation: Take the time to help develop visuals that builders can use to show homeowners the key systems that require regular maintenance or replacement (e.g., key equipment locations). Include the manuals for important equipment.

Digital Package of Reference Materials

Recommendation: Provide homeowners with clear, accessible resources that can be standardized and reused across projects, such as:

- Short videos demonstrating how to change filters
- Digital package with appliance manuals and system guides
- Maintenance manual outlining system importance, maintenance schedules, warranty information, and key contacts for maintenance and warranty.

First Year of Occupancy

Recommendation: Many homeowners are overwhelmed with information at the project completion stage. Consider scheduling a 6-month or 1-year check-in to walkthrough and reinforce key system information and answer any questions.

Long-Term and Continued Encouragement

Recommendation: Send bi-annual filter change reminders (e.g., around the spring and fall equinoxes) to help homeowners maintain system performance. Use a mailing list to automate reminders across all past projects.

Section 3

Recommendations for Mechanical Contractors

Mechanical contractors play a key role in making high-performance gentle density housing work—from ensuring energy-efficient heating and cooling systems to integrating smart, space-saving mechanical designs in compact homes. Your expertise helps turn good design into reality.

In this section, you'll find insights on:

- Managing Restrictive Zoning Bylaws
- Commissioning Heat Pumps
- Setting Switch-over Points
- Sizing Mechanical Systems
- Mitigating Air Leakage
- Training for Mechanical Contractors

Managing Restrictive Zoning Bylaws

In GDH projects, space is often tight—and zoning bylaws can make it even trickier to find the right spot for mechanical systems. Setback rules, design guidelines, noise restrictions, and fire access requirements all influence where equipment can go, especially outdoor heat pumps. Here are a few key strategies to manage these constraints:

Coordinate Early with Design Teams and Builders

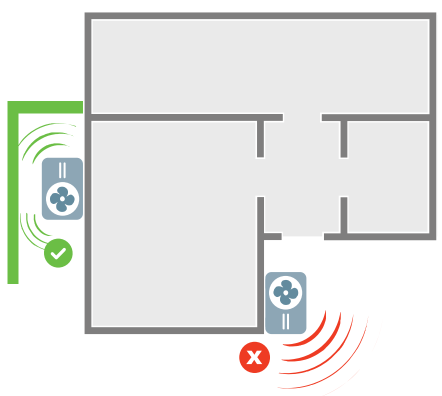
To realize the full benefits of high-performance mechanical systems, planning is needed to ensure the system layout and design are optimized. Similar to the shift from a typical Part 9 build to a GDH project, those new to high-performance projects may require additional planning time to determine different layouts and approaches.

> **Recommendation:** Get involved in the design process to ensure mechanical systems are considered from the start.

Avoid Hard Corners

Placing condenser units in hard corners can amplify noise. This includes balcony corners or near fence and retaining wall corners.

> **Recommendation:** Choose open areas where sound can dissipate more easily.



Use Visual Screening

> **Recommendation:** Where possible, cover condenser units to meet design guidelines.

Keep Fire Access Clear

> **Recommendation:** Make sure your equipment placement doesn't block access routes for emergency services. Check BC Building Code Section 9.10.20 (Fire Department Access) when deciding where to place exterior equipment.

Commissioning Heat Pumps

Commissioning is a critical step in any heat pump installation—but it's one that's often skipped. Proper commissioning ensures the system is installed correctly, performs efficiently, and lasts as long as it should. It's not just about catching major issues like improper system charging or duct leakage – it's also about fine-tuning the system for performance and longevity. Skipping this step could lead to higher energy consumption, reduced comfort, or premature equipment failure.

> **Recommendation:** Refer to the equipment manufacturer's commissioning guidelines as they often include model-specific steps that are essential for warranty and performance.

Commissioning must comply with Section 6.3 of CSA Standard C273.5-11. This standard also includes helpful guidance on right-sizing equipment, an important consideration in compact GDH builds.

To properly commission a heat pump, mechanical contractors can carry out some or all the following tests:

Nitrogen Pressure Test

Vacuum Decay Test

Refrigerant Charge Verification

Total External Static Pressure (TESP)

Airflow Measurement

Duct Leakage Test

Check thermostat operation and calibration

System Performance Verification (Capacity and Efficiency)

Setting Switch-over Points

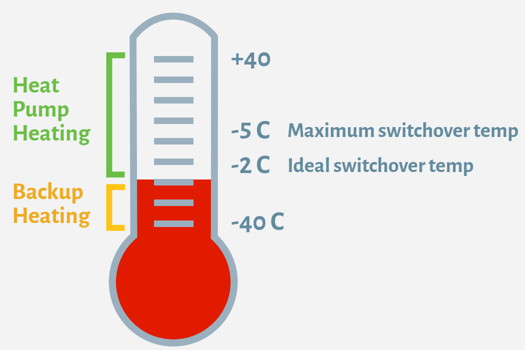
In dual energy systems, the switch-over temperature—or the point at which a system shifts from heat pump to backup heating—has a major impact on both greenhouse gas (GHG) emissions and operating costs. This setting is often set higher than necessary, and there are two potential reasons for overly conservative switch-over settings:

Outdated Assumptions. Heat pump technology has advanced significantly and modern models, especially those used in colder regions, perform very well at lower temperatures. Whatever your requirements may be, it is nearly certain that an existing heat pump system can meet them.

Misinterpreted Guidance. Some contractors interpret utility or manufacturer recommendations as fixed switch-over temperatures. In reality, these are maximum thresholds, not default settings.

> **Recommendation:** Set the switch-over point based on system performance and local fuel costs, and treat the maximum switchover temperature as an uppermost limit.

Optimal switchover temps can decrease annual energy usage by 50% in some cases.



Setting the right switch-over temperature involves balancing **performance data** on how the specific heat pump model performs at different temperatures with **fuel costs** to determine the most cost-effective switch-over point.

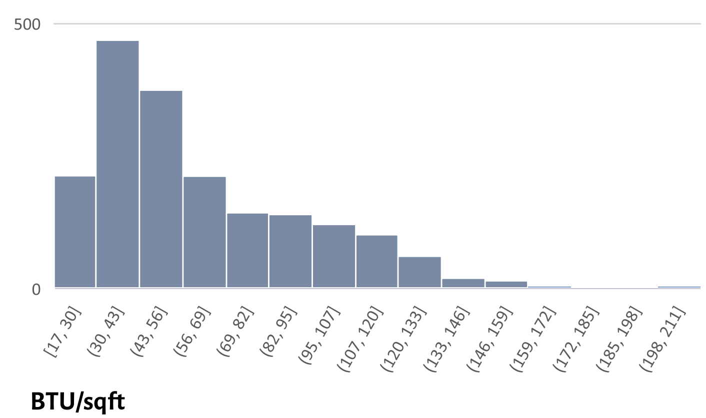
> **Recommendation:** Use available tools, such as the [NRCan switch-over calculator](), to model the best setting for your project.

Tip: For systems using electric heating as a backup, the switch-over point is typically determined by the heat pump's efficiency alone, since both systems use electricity.

Right-Sizing Mechanical Systems

In the past, mechanical systems were often sized using general guidelines based on square footage and insulation quality. But in today's high-performance gentle density homes, that approach no longer holds up. The figure below shows just how much heat loss can vary from home-to home. Accurate sizing—based on project specific performance data—is essential and is covered in existing guides, such as [TECA's Quality First Manuals.]()

Average heating loads for new small homes:



Why Proper Sizing Matters

Accurate heat load calculations help ensure:

- Comfort: Even heating and cooling across all rooms
- Efficiency: Lower energy use and operating costs
- Durability: Less wear and tear on equipment
- Compliance: Meets code and warranty requirements

Oversized Systems are:

- More expensive
- Noisier
- Less efficient
- Prone to early failure

How to Properly Calculate Heat Loads for High-Performance GDH

> **Recommendations:**
>
> - **Start early.** Perform heat loss and gain calculations during the design phase. This allows time to coordinate with design teams and Energy Advisors, and avoids last-minute pressure that often leads to oversizing.
> - **Use a room-by-room approach**. Room-by-room calculations are required because they help ensure consistent comfort. In B.C., residential construction standards require no more than a 3°C difference between rooms – anything more can trigger a warranty claim. This is especially important in *multi-unit* GDH projects.
> - **Work with an Energy Advisor.** Partner with a certified Energy Advisor if your team doesn't have the capacity to do CSA F280 calculations.

Tip: You can find qualified advisors in your area through [Better Homes BC]().

Understand the Tools and Requirements

The BC Building Code (Section 9.33, clause 5.1) requires room-by-room heat load calculations to follow the CSA F280 standard. This is separate from the energy modeling that an Energy Advisor will do for the BC Energy Step Code, which often uses HOT2000. HOT2000 provides whole-home values and does *not* meet CSA F280 standards.

> **Recommendation:** Do both CSA F280 and HOT2000 calculations.

Tip: In many cases, your Energy Advisor will be able to do both calculations, but mechanical contractors may still be held responsible for deficiencies.

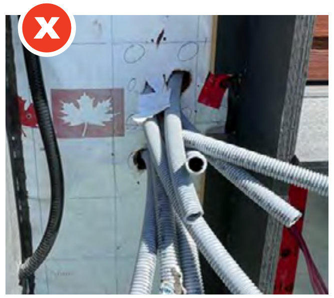
Don't Forget Duct Design – Ducts should be sized based on airflow requirements and not intuition or estimation. CSA F280 calculations will indicate how much airflow is required for each room, and ducts should be sized based on these numbers. Undersized, oversized or poorly routed ducts can lead to pressure drops, noise, and uneven heating or cooling.

Tip: Avoid sharp corners and long runs where possible.

Mitigating Air Leakage

Preserving the integrity of the air barrier is essential to maximize performance, and mechanical contractors play a role in ensuring airtightness is maintained. Mechanical systems (ductwork, wiring, and refrigerant lines) can penetrate the building envelope, including the air barrier system, during installation. This creates potential leakage points.

> **Recommendation:** Seal all penetrations you create. Don't assume others will catch or fix penetrations you create in the air barrier system. Use appropriate sealants to maintain continuity of the air barrier system. For ducting joints, choose sealants that can flex and move with the air barrier materials over time.



Training for Mechanical Contractors

In B.C., residential HVAC installations for Part 9 buildings are not as tightly regulated as other professions, and existing rules lack enforcement. While Technical Safety BC provides strong oversight of more complex systems, many HVAC installers working on smaller residential projects are unregistered, have not had their skills formally assessed, are without required training, and lack access to consistent training.

Despite this gap, **valuable training resources are available.** These programs help contractors build their skills and qualify for important rebates. Investing in these skills is a win-win: better quality installations for homeowners and more credible businesses for contractors.

Training and Upskilling Opportunities- Edits to SHBC based on SME feedback

- TECA's Quality First Training Courses is a suite of 8 courses covering key topics such as residential air-to-air heat pump design and installation, HRV system design, heat loss/heat gain theory, and duct layout. These courses are widely recognized in the industry and support high-quality installations.
- The Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) offers training on both heat pumps and HRVS to help contractors stay current with best practices and evolving technologies.
- Home Performance Contractor Network (HPCN) provides subsidized training for mechanical contractors and connects homeowners and builders with highly qualified contractors. Membership is required to access certain rebate programs from BC Hydro and FortisBC and signals to homeowners that a contractor meets performance and quality standards.

Small Housing is working to compile new training courses that Mechanical Contractors will find useful. Visit smallhousing.org to stay up to date on progress.

small housing

Conclusion

Appendix A: Resources

1. Instruction Manual: BC Energy Compliance Reports for Part 9 Residential Buildings
2. BC Housing Illustrated Guide: R22+ Effective Walls in Residential Construction
3. CMHC Housing Design Catalogue
4. B.C. Ministry of Housing Standardized Housing Designs Catalogue
5. BC Housing Illustrated Guide: Achieving Airtight Buildings
6. Wall air barrier reference sheet
7. NRCan Air-source Heat Pump Sizing and Selection Guide
8. Better Homes BC *(to find a qualified Energy Advisor in your area)*
9. TECA's Quality First Training Courses
10. Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) Post HVAC Trades Training Courses
11. Home Performance Contractor Network (HPCN)

Glossary

- **Air Barrier System**- a part of a building envelope, intended to eliminate the unintentional flow of air into or out of a building.
- **CSA F280** - A standard for conducting room-by-room heat loss/heat gain calculations which is required for new part 9 residential buildings in British Columbia.
- **HOT2000** - An energy simulation software developed by Natural Resources Canada, which is often (but not always) used by Energy Advisors to model a home's energy performance.
- **GDH** - Gentle Density Housing, a type of housing that generally makes maximum use of an available lot size to provide multiple units on a single property, but still conforms to the character and feel of residential neighbourhoods.
- **PMT** - Pad Mounted Transformer, an electrical transformer which, instead of being mounted on utility poles, is mounted on a concrete pad on the ground.
- **MURB** - Multi Unit Residential Building: A building with at least two separate dwelling units in it and is conventionally less than 3 stories.
- **NLA** - Normalize Leakage area: a metric used for assessing airtightness, NLA is the size of a hole which would give an equivalent leakage rate to all of the smaller leakage points in a building's envelope. The metric is normalized to a building's surface area.
- **NLR** - Normalized Leakage rate: a measure of how much air leaks from a building, relative to the internal volume of the home.
- **TEDI** - Thermal Energy Demand Intensity: a measure of the amount of heating energy a building's needs for space heating and cooling and ventilation air, relative to the building's floor area.
- **MEUI** - Mechanical Energy Use Intensity: a measure of the annual energy consumption of a building's needs for space heating and cooling, ventilation, and domestic hot water, relative to the building's floor area.
- **ACH** - Air Changes per hour: a measure of how much air cycles through a building within a one-hour time period, relative to the internal volume of the home.