CHBA NET ZERO HOME LABELLING PROGRAM
Summary Report – 2023

This report details the assemblies and technologies used in the homes qualifying under the Net Zero Home Labelling Program from the Pilot to December 31, 2023, and the resulting performance metrics they achieved.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Founded in 1943, **the Canadian Home Builders' Association (CHBA) is the voice of Canada's residential construction industry**. The residential construction industry is a vital part of Canada's economy in every community across the country:

- Directly and indirectly supporting more than 1.5 million jobs
- Paying more than $107.2 billion in wages
- Generating $211.3 billion in annual economic activity

The CHBA is one association serving our members at three levels. Membership with a local Home Builders' Association (HBA) automatically provides membership at the provincial and national levels. The national office is in Ottawa, Ontario. Representing some 8,500 companies across Canada, CHBA members include builders, renovators, land developers, trade contractors, product and material manufacturers, building product suppliers, lending institutions, warranty and insurance providers, service professionals, municipalities and more.

On April 3, 2014, the CHBA Board of Directors approved the motion to establish a Net Zero Energy Housing Council (NZC). The NZC supports innovation in the industry with the goal of creating a market advantage for builder and renovator members pursuing net zero energy performance on a voluntary basis. The Council's work will help the industry meet the housing aspirations of Canadians and renew Canadian leadership in high-performance housing. More information can be found at www.chba.ca/nzc.

On September 29, 2015, CHBA launched a Pilot of the Association's Net Zero Energy (NZE) Labelling Program—continuing CHBA's long history in leading energy efficiency in residential construction. The pilot was used to validate both administrative and technical details prior to launching "version 1" of the Program on May 2, 2017. On October 28, 2021, CHBA launched the Net Zero Home Labelling Program for Renovations. More information can be found at www.chba.ca/nze (for industry) and www.netzerohome.com (for consumers).

A key priority of the Net Zero Council, the CHBA Net Zero Home Labelling Program (the Program) distinguishes and recognizes Net Zero and Net Zero Ready Homes (detached, attached, and MURBs), Renovations, and Neighbourhoods, and the participating builders/renovators - focused on both energy efficiency and more recently on emissions reductions. To support industry adoption of this voluntary program, the following efforts will be delivered:

- **Technical & Administrative Requirements** that support market preparedness for the implementation and compliance of the highest feasible tiered energy codes, and for operational and embodied emissions planned for the 2025 and 2030 codes.
- **Educational initiatives** to bridge the knowledge gap, support cost-optimization, and accelerate the industry's capacity to capitalize on Net Zero, such as training (which utilize the CHBA manuals), webinars, and the Net Zero Leadership Summit.
- **Marketing & Communications initiatives** to strengthen the Net Zero Home Labelling Program brand, build awareness and understanding of the value of CHBA Net Zero Homes, and stimulate market demand.
- **Financing solutions** using program information/data to inform the development of innovative and effective financing mechanisms by key industry players to address the initial cost, helping accelerate voluntary adoption of Net Zero/Ready Homes.

In addition to the Program, the Council engages in **Applied Research, Development, and Demonstration (RD&D)** initiatives (including LEEP field trials), working with industry leaders to identify and prioritize barriers and seek innovative solutions for cost-effective Net Zero levels of performance focused on both energy efficiency and emissions reductions for all housing forms, including multi-family and renovations, and for neighbourhoods. These initiatives support energy efficient construction by enabling builders and renovators to reduce their time and risk identifying, exploring, and adopting innovations in the residential construction industry. These efforts contribute to and leverage CHBA RD&D work in Climate Change Mitigation, Adaptation and Resilience guidelines and standards.

1.1 Executive Summary

The purpose of this report is to support CHBA members' voluntary adoption of Net Zero Energy housing by building awareness and knowledge via the consolidation and sharing of information. The desired outcomes of this report are to communicate the activity of the CHBA Net Zero Home Labelling Program, share information about the construction assemblies, technologies, and performance of the homes, and support current and future research regarding Net Zero and Net Zero Ready construction.

This report includes information on the uptake of Net Zero and Net Zero Ready Homes labelled under the Program from September 29, 2015, until December 31, 2023, as well as participation in the Net Zero Training courses. The analysis of the homes is separated into three housing types. 1) New homes are reviewed in sections 4 through 8 and sub-categorized into detached homes and attached homes, 2) multi-unit residential buildings are reviewed in section 9, and 3) renovations are reviewed in section 10. Within these building type categories, trends from the data are presented on building envelope efficiency, mechanical systems installed, and fuel source configurations.

In addition, seven performance metrics are also analyzed: annual energy consumption, whole home heat loss, airtightness, total energy use intensity, percent better than reference house – building envelope, percent better than reference house – annual energy consumption, and operational GHG emissions. These performance metrics are based on the modelled values determined by the Qualified Net Zero Energy Advisor using the HOT2000 modeling software.

Here are some highlights of this years' report content:

- In 2023, 41 Net Zero Homes and 474 Net Zero Ready Homes were labelled, bringing the total to 1,703 homes labelled under the Program as of December 31, 2023.
- In total, there are 1,061 detached homes, 553 attached homes, 80 units contained in 9 multi-unit residential buildings, and 9 renovations.
- Operational GHG emissions of the homes were highly dependent on the province in which the homes were located; on average, homes in Manitoba, Newfoundland & Labrador, British Columbia, and Ontario had the lowest annual operational GHG emissions, and homes in Alberta, Saskatchewan, and Nova Scotia had the highest annual operational GHG emissions.

New Homes Highlights (Detached & Attached Homes):

- The majority (78%, 1,255/1,614) of detached and attached homes used above-grade walls with an RSI between 4.22 and 6.0 (R24-R35).
- The most common (58%, 929/1,614) space heating and cooling configuration for detached and attached homes is an air source heat pump as the primary heating and cooling source with a natural gas furnace as a supplementary heating source.
- The most common (57%, 909/1,599) fuel source configuration is "hybrid heating + gas DHW". Within this group of homes, the average modelled natural gas consumption is 341 m^3/year, and the average modelled electricity consumption is 9,999 kWh/year.
- In general, windows and doors typically represent the largest percentage (26% to 38%) of whole home heat loss.
- The average annual energy consumption for all 1,614 detached and attached homes is 48 GJ/year.
- The average airtightness for the 1,061 detached homes was 1.04 ACH@50 and for the 553 attached homes was 1.46 ACH@50.
- The average calculated Total Energy Use Intensity (TEUI) for the 1,061 detached homes was 0.18 GJ/m^2/year (48.9 ekWh/m^2/year) and for the 553 attached homes was 0.23 GJ/m^2/year (62.8 ekWh/m^2/year).
- The average percent better than reference – annual energy consumption was 63.0% for the 1,061 detached homes and 55.8% for the 553 attached homes.
- The average percent better than reference – envelope was 50% for the 1,061 detached homes and 55% for the 553 attached homes.

Multi-Unit Residential Building (MURB) Highlights:

- The average annual energy consumption per unit was 27.3 GJ/year.
- The majority (85%, 68/80) of the units were all-electric. They typically used electric space heating and cooling configurations, such as an ASHP primary system with an electric furnace for supplementary heating, as well as an electric tank for domestic hot water.

Renovation Highlights:

- The average decrease in annual energy consumption was 75 GJ/year (60.5%).
- The average Post-Reno airtightness achieved was 1.10 ACH@50Pa.
- The average decrease in airtightness was 5.13 ACH@50Pa (82%).

We release a detailed summary report annually, presenting the highlights at the annual CHBA Net Zero Council Spring meeting to share advancements in the program.

2.0 DEFINITIONS

Attached House
One residential unit that shares a wall with one or more adjacent dwellings, each with a separate entrance. Alternate names are row house, townhouse, and semi-detached.

Building Envelope / Space Cooling (BE/SC) Evaluation Tool
This CHBA spreadsheet tool calculates and tracks the elements of the home's design to document Program compliance.

CHBA Qualified Net Zero Home ("Net Zero Home")
A CHBA Qualified Net Zero Home that is labelled under the Program is a home that is recognized by CHBA, on the basis of the attestations by the builder/renovator, its Qualified Net Zero Service Organization and a Qualified Net Zero Energy Advisor to have met the Technical Requirements, including the energy performance rating using Natural Resources Canada's (NRCan's) EnerGuide Rating System (ERS) to be designed, modelled and constructed to produce as much energy (from on-site renewable energy sources) as it consumes, on an annual basis.

CHBA Qualified Net Zero Ready Home ("Net Zero Ready Home")
A CHBA Qualified Net Zero Ready Home that is labelled under the Program is a home that is recognized by CHBA, on the basis of the attestations by the builder/renovator, its Qualified Net Zero Service Organization and a Qualified Net Zero Energy Advisor to have met the Technical Requirements, including the energy performance rating using NRCan's EnerGuide Rating System (ERS), to be a Net Zero Home that has a renewable energy system designed for it that will allow it to achieve Net Zero Home performance, but the renewable energy system is not yet installed.

CHBA Qualified Net Zero Renovation ("Net Zero Reno")
CHBA Qualified Net Zero Renovations are homes that have been renovated to the same performance requirements as newly constructed Net Zero Homes. A Net Zero Renovation is modelled and renovated to produce as much energy (from on-site renewable energy sources) as it consumes, on an annual basis.

CHBA Qualified Net Zero Ready Renovation ("Net Zero Ready Reno")
CHBA Qualified Net Zero Ready Renovations are homes that have been renovated to the same performance requirements as newly constructed Net Zero Ready Homes. A Net Zero Ready Renovation has a renewable energy system designed for it that will allow it to achieve Net Zero performance, but the renewable energy system is not yet installed.

Detached House
A dwelling unit with walls, floors, ceilings, and roof independent of any other building, as opposed to semi-detached or row houses sharing common walls. An alternate name is single-family detached house.

Heating Degree Days
Heating Degree Days (HDD) are equal to the number of degrees Celsius that a given day's mean temperature is below 18 °C. For example, if the daily mean temperature is 12 °C, the HDD value for that day is equal to 6 °C. If the daily mean temperature is above 18 °C, the HDD value for that day is set to zero.

Annual Operational GHG Emissions
Annual operational greenhouse gas (GHG) emissions are a measure of the resulting greenhouse gases emitted from the energy consumed to power a home for one year. Operational GHG emissions are measured in CO_2 equivalents per year (CO_2e) and consider the modelled energy consumption of the home using HOT2000 energy simulations as well as the fuel source.

Single Unit – MURB
These homes are multi-unit residential buildings (MURBs) that have been modelled in HOT2000 using a single unit approach. In this Program a MURB is defined as a purely residential occupancy building with a minimum of two vertically stacked units and a minimum of two storeys above finished grade in which each unit has a private entrance either outside the building or from a common hall, lobby, vestibule, or stairway.

Whole Building – MURB
These homes are multi-unit residential buildings (MURBs) that have been modelled in HOT2000 using a whole building approach. In this Program a MURB is defined as a purely residential occupancy building with a minimum of two vertically stacked units and a minimum of two storeys above finished grade in which each unit has a private entrance either outside the building or from a common hall, lobby, vestibule, or stairway.

3.0 PROGRAM TO-DATE

This section provides an overall evaluation of Program activity and uptake as of December 31, 2023, which includes participants and homes in the Pilot through to the end of Year 7 of the Program.

Pilot September 29, 2015 – December 2, 2016
2017 May 2, 2017 – December 31, 2017
2018 January 1, 2018 – December 31, 2018
2019 January 1, 2019 – December 31, 2019
2020 January 1, 2020 – December 31, 2020
2021 January 1, 2021 – December 31, 2021
2022 January 1, 2022 – December 31, 2022
2023 January 1, 2023 – December 31, 2023

Homes labelled from 2017 to 2023 were qualified under Version 1. The Pilot homes and the Version 1 homes both used the same energy modelling software, HOT2000, but different versions (v10.51 and v11 respectively).

3.1 Uptake and Capacity

There are five CHBA Net Zero Qualifications for participants:
1. CHBA Qualified Net Zero Service Organization (SO)
2. CHBA Qualified Net Zero Energy Advisor (EA)
3. CHBA Qualified Net Zero Trainer (Trainer)
4. CHBA Qualified Net Zero Builder (Builder)
5. CHBA Qualified Net Zero Renovator (Renovator)

The requirements for participants to become qualified under the Program can be found on the CHBA website at www.chba.ca/nze. The lists of Qualified Net Zero Service Organizations (SO), Energy Advisors (EA) and Trainers can be found on the CHBA website at www.chba.ca/nze and Qualified Net Zero Builders and Renovators can be found at www.netzerohome.com.

TRAINING
Builders, Renovators, Energy Advisors, and Trainers are required to successfully complete the CHBA Net Zero Builder Training. Renovators are also required to successfully complete the CHBA Net Zero Renovator Training. Additionally, EAs and Trainers are required to successfully complete CHBA Net Zero Energy Advisor Training. All the courses are offered through a CHBA Qualified Net Zero Service Organization and delivered by a CHBA Qualified Net Zero Trainer.

Table 1: Number of Newly Trained Participants by Year

Program Year	Pilot	2017	2018	2019	2020	2021	2022	2023	Total
Participants	261	190	82	71	338	397	407	675	**2,421**

During the Pilot, NZC Sponsor Members Owens Corning, JELD-WEN and Dettson provided support to run a “blitz” of training sessions across Canada which resulted in excellent attendance by early adopters in the training during that timeframe. In 2020 the Net Zero Builder course and Net Zero Energy Advisor course were updated, and the Net Zero Renovator course and Net Zero Sales & Marketing course were launched. In 2023 a series of Net Zero Reno Bootcamps were delivered in participating municipalities across the country as part of The Towards Net Zero Reno Initiative. Learn more at www.NetZeroRenos.com.

3.2 Number of Homes

Table 2: Number of Qualified Net Zero and Net Zero Ready Homes by Year

Label	Pilot	2017	2018	2019	2020	2021	2022	2023	Total
Net Zero Home	26	9	8	106	31	28	28	41	277
Net Zero Ready Home	2	10	12	109	207	214	398	474	1426
Total	28	19	20	215	238	242	426	515	1,703

Figure 1: Number of Qualified Net Zero and Net Zero Ready Homes by Year

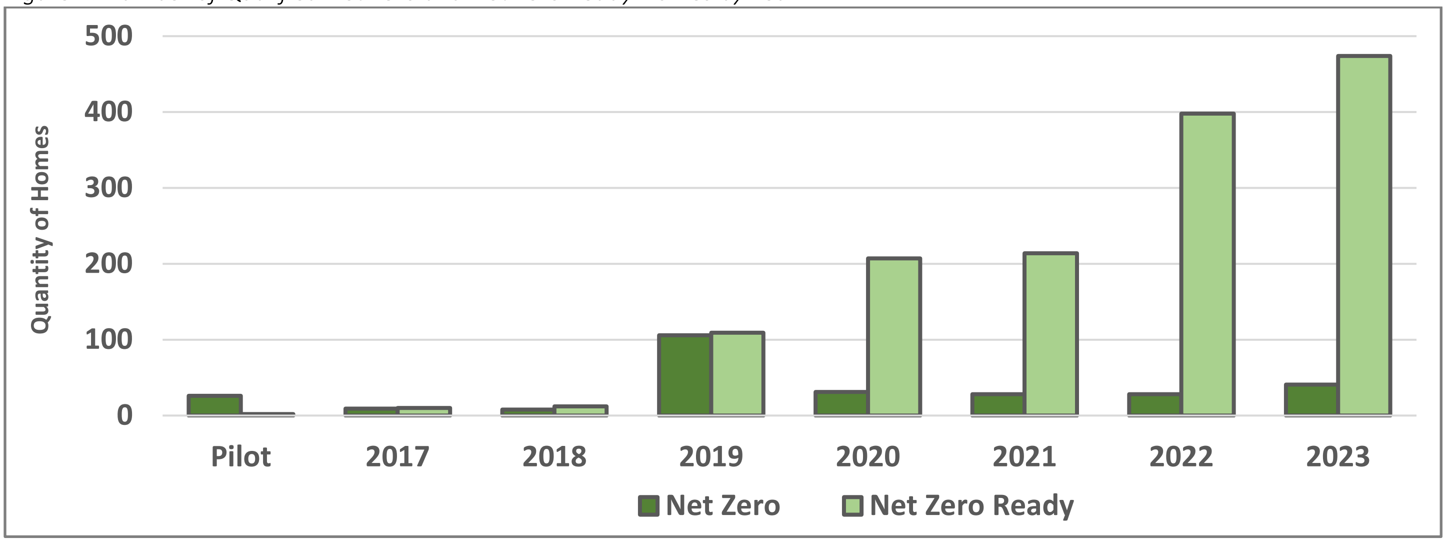


Table 3: Type of Homes by Province

Province	Houses (Detached + Attached)	MURBS (Units)	Renovations	Total
Alberta	66	16	3	85
British Columbia	49	2	3	54
Manitoba	2	0	0	2
New Brunswick	19	0	0	19
Newfoundland & Labrador	2	0	0	2
Northwest Territories	0	0	0	0
Nova Scotia	16	0	0	16
Nunavut	0	0	0	0
Ontario	1449	44	3	1,496
PEI	0	0	0	0
Quebec	0	6	0	6
Saskatchewan	11	12	0	23
Yukon	0	0	0	0
Total	1,614	80	9	1,703

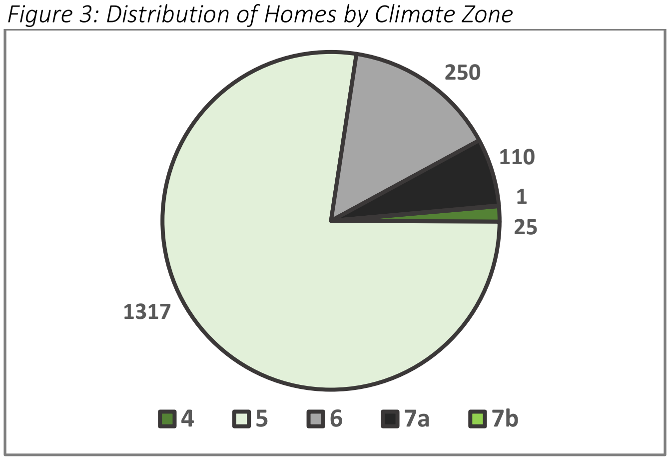
Figure 2: Climate Zone Map of Canada (source: Natural Resource Council of Canada, colour coding by NAIMA Canada).

Table 4: Distribution of Homes by Type and by Climate Zone

Type of Homes	Qty. per Climate Zone					
	4	5	6	7a	7b	Total
Detached Home	16	806	178	60	1	1061
Attached Home	7	466	61	19	0	553
Single Unit - MURB	0	16	6	16	0	38
Whole Building - MURB	0	28	2	12	0	42
Renovation	2	1	3	3	0	9
Total	**25**	**1,317**	**250**	**110**	**1**	**1,703**

Note: The 'Whole Building – MURB' row includes 42 dwelling units within 5 different buildings.

Figure 3: Distribution of Homes by Climate Zone



ANALYSIS

The Program uptake since 2019 has increased significantly. In 2023, the Program's number of homes labelled remained steady with 21% increase over the year previous. There is now a clear trend of homes being labelled Net Zero Ready (84%) versus Net Zero. In 2023, the number of training participants grew by 66% in comparison to the year previous, largely in part to the Net Zero Reno Bootcamps, a capacity building effort within our NRCan funded Towards Net Zero Renovations Initiative Project.

4.0 ENVELOPE

This section explores the envelope assemblies used by the 1,614 detached or attached Net Zero and Net Zero Ready New Homes labelled under the Program up to December 31, 2023. This section does not include labelled renovations or MURBs.

Table 5 summarizes the project types and their average thermal resistance values. The project types are:

- Detached home less than 2,600 ft^2 in floor area
- Detached home greater than 2,600 ft^2 and less than 4,000 ft^2 in floor area
- Detached home greater than 4,000 ft^2 in floor area
- Attached home

Table 5: Building Envelope Performance Summary by Project Type and Climate Zone

Project Type	Climate Zone(s)	# of Labels	Avg. Area m^2	Avg. Area ft^2	Above Grade Wall Eff. Avg. RSI [R] Min. RSI [R] Max. RSI [R]	Ceiling Eff. Avg. RSI [R] Min. RSI [R] Max. RSI [R]	Basement Eff. Avg. RSI [R] Min. RSI [R] Max. RSI [R]
Detached <2,600 ft^2	4,5,6,7a	231	213	2,290	**4.84 [27.5]** 3.45 [19.6] 7.69 [43.7]	**10.60 [60.2]** 4.88 [27.7] 17.97 [102.0]	**4.00 [22.7]** 0.00 8.57 [48.7]
Detached ≥2,600 ft^2 <4,000 ft^2	4,5,6,7a, 7b	702	294	3,165	**4.67 [26.5]** 3.73 [21.2] 9.22 [52.4]	**10.31 [58.6]** 6.98 [39.6] 16.19 [91.9]	**3.86 [21.9]** 0.00 9.16 [52.0]
Detached ≥4,000 ft^2	4,5,6,7a	128	494	5,321	**5.12 [29.1]** 3.66 [20.8] 9.76 [55.4]	**10.41 [59.1]** 6.01 [34.12] 22.94 [130.3]	**4.32 [24.6]** 0.00 8.01 [45.5]
Attached	4,5,6,7a	553	193	2,082	**4.67 [26.5]** 3.54 [20.1] 8.74 [49.6]	**10.20 [57.9]** 5.29 [30.0] 15.78 [89.6]	**4.14 [23.5]** 0.00 6.81 [38.7]

Note: Climate zones have been updated in this report which resulted in a discrepancy in how homes were reported in previous reports compared to this report, primarily for climate zones 5 and 6.

Note: *In Table 5 "Basement Eff."* represents the effective thermal resistance of the foundation wall. The slab efficiency is not included in this report because the data is not readily exported from the modelling software. Some of homes did not have basements.

Table 6: Detached Homes - Building Envelope Performance by Climate Zone

Climate Zone	[# of homes]	Above Grade Wall Efficiency Avg. RSI [R]	Ceiling Efficiency Avg. RSI [R]	Basement Efficiency Avg. RSI [R]
4	[16]	5.15 [29.2]	8.18 [46.5]	4.24 [24.1]
5	[807]	4.56 [25.9]	10.28 [58.4]	3.81 [21.6]
6	[178]	5.36 [30.5]	10.79 [61.3]	4.44 [25.2]
7a	[59]	5.46 [31.0]	11.24 [63.8]	5.24 [29.8]

Note: *One detached home was labelled in climate zone 7b which is not statistically relevant. Therefore, climate zone 7b is not represented in Table 6, Figure 4, or Figure 5. The home labelled in climate zone 7b has an above-grade walls RSI of 8.29 (R-47), a ceilings RSI of 14 (R-79), and a basement wall RSI of 5.46 (R-31).*

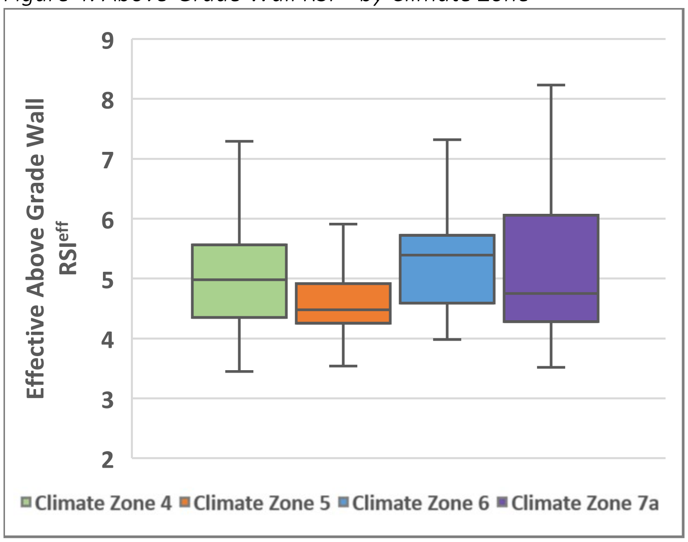
Table 7: Attached Homes - Building Envelope Performance by Climate Zone

Climate Zone	[# of homes]	Above Grade Wall Efficiency Avg. RSI [R]	Ceiling Efficiency Avg. RSI [R]	Basement Efficiency Avg. RSI [R]
4	[7]	5.08 [28.9]	7.56 [42.9]	4.75 [27.0]
5	[466]	4.60 [26.1]	10.09 [57.3]	4.09 [23.2]
6	[61]	5.21 [29.6]	11.12 [63.2]	4.30 [24.4]
7a	[19]	4.55 [25.9]	10.65 [60.5]	5.86 [33.3]

4.1 Above-Grade Wall Assemblies

This section considers the effective thermal resistance of above-grade wall assemblies. The 1,061 detached homes as well as the 553 attached homes are evaluated by climate zone. The evaluation measures an assemblies' resistance to heat flow using the metrics RSI and R-value, with a higher value being favourable. The CHBA Program has minimum requirements for the effective thermal resistance of above-grade wall assemblies outlined in the Technical Requirements. The charts below show the minimum, average, and maximum values reported.

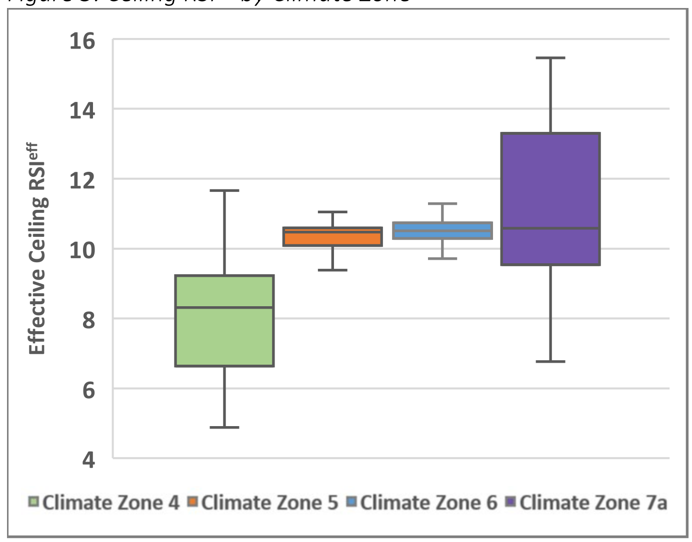
Figure 4: Above-Grade Wall RSI^{eff} by Climate Zone



4.2 Ceiling Assemblies

This section considers the effective thermal resistance of ceiling assemblies. The 1,061 detached homes as well as the 553 attached homes are evaluated by climate zone. The evaluation measures an assemblies' resistance to heat flow using the metrics RSI and R-value, with a higher value being favourable. The CHBA Program has minimum requirements for the effective thermal resistance of ceiling assemblies outlined in the Technical Requirements. The charts below show the minimum, average, and maximum values reported.

Figure 5: Ceiling RSI^{eff} by Climate Zone



Analysis

- 73% (778/1,061) of detached homes used effective thermal resistance of wall assemblies of ≥ RSI 4.4 [R25].
- 62% (343/553) of attached homes used effective thermal resistance of wall assemblies of ≥ RSI 4.4 [R25].
- 89% (949/1,061) of detached homes used effective thermal resistance of ceiling assemblies of ≥ RSI 9.7 [R55].
- 74% (409/553) of attached homes used effective thermal resistance of ceiling assemblies of ≥ RSI 9.7 [R55].

In general, most homes built within colder climate zones are constructed with higher levels of insulation in both their wall assemblies and their ceiling assemblies.

5.0 MECHANICALS

This section explores the mechanical systems in the homes relating to space heating and cooling, water heating, and ventilation.

5.1 Space Heating & Cooling

This section looks at the space heating and cooling systems used in the 1,614 attached and detached homes labelled under the Program.

- **Dual fuel space heating source:** 59.7% (964/1,614 homes)
- **Only electric space heating source:** 39.8% (643/1,614 homes)
- **Only gas space heating source:** <0.5% (7/1,614 homes)

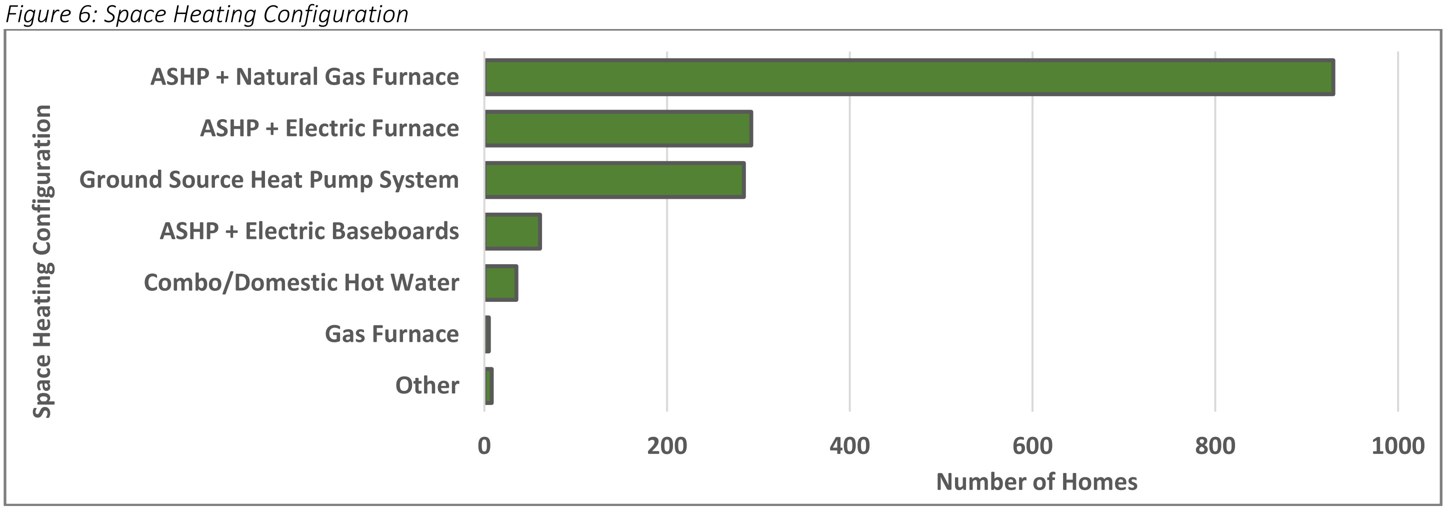
99.5% of homes in the Program installed a heat pump for space heating and cooling, therefore only 0.5% of homes were required to perform the space cooling threshold calculation. Air-source heat pumps (ASHP) are still used in the majority (82%) of homes. However, in 2023 18% of the homes used ground-source heat pumps (GSHP). This is mainly due to one specific Net Zero Ready development utilizing a community scale ground-source heat pump system for all the homes. 1 home installed a water-source heat pump (WSHP).

Table 8: Space Heating System Configuration of Homes by Province

Heating System Configuration	AB	BC	MB	NB	NL	NS	ON	SK	Total
ASHP + Natural Gas Furnace	3	0	0	14	0	0	905	7	929
ASHP + Electric Furnace	44	15	2	3	0	4	221	3	292
ASHP + Electric Baseboards	5	21	0	1	2	12	20	0	61
Combo/Domestic Hot Water	9	8	0	0	0	0	18	0	35
Natural Gas Furnace	0	1	0	0	0	0	3	1	5
Ground Source Heat Pump System	4	0	0	1	0	0	279	0	284
Other	1	4	0	0	0	0	3	0	8
Total	66	49	2	19	2	16	1449	11	1,614

Note: *The eight homes in the row titled 'Other' used the following heating system configurations.*
- *AB: Baseboards electric heaters and conventional air conditioning.*
- *BC: Air-to-water heat pump with radiant in floor heating.*
- *BC: Water-source heat pump with radiant in floor heating.*
- *BC: Air source heat pump with radiant in floor heating.*
- *BC: Baseboard electric heaters.*
- *ON: Air source heat pump with propane furnace.*
- *ON: Air source heat pump with propane furnace and with radiant in floor heating.*
- *ON: Air source heat pump with radiant in floor heating.*

Figure 6: Space Heating Configuration

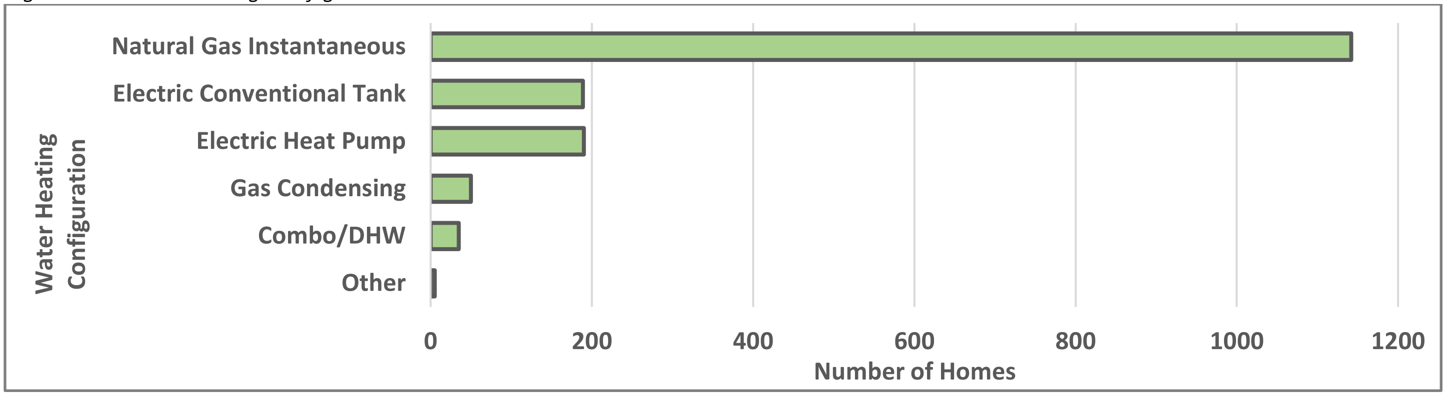


5.2 Water Heating

This section looks at the water heating systems used in the 1,614 attached and detached homes labelled under the Program.

- **Natural gas water heating:** 75.8% (1,223/1,614 homes)
- **Electric water heating:** 23.8% (384/1,614 homes)
- **Solar water heating:** <0.2% (3/1,614 homes)
- **Propane water heating:** <0.2% (4/1,614 homes)

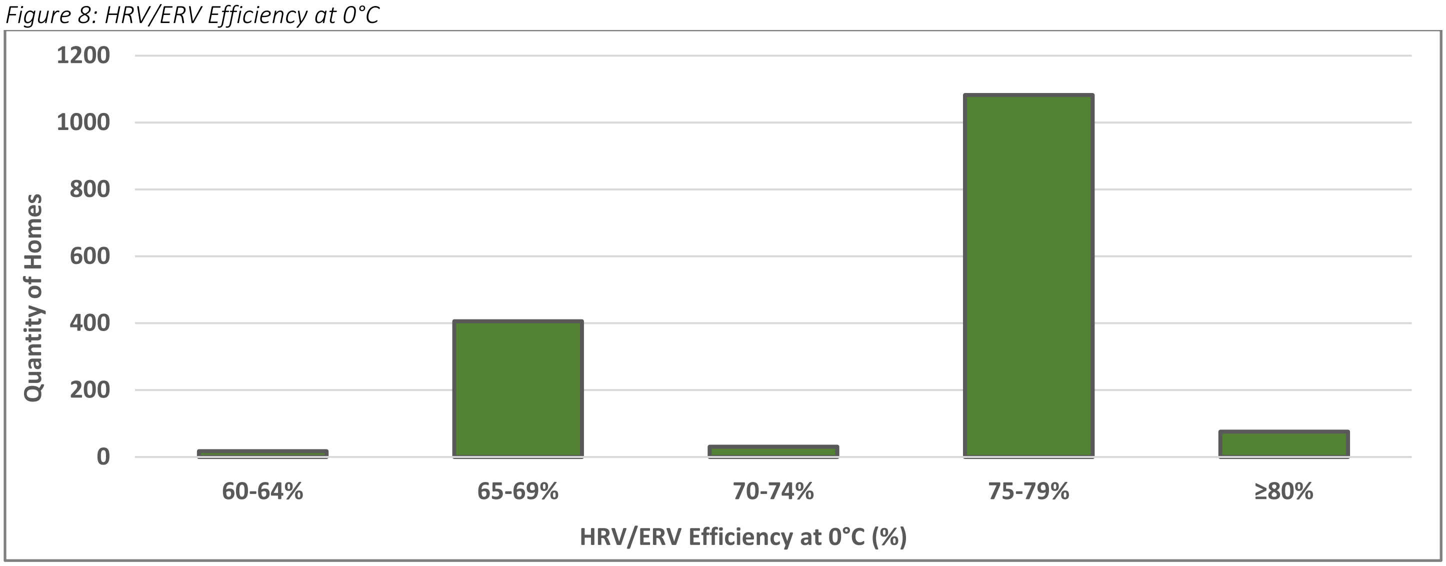
Figure 7: Water Heating Configuration



5.3 Ventilation

This section looks at the efficiency of the mechanical ventilation system used in the 1,614 attached and detached homes labelled under the Program. The CHBA Program has a requirement to include mechanical ventilation with a minimum 60% sensible heat recovery efficiency at 0°C. 100% of homes had a mechanical ventilation system installed.

Figure 8: HRV/ERV Efficiency at 0°C



Analysis

- 58% (929/1,614) of homes used an air-source heat pump with a back up natural gas furnace for space heating.
- 71% (1,142/1,614) of homes used a tankless natural gas instantaneous water heater.
- 72% (1,158/1,614) of homes used an HRV/ERV with an efficiency of 75% or greater at 0°C.

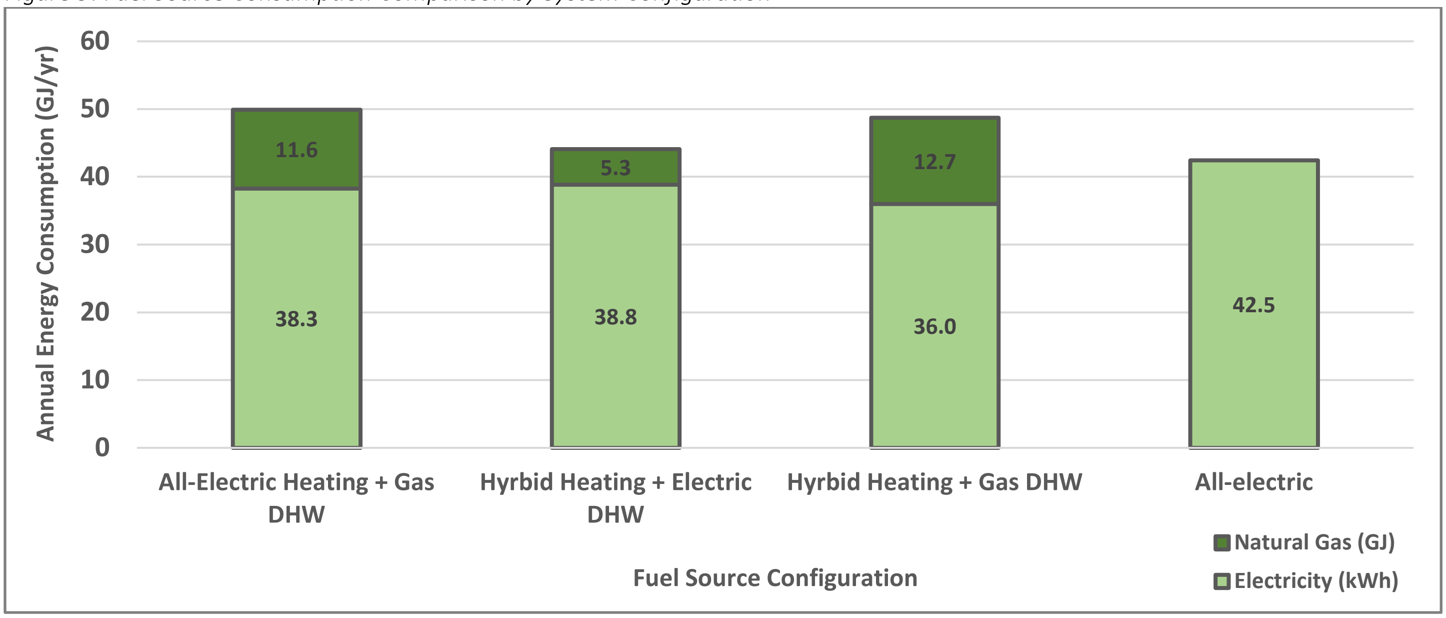
The majority of Net Zero and Net Zero Ready Homes continue to install an air-source heat pump as a primary heat source with a conventional heating source such as an electric or natural gas furnace used for supplementary heating. Domestic water heating is typically accomplished using highly efficient yet conventional systems like natural gas tankless water heaters, electric tank water heaters, or electric heat pump water heaters. Some homes have combined heating systems using a combination domestic hot water system (Combo/DHW). The largest percentage of homes use an HRV/ERV with a sensible heat-recovery efficiency (at 0°C) between 75-79%.

6.0 FUEL SOURCE

This section looks at the fuel source configurations used in the 1,614 Net Zero and Net Zero Ready Homes. The fuel sources that are used in these homes include electricity, natural gas, propane, and solar thermal water heating. The CHBA Program has no requirement for specific heating fuel sources – it is fuel agnostic. The only related requirement is that the total energy consumption is modelled to 0 GJ/year using onsite renewables.

This section considers the total modelled annual energy consumption which includes energy required for space heating, space cooling, water heating, ventilation, and occupant loads (lighting, appliances, and plug loads). Four categories are used to describe alike homes based on their respective mechanical system configurations. Table 9 provides details from the four categories. The categories are named based on the fuel source used for space heating and the fuel source used for domestic hot water (DHW). The majority of homes used a dual system space heating configuration, such as an air source heat pump paired with a supplementary conventional furnace. In the category names, "Hybrid Heating" denotes a home that used an electric primary with a natural gas supplementary system, where as "All-Electric Heating" indicates a home that uses an electric primary and an electric supplementary heating system.

Figure 9: Fuel Source Consumption Comparison by System Configuration



Note: *Figure 9 considers a comparison between natural gas consumption and electricity consumption – the two most common fuel sources used in Net Zero and Net Zero Ready Homes. 15 homes were not included in the chart below as they did not conform to the categories selected[1]. The modelled cubic metres of natural gas was converted to Gigajoules using a conversion rate of 0.0373. Source: https://natural-resources.canada.ca/energy/energy-sources-distribution/natural-gas/natural-gas-primer/5641*

Table 9: Fuel Source Configuration Comparison Category Details

Fuel Source Configuration	Avg. Natural Gas Consumption (m^3)	Avg. Electricity Consumption (kWh)	Number of Homes	Avg. Floor Area (m^2)	Climate Zones
All-Electric Heating + Gas DHW	311	10,633	308	250	4[4], 5[278], 6[18], 7a[8]
Hybrid Heating + Electric DHW	141	10,791	50	324	5[28], 6[24], 7a[8]
Hybrid Heating + Gas DHW	341	9,999	909	276	4[3], 5[787], 6[108], 7a[11]
All-Electric	0	11,792	332	230	4[15], 5[176], 6[89], 7a[51], 7b[1]

1 - 15 homes did not align with one of the four fuel source configurations selected.
- 3 homes used solar water heating and were not considered in this comparison.
- 5 homes used propane for heating and/or DHW and were not considered in this comparison.
- 7 homes used only a natural gas furnace for space heating and therefore did not fit in a category.

Analysis

All-Electric Heating + Gas DHW

- 90% (277/308) of homes used a GSHP system for space heating. This increase from the 2022 Summary report is largely in part to a single development that included the use of ground source heat pump technology.
- 95% (291/308) of homes were modelled to consume less than 310 m^3 of natural gas annually.

Hybrid Heating + Electric DHW

- 100% (50/50) of homes used an ASHP + natural gas furnace for space heating and cooling.
- 82% (41/50) of homes were modelled to consume less than 200 m^3 of natural gas annually.

Hybrid Heating + Gas DHW

- 97% (878/909) of homes used an ASHP + natural furnace for space heating and cooling.
- 72% (657/909) of homes were modelled to consume less than 400 m^3 of natural gas annually.

All-Electric

- 81% (269/332) of homes used an ASHP + electric furnace for space heating and cooling.
- 56% (185/332) used a conventional tank for water heating. 44% (147/332) of homes used a heat pump water heater.

A variety of reasons could influence why builders choose these fuel source configurations for their Net Zero/Ready Homes. Some examples are homeowner goals, cost, availability, and utility policy. To date, the majority of labelled homes have used a hybrid fuelled space heating configuration and a natural gas fuelled domestic hot water system. The second most popular configuration is an entirely electrically powered home.

7.0 PERFORMANCE

This section looks at the performance metrics used to evaluate these homes. Each metric is explained in detail in its respective section. The metrics are:

- Annual energy consumption, measured in GJ/year (AEC),
- Whole home heat loss, measured in GJ/year (WHHL),
- Airtightness, measured in air changes per hour at 50 pascals (ACH@50),
- Total energy use intensity, measured in GJ/m^2/year (TEUI),
- Mechanical energy use intensity, measured in GJ/m^2/year (MEUI),
- Percent better than reference house—whole house annual energy consumption (Ref AEC), and
- Percent better than reference house—building envelope (Ref Env).

Table 10: Performance Metrics Summary by Project Type

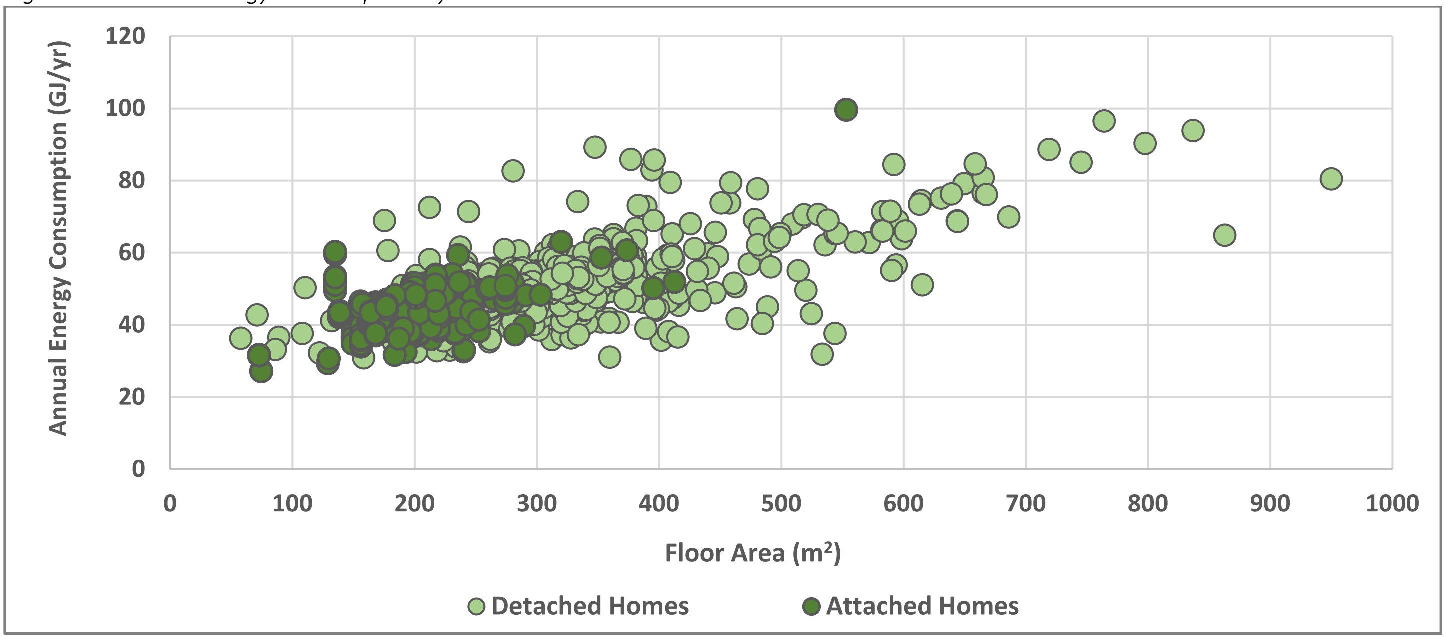
Project Type	# of Labels	Avg. Area m^2	Avg. Area ft^2	AEC ***Avg.*** *Min.* *Max.*	WHHL ***Avg.*** *Min.* *Max.*	ACH@50 ***Avg.*** *Min.* *Max.*	TEUI ***Avg.*** *Min.* *Max.*	MEUI ***Avg.*** *Min.* *Max.*	Ref AEC[2] ***Avg.*** *Min.* *Max.*	Ref Env[3] ***Avg.*** *Min.* *Max.*
Detached <2,600 ft^2	231	213	2,290	**45.3** 30.9 72.7	**49.4** 22.9 91.6	**1.04** 0.37 1.79	**0.22** 0.14 0.63	**27.9** 12.3 69.7	**61.9** 21.1 83.0	**54.7** 33.0 89.7
Detached ≥2,600 ft^2 <4,000 ft^2	702	294	3,165	**50.1** 31.1 89.3	**63.2** 38.8 123.0	**1.05** 0.28 1.76	**0.17** 0.09 0.30	**24.3** 8.5 56.6	**62.5** 27.7 86.9	**48.6** 33.0 88.7
Detached ≥4,000 ft^2	128	494	5,321	**62.3** 31.9 130.8	**104.2** 42.3 227.6	**1.00** 0.21 2.00	**0.13** 0.06 0.25	**21.7** 6.2 56.1	**67.6** 29.4 85.0	**50.9** 33.3 84.1
Attached	553	193	2,082	**43.4** 27.2 99.7	**38.6** 18.9 101.3	**1.46** 0.46 3.25	**0.23** 0.13 0.45	**27.3** 8.4 71.4	**55.8** 7.6 86.7	**54.5** 33.0 86.9

[2] 19 Detached homes and 6 attached homes did not have this calculation ("Ref AEC").
[3] 3 Detached homes did not have this calculation ("Ref Env").

7.1 Annual Energy Consumption

Annual energy consumption is defined as the amount of energy required to operate the home on an annual basis. This includes energy required for space heating, space cooling, water heating, ventilation, and occupant loads (lighting, appliances, and plug loads). Annual energy consumption is measured in GJ/year with a lower value being favourable. The CHBA Program has a modelled performance target of 0 GJ for the annual energy consumption, after offsets by the on-site renewable energy production have been included.

Figure 10: Annual Energy Consumption by Floor Area



Note: *2 homes were removed from Figure 10 as outliers. 1 home had a very large floor area relative to the other homes – 1062 m^2, and 1 home had a very high modelled annual energy consumption relative to the other homes – 130.8 GJ/year.*

Figure 11: Average Energy Load Distribution of Attached Homes

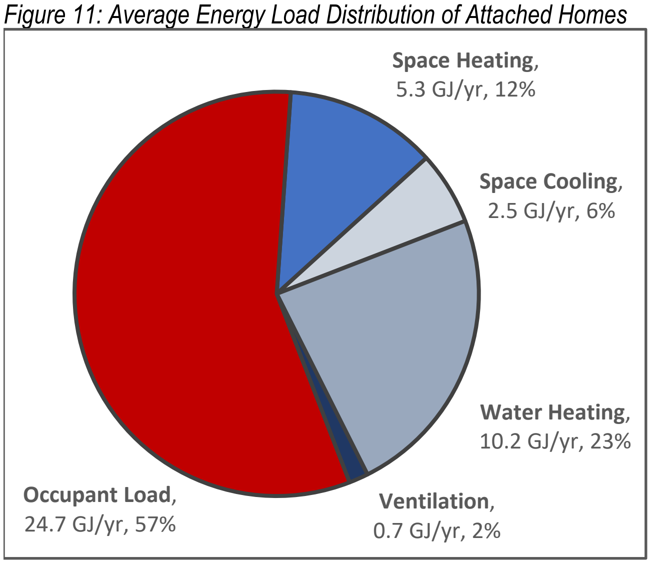


Figure 12: Average Energy Load Distribution of Detached Homes <2600ft^2

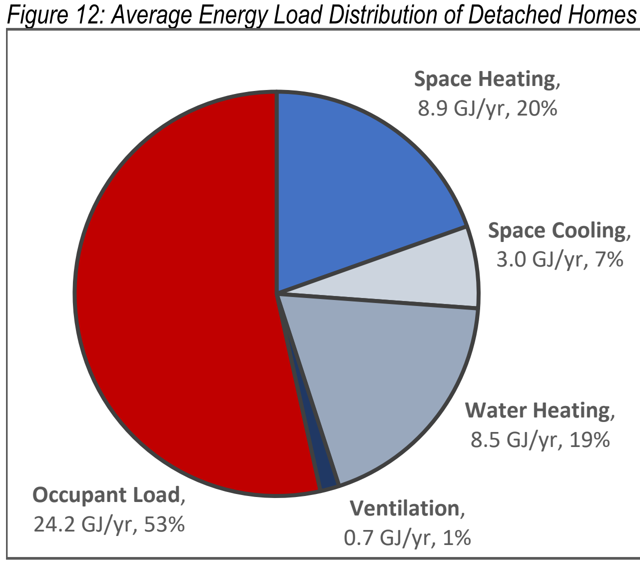


Figure 13: Average Energy Load Distribution of Detached Homes ≥ 2600ft² and <4000ft²

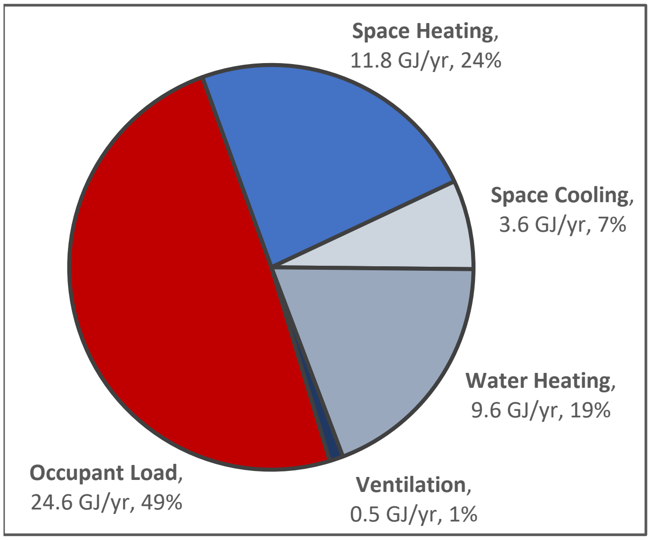
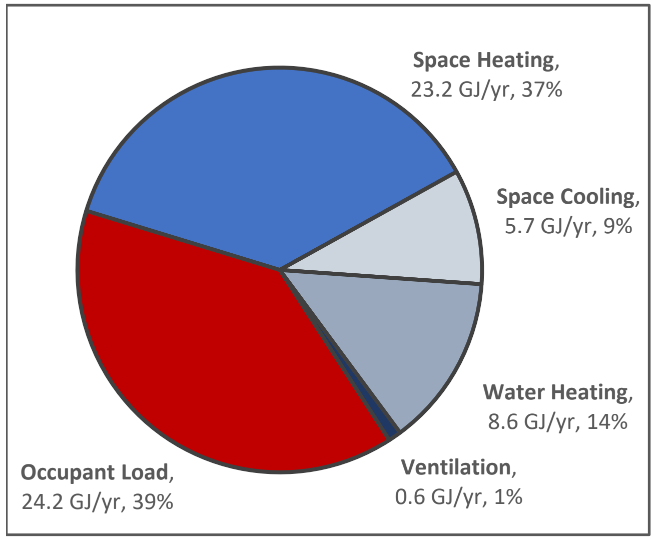


Figure 14: Average Energy Load Distribution of Detached Homes >4000ft²



AVERAGE ANNUAL ENERGY CONSUMPTION BY FLOOR AREA

- Attached Homes = 43.4 GJ/year
- Detached Homes <2,600 ft² = 45.3 GJ/year
- Detached Homes ≥2,600 ft² and <4,000 ft² = 50.1 GJ/year
- Detached Homes ≥4,000 ft² = 62.3 GJ/year

Analysis

- 71% (664/933) of detached homes with a heated floor area less than 4,000 ft² were modelled to have a total energy consumption of less than 52 GJ/year.
- 82% (456/553) of attached homes were modelled to have an annual energy consumption of less than 47 GJ/year.

There is a strong correlation between the size of the homes and the amount of total annual energy consumption modelled. In particular, the space heating energy required to heat the home typically increases directly with the increasing size of homes. On average, across all home types and sizes, ventilation and space cooling systems require the least amount of energy when compared to space heating, water heating, and occupant load. In general, as home floor area trends smaller, the occupant load makes up a larger percentage of the home's overall annual energy consumption.

7.2 Whole Home Heat Loss

Whole home heat loss is defined as the total amount of heat lost from the whole home on an annual basis. This includes heat lost from air leakage and heat lost through the foundation, ceilings, walls, exposed floors, and windows and doors. Whole home heat loss is measured in GJ/year with a lower value being favourable. The CHBA Program does not have a performance target for whole home heat loss.

Figure 15: Whole Home Heat Loss by Floor Area

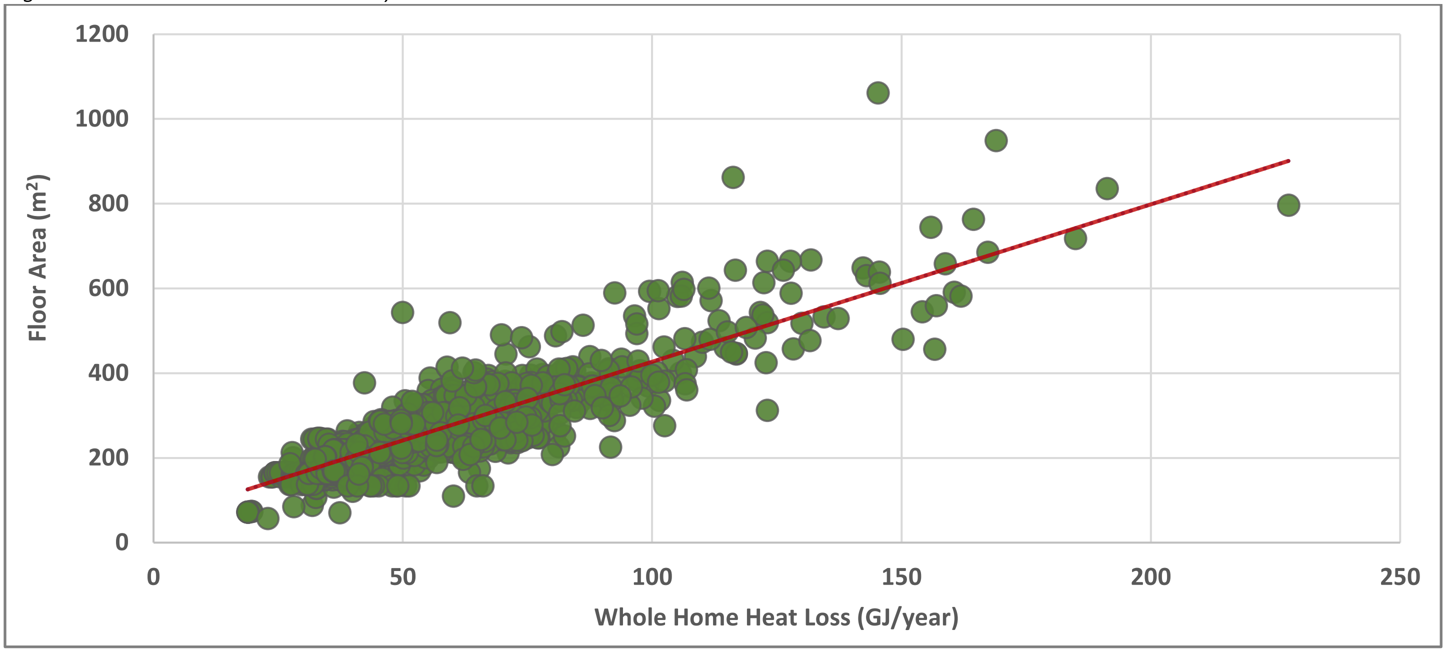


Figure 16: Detached Homes – Assembly Distribution of Whole Home Heat Loss by Climate Zone

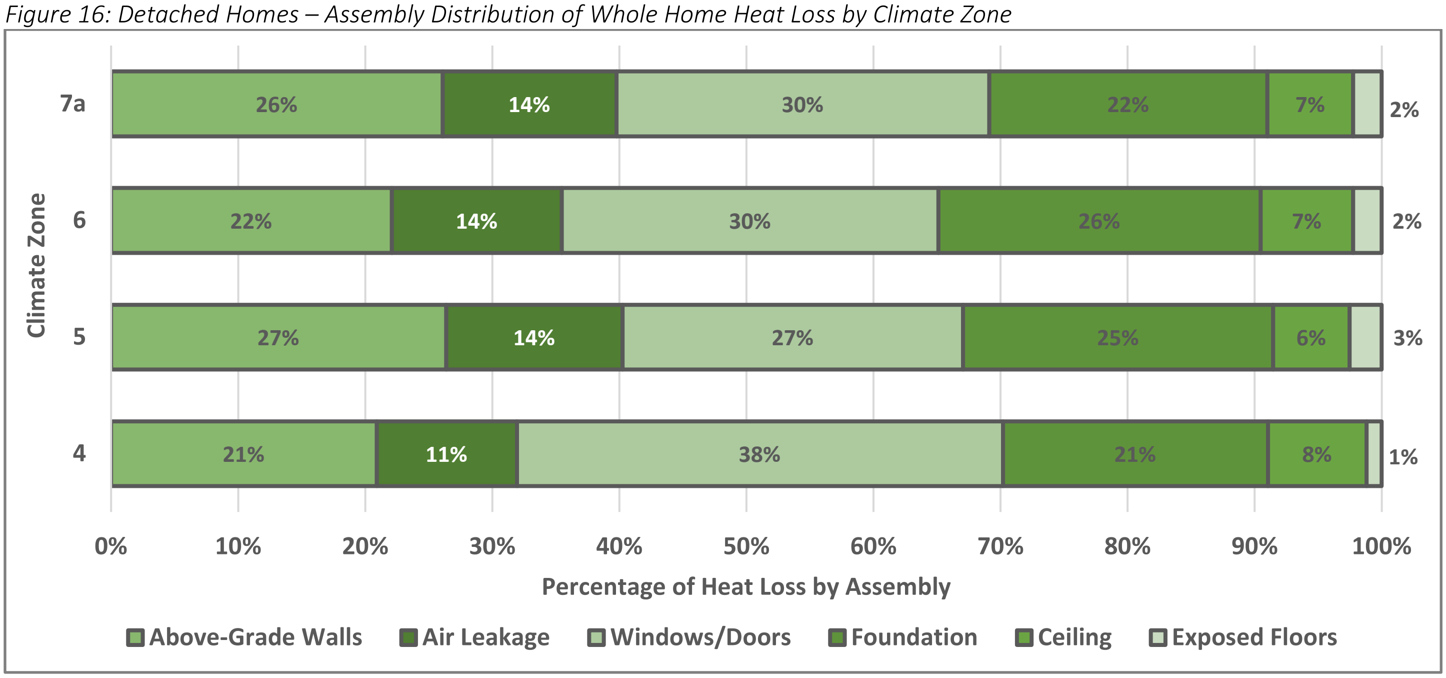
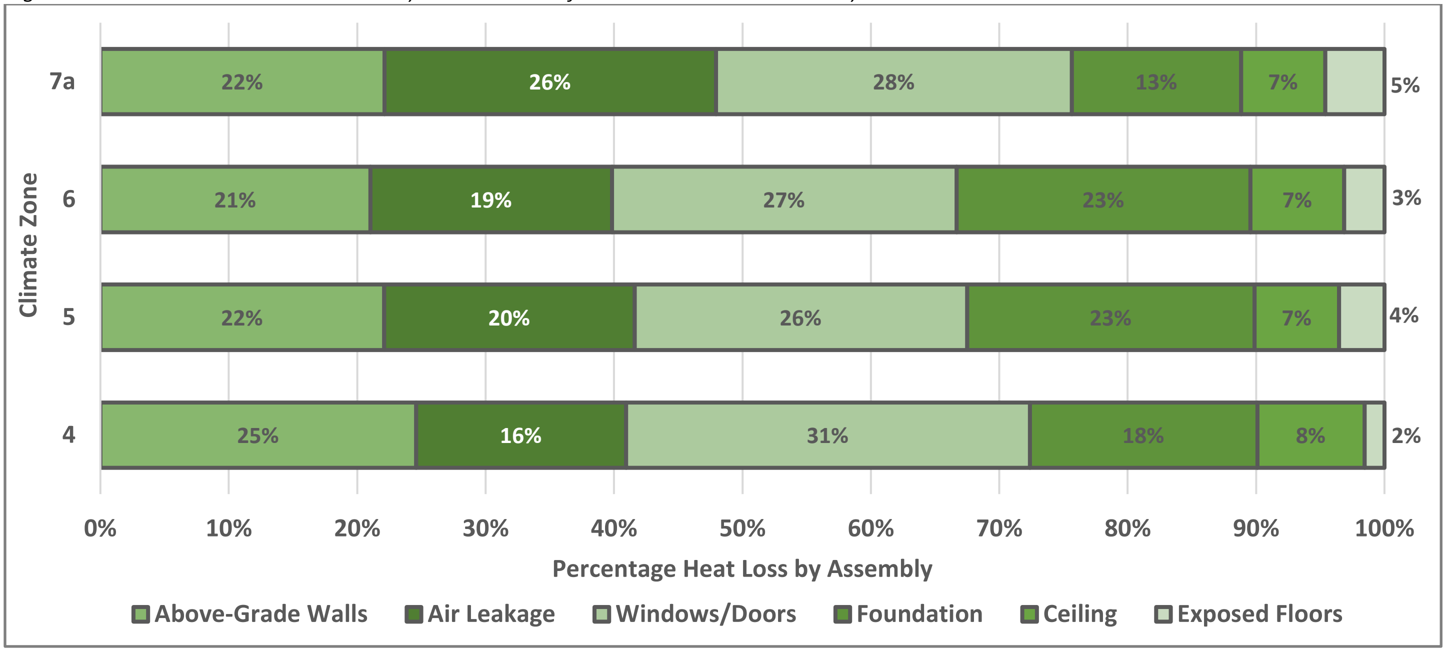


Figure 17: Attached Homes – Assembly Distribution of Whole Home Heat Loss by Climate Zone



DETACHED HOMES - AVERAGE WHOLE HOME HEAT LOSS

- Climate Zone 4 = 72.3 GJ/year
- Climate Zone 5 = 56.9 GJ/year
- Climate Zone 6 = 69.4 GJ/year
- Climate Zone 7a = 75.5 GJ/year

ATTACHED HOMES - AVERAGE WHOLE HOME HEAT LOSS

- Climate Zone 4 = 53.6 GJ/year
- Climate Zone 5 = 34.0 GJ/year
- Climate Zone 6 = 43.5 GJ/year
- Climate Zone 7a = 56.2 GJ/year

Analysis

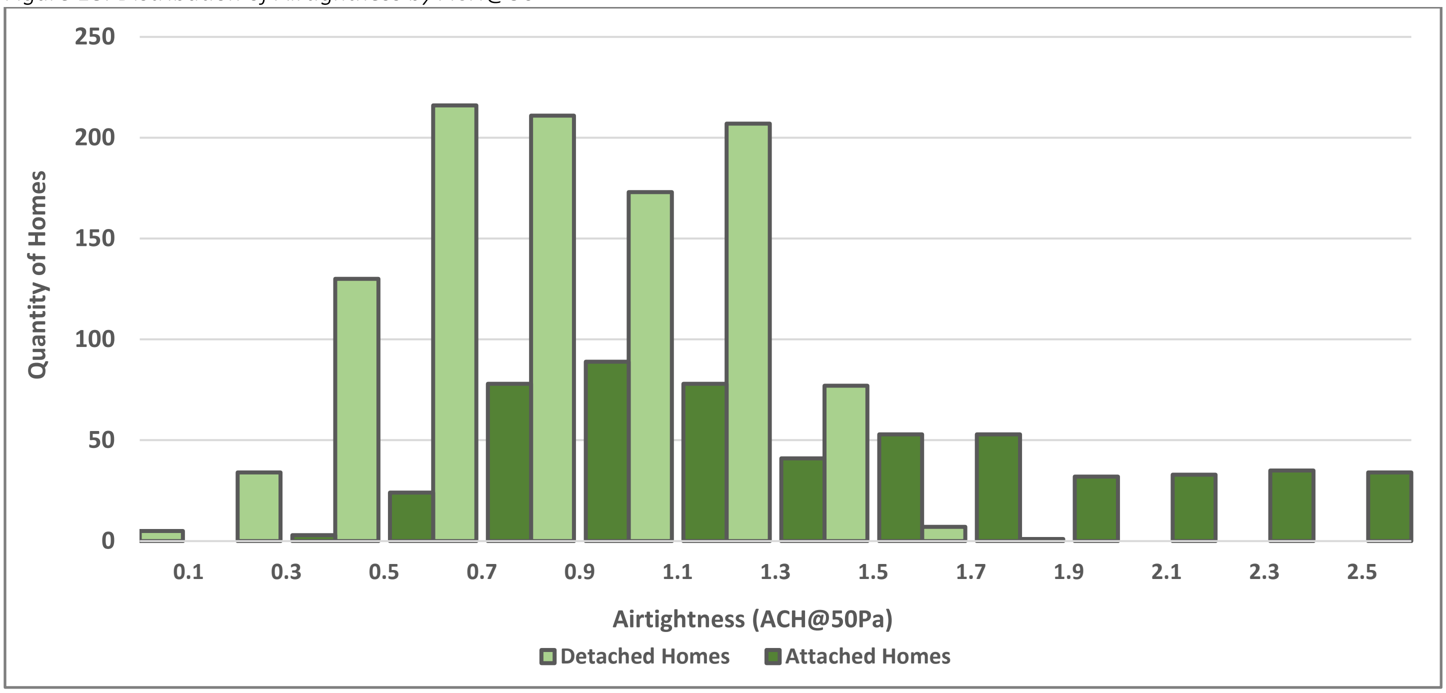
- 65% (504/775) of detached homes were modelled to have a whole home heat loss of less than 65 GJ annually.
- 76% (260/342) of attached homes were modelled to have a whole home heat loss of less than 40 GJ annually.

In general, larger homes lose more heat through their envelope. Windows and doors are a top contributor to heat loss by percentage in all climate zones. Ceilings typically contribute to a relatively small percentage of homes' total heat loss. This is likely because ceilings typically have the highest level of insulation compared to other building assemblies. The 23 homes in climate zone 4 had and average heated floor area of 318m^2 (3,423 ft^2).

7.3 Airtightness

Airtightness is a measurement of how resistant the dwelling unit is to inward and outward air leakage. Airtightness is measured in air changes per hour (ACH@50) with a lower value indicating better performance. The dwelling unit is depressurized to 50 pascals with a fan typically positioned and enclosed in the front door frame. The volume of air passing through the fan at a constant pressure is recorded. This amount represents the amount of air escaping the dwelling unit. ACH measures the number of times the air is replaced in one hour compared to the volume of the dwelling unit, for example, an ACH@50 of 1, 2, and 0.5 means the amount of air replaced in one hour is the same, double and half (respectively) the volume of the unit being tested. **The CHBA Program has a performance target of maximum 1.5 ACH@50 for detached homes and maximum 2.0 ACH@50 for attached homes. The Program also has airtightness targets using two additional recognized metrics: Normalized Leakage Area at 10 Pascals (NLA@10) and Normalized Leakage Rate at 50 Pascals (NLR@50). The Program requires that only one of these targets be met.**

Figure 18: Distribution of Airtightness by ACH@50



Note: *The homes that failed to meet the ACH targets in Figure 18 achieved compliance using one of the other airtightness target metrics – Normalized Leakage Rate (NLR@50Pa) or Normalized Leakage Area (NLA@10Pa).*

Analysis

- The average airtightness of all 1,061 detached homes is 1.04 ACH@50Pa.
- The average airtightness of all 553 attached homes is 1.46 ACH@50Pa.
- The overall airtightness average for detached and attached homes is 1.19 ACH@50Pa.

Builders of Net Zero and Net Zero Ready Homes continue to build very tight envelopes. 1.0 ACH@50Pa or less has proven to be an affective airtightness target to achieving Net Zero/Ready.

7.4 Energy Use Intensity

Measures of energy use intensity express the home's energy consumption in relation to the size of the home's heated floor area.

Total Energy Use Intensity (TEUI), shown in Figure 19, compares the total annual energy consumption of the home to the size of the home's heated floor area. TEUI includes the energy required for space heating, space cooling, domestic water heating, ventilation, and occupant load and divides the total by the heated floor area with a lower value indicating better performance.

Mechanical Energy Use Intensity (MEUI), shown in Figure 20, compares the home's annual energy consumption (excluding the occupant load) to the size of the home's heated floor area. MEUI includes the energy required for space heating, space cooling, water heating, and ventilation, and divides the total by the heated floor area.

Figure 19: Total Energy Use Intensity by Floor Area

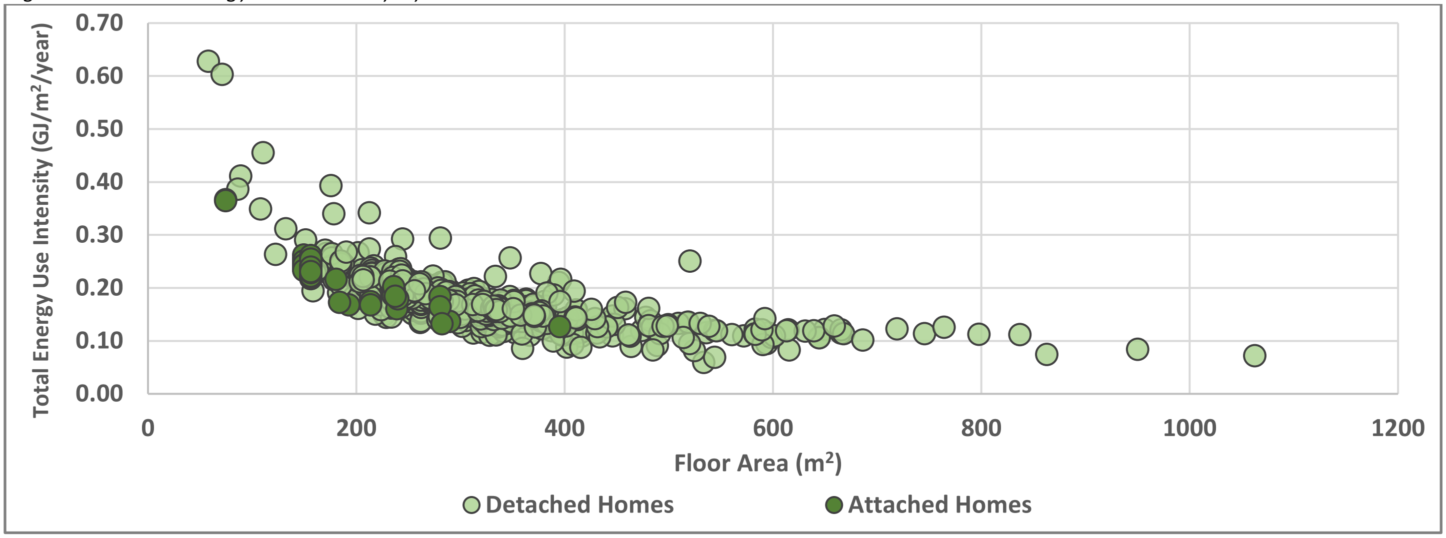
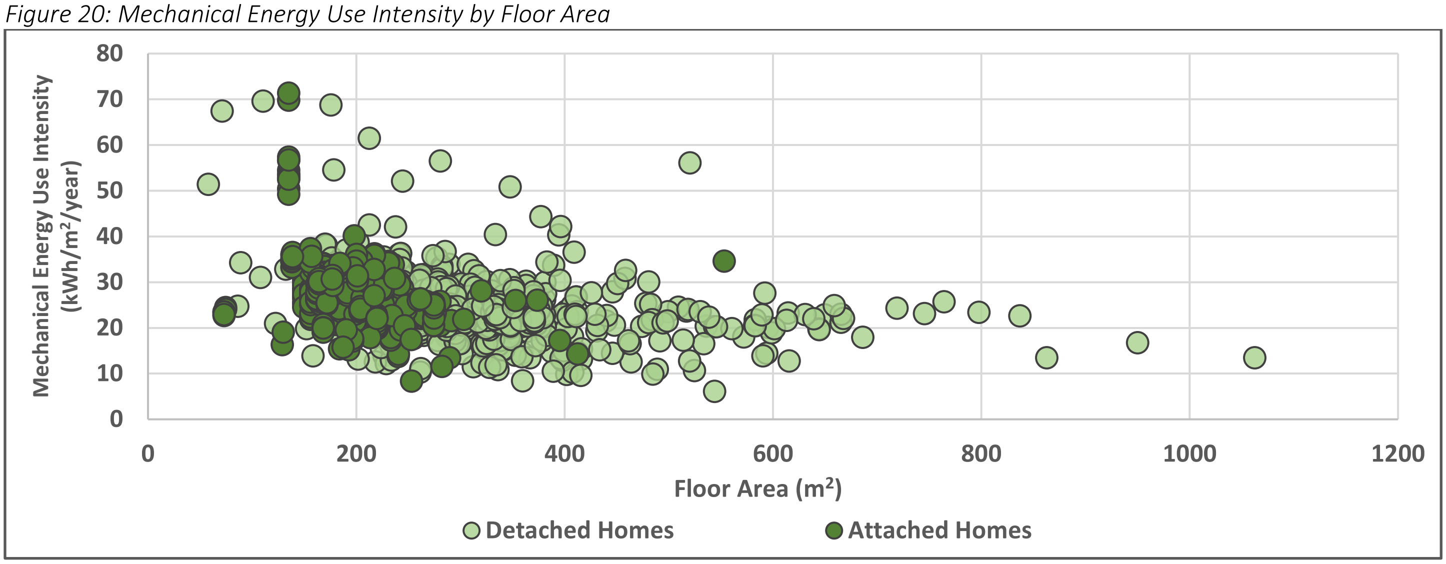


Figure 20: Mechanical Energy Use Intensity by Floor Area



Analysis

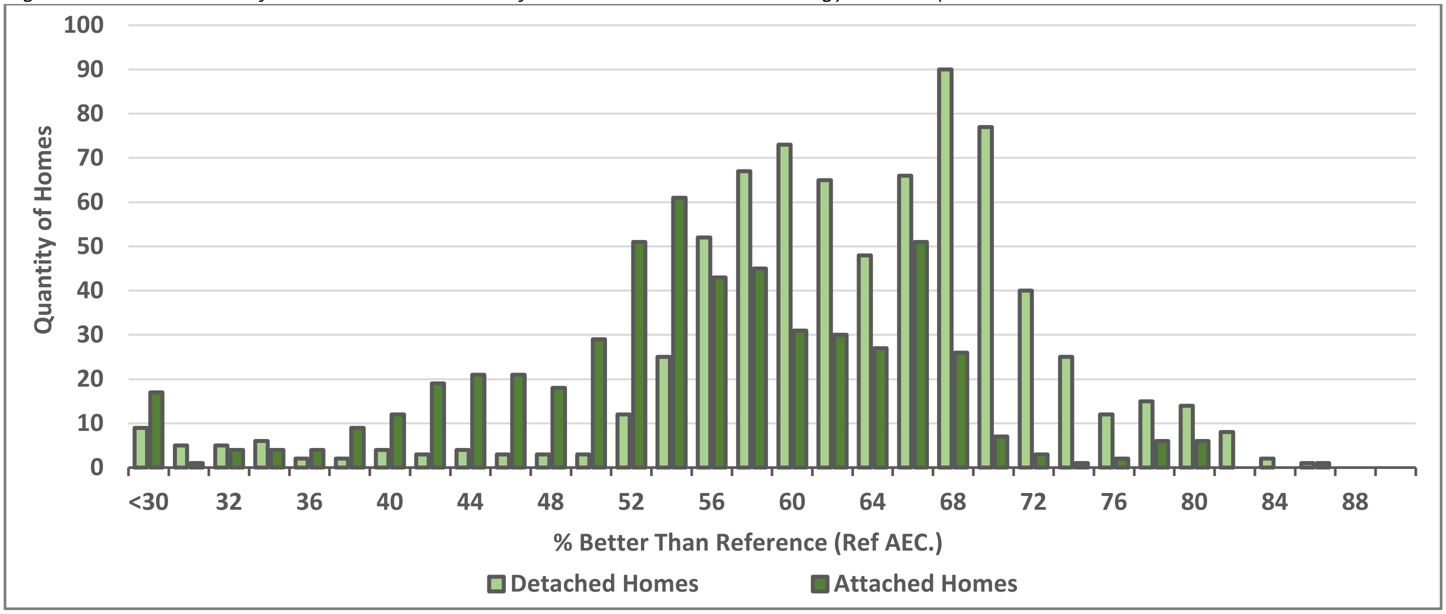
- 80% (1,292/1,614) of all detached and attached homes have a TEUI less than 0.23 GJ/m^2/year.
- 73% (1,173/1,614) of all detached and attached homes have a MEUI less than 28 kWh/m^2/year.

In general, smaller homes often have a higher TEUI and MEUI than larger homes. A smaller heated floor area can impact the ability of a home to achieve a low TEUI and MEUI.

7.5 Percent Better than Reference House – Annual Energy Consumption ("Ref. AEC")

Percent Better than Reference House—Whole House Energy Consumption is a measure of how much better the proposed house is in whole house energy consumption compared to its respective Reference House, which is a Code-minimum version of the proposed house. "Ref. AEC" is measured as a percentage (%) with a higher value indicating better performance. The "Ref. AEC" calculation in this report follows the "Ref AEC" calculation as defined in the BC Energy Step Code. Ref. AEC includes the energy consumption of the home's space heating, space cooling, water heating, and ventilation and excludes the occupant baseloads (lights, appliances, plug loads) from both the proposed house and the Reference House. The CHBA Program does not have a performance target for "Ref. AEC". The fifth tier in the 2020 National Building Code energy performance tiers is 70% overall energy improvement.

Figure 21: Distribution of Percent Better Than Reference House - Annual Energy Consumption



Note: *Only 1,589 detached and attached homes have this calculation because it was included in the updated version of HOT2000, v11.*

ANALYSIS

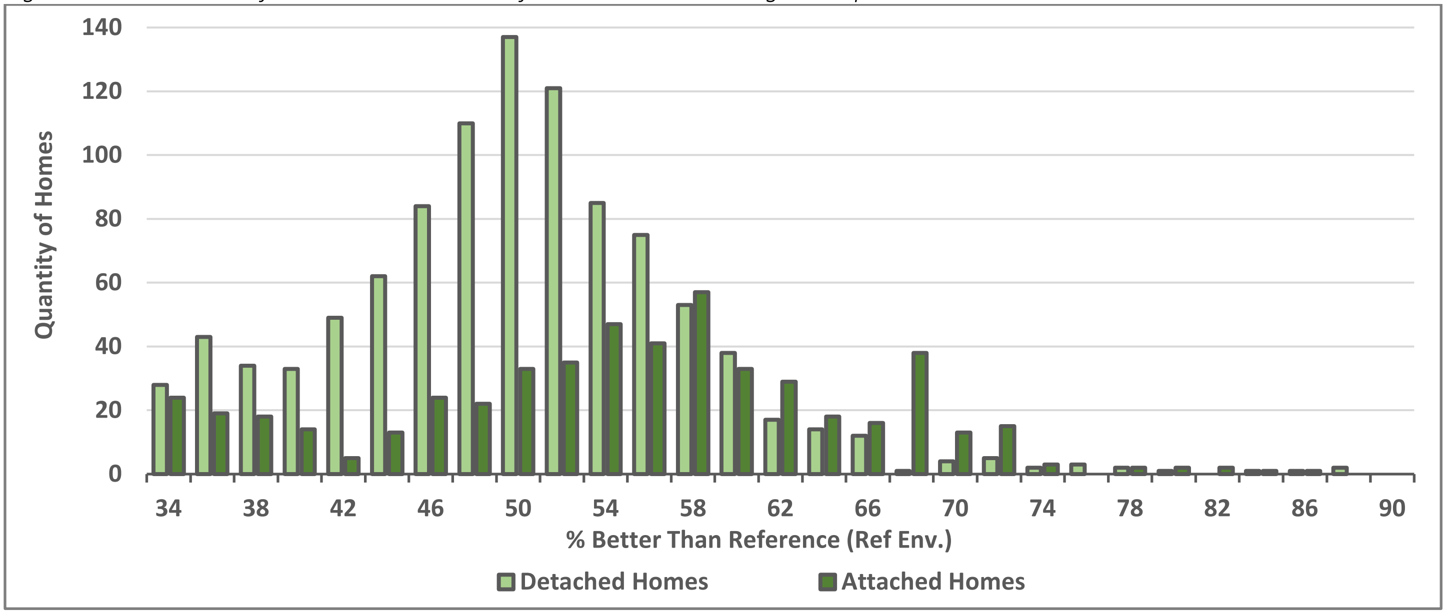
- The average for all 1,042 detached homes is 63.0% better than "Ref. AEC".
- The average for all 547 attached homes is 55.8% better than "Ref. AEC".
- Of all the detached and attached homes 15% (238/1,589) achieved 70% better than "Ref. AEC" or greater, and 58% (916/1,589) achieved a level of 60% better than "Ref. AEC" or greater.

The majority (76%) of Net Zero and Net Zero Ready Homes achieved between 55% and 80% better than the reference house for annual energy consumption.

7.6 Percent Better than Reference House – Building Envelope ("Ref. Env.")

Percent Better than Reference House—Building Envelope is a measure of how much better the proposed house is in building envelope compared to its respective Reference House, which is a Code minimum version of the proposed house. "Ref. Env" is measured as a percentage (%) with a higher value indicating better performance. The "Ref. Env." calculation compares the space heating energy requirements from the proposed house energy model and the Reference House energy model. The CHBA Program includes a performance target of minimum 33% better than its Reference House for building envelope.

Figure 22: Distribution of Percent Better Than Reference House - Building Envelope



Note: *Only 1,057 detached homes have been included in this calculation because it was only included in the updated version of HOT2000, v11 in 2017.*

ANALYSIS

- The average for all 1,057 detached homes is 50% better than "Ref. Env."
- The average for all 553 attached homes is 55% better than "Ref. Env."

The distribution of building envelope percent improvement better than the reference house shows a tighter correlation for detached homes than attached homes. 72% of detached homes achieve a building envelope between 45% and 65% better than the reference house, and 61% of the attached homes achieve a building envelope between 45% and 65% better than the reference house.

8.0 OPERATIONAL GHG EMISSIONS

This section considers the annual greenhouse gas emissions (GHG) from the modeled operation of the 1,614 detached and attached homes labelled under the Program as of December 31, 2023. The operational GHG emissions vary depending on the energy sources (electricity, natural gas, and propane) used to operate the homes as well as the greenhouse gas emissions associated with the respective energy sources. In order to standardize and simplify this calculation, the GHG emissions of specific energy sources is typically expressed in terms of emission factors. Since emission levels vary from utility to utility and with time, the specific emission factors for this section of the report are taken as average emission factor for each province according to the National Inventory Report published by Environment and Climate Change Canada. Details on the operational GHG emissions calculation methodology can be found in Appendix A.

In this report, two metrics are used to analyze operational GHG emissions:

- Annual operational GHG emissions, measured in kgCO_2e/year
- Annual operational GHG emissions intensity, measured in kgCO_2e/m^2/year

Table 11: Annual Operational GHG Emission of Homes by Province

Project Location	Climate Zone(s)	# of Labels	Avg. Area m^2	Avg. Area ft^2	Total Operational GHGs kgCO_2e/year			Operational GHG Intensity kgCO_2e/m^2/year		
					Avg.	Min.	Max.	**Avg.**	Min.	Max.
Alberta	6,7a	58	264	2,841	**6,195**	4,273	11,662	**27.0**	14.6	45.1
British Columbia	4,5,6,7a	49	324	3,488	**456**	115	3,641	**1.44**	0.28	7.87
Manitoba	7a	2	289	3,111	**14**	12	17	**0.05**	0.05	0.05
New Brunswick	6	19	297	3,197	**4,275**	3,377	4,992	**15.0**	8.41	21.3
Newfoundland & Labrador	6	2	441	4,744	**292**	275	309	**0.69**	0.57	0.82
Nova Scotia	6	16	181	1,948	**7,004**	4,984	10,265	**57.4**	15.3	115.3
Ontario	5,6,7a	1441	262	2,820	**904**	3	5,604	**3.59**	0.02	12.9
Saskatchewan	7a,7b	11	258	2,777	**8,913**	6,244	15,033	**37.4**	22.8	63.1

Note: *16 homes were excluded from this section as they did not have the appropriate data to calculate GHG emissions.*

8.1 Annual Operational GHG Emissions

This section considers total annual operational GHG's emitted as well as annual operational GHG emissions intensity based on heated floor area. It does not consider GHG offsets from the on-site renewable energy installed on some homes. Figure 23 shows the average annual operational GHG emissions of the Net Zero and Net Zero Ready Homes labelled within each province and Figure 24 shows the same data normalized by the homes' heated floor area.

Figure 23: Average Annual Operational GHG Emissions of Homes by Province

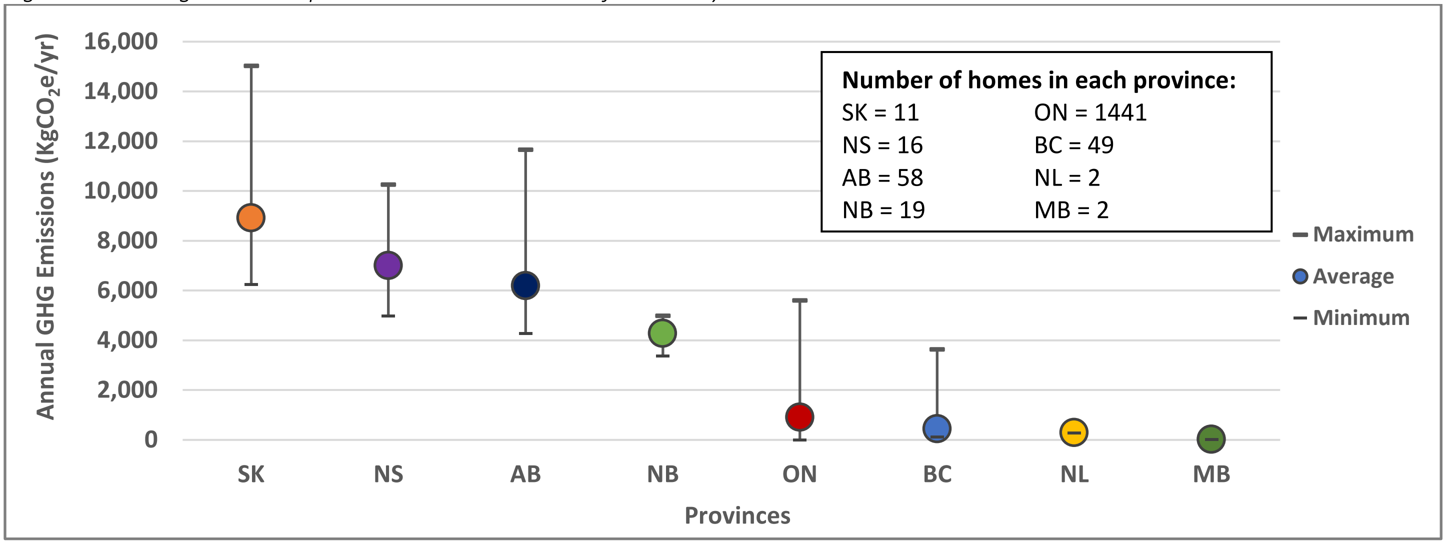
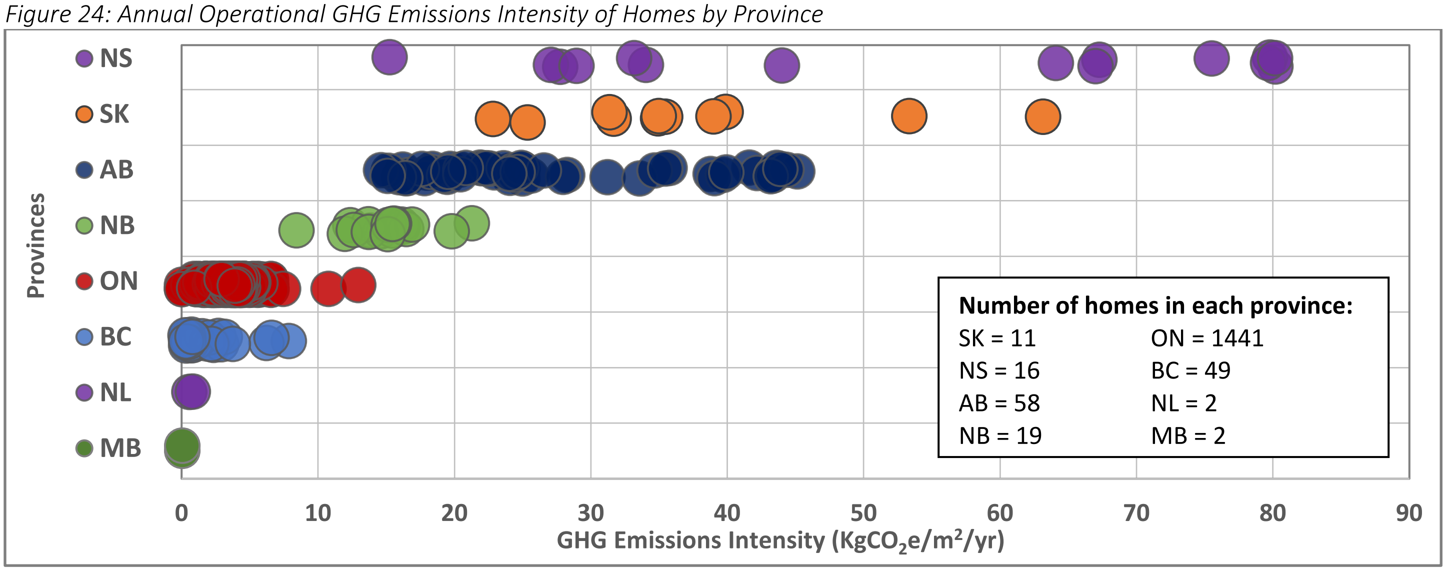


Figure 24: Annual Operational GHG Emissions Intensity of Homes by Province



ANALYSIS

Annual operational GHG emissions is greatly dependant on the provincial emission factors as well as the fuel selection of the project. Nationally, projects can not be compared fairly to one another from province to province because of the different grid emission intensities between provinces.

Note that this report does not consider the GHG emissions offsets from homes with renewables installed. This is done so that Net Zero Ready Homes can be compared to Net Zero Homes. With GHG emissions offsets included Net Zero Homes would have substantially fewer operational GHG emissions. In the case of renewable offsets, a Net Zero Home labelled in a province with higher grid emission intensities would have a high degree of GHG emissions avoidance in comparison to the same home in a province with a lower grid emission intensity.

9.0 MULTI-UNIT RESIDENTIAL BUILDINGS (MURBs)

This section looks at the multi-unit residential buildings (MURBs) labelled under the Net Zero Home Labelling Program. Only NBC Part 9 MURBs are eligible to label within the Program. **Nine buildings, with a total of 80 dwelling units**, have been labelled under the Program. MURBs labelled within the Program have complied under the *Net Zero Home Labelling Program for New Homes - Technical Requirements*. Within this analysis trends from the data are presented in the categories of building envelope efficiency, mechanical systems installed, annual energy consumption, total energy use intensity, airtightness, percent better than reference house – building envelope, percent better than reference house – annual energy consumption and annual operational GHG emissions.

The buildings are categorized into two groups based on how the buildings were modelled in HOT2000 – 'Single Units - MURBs' and 'Whole Building - MURBs'. Single Unit MURBs are multi-unit residential buildings that have been modelled in HOT2000 using a single unit approach and Whole Building – MURBs are multi-unit residential buildings that have been modelled in HOT2000 using a whole building approach. **It's important to note that building size varied greatly, from 2 units to 16 units**. In some of the Figures below, performance was divided by number of dwelling units in order to normalize results across all buildings.

9.1 Envelope Efficiency

This section considers the effective thermal resistance of above-grade wall assemblies and ceiling assemblies of the nine MURBS labelled under the Program. The evaluation measures an assemblies' resistance to heat flow using the metrics RSI and R-value, with a higher value being favourable. The charts below show the average RSI value per assembly within each building.

Figure 25: Net Zero MURBs – Above-Grade Wall RSI^{eff}

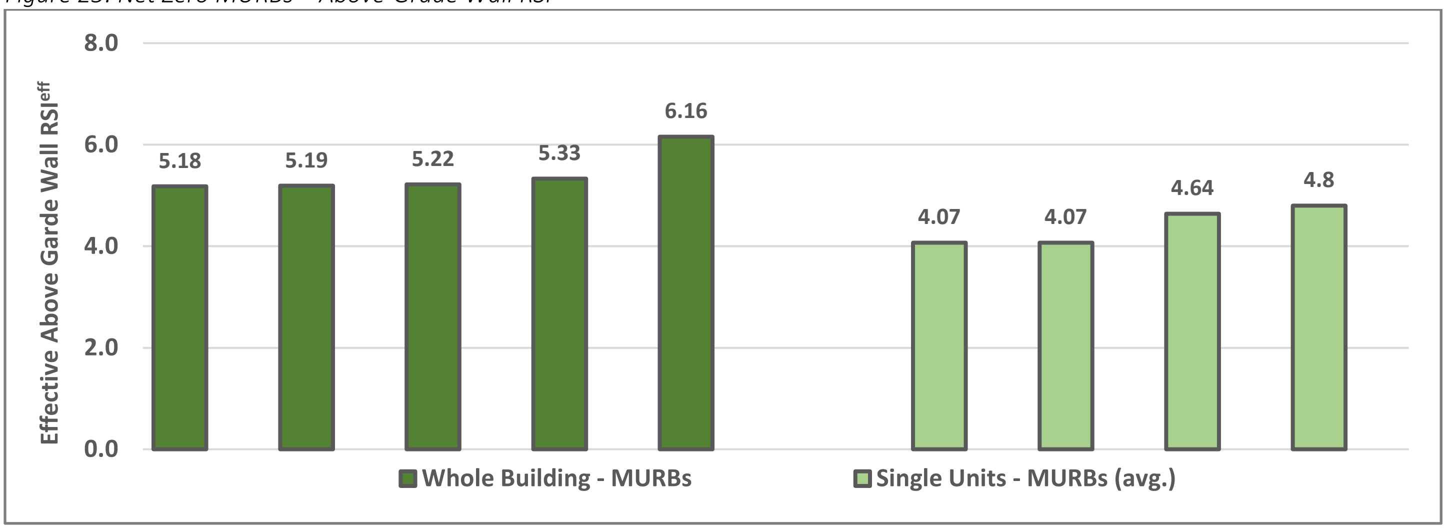
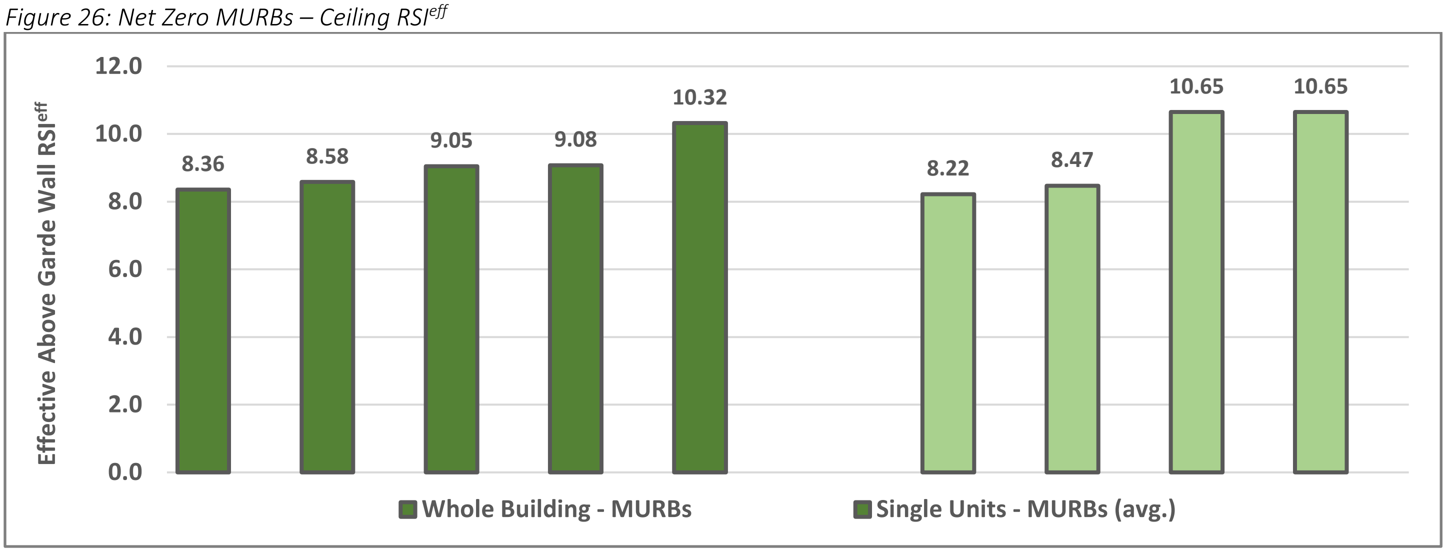


Figure 26: Net Zero MURBs – Ceiling RSI^{eff}



9.2 Mechanical Systems

This section looks at the mechanical systems used in the MURBS relating to space heating and cooling, water heating, and ventilation. Note that some of the buildings did not install the same mechanical systems configurations uniformly throughout each dwelling unit. In some of the smaller units, and/or basement units. simplified systems were used to achieve the same outcome.

Table 12: Net Zero MURBs – Space Heating and Cooling Configurations

Space Heating and Cooling Configuration	Dwelling Units
ASHP + Electric Furnace	44
ASHP + Electric Baseboards	16
Electric Baseboards	8
ASHP + Gas Furnace	6
Gas Furnace	6

Table 13: Net Zero MURBs – Water Heating Configurations

Water Heating Configuration	Dwelling Units
Electric Tank	60
Heat Pump Water Heater	20

Table 14: Net Zero MURBs – HRV/ERV Efficiency at 0°C

HRV/ERV Efficiency at 0°C	Dwelling Units
65-69%	18
70-74%	18
75%-79%	44

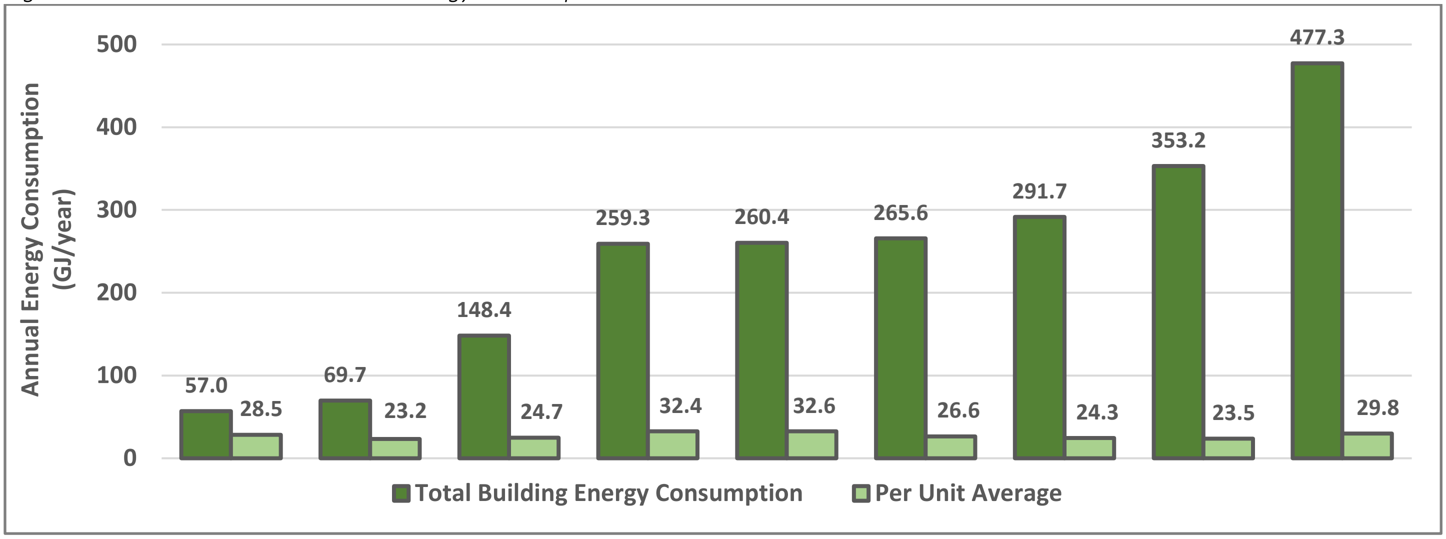
ANALYSIS

The majority of the Net Zero and Net Zero Ready MURBs utilized all-electric mechanical systems: 85% of the units had all-electric space heating and cooling configurations installed, such as an ASHP primary system with an electric furnace or electric baseboards for supplementary heating. 100% of the MURB units had all-electric water heating configurations installed. Most of the units (78%) utilized a mechanical ventilation system with a sensible recovery efficiency of 70% (at 0°C) or greater.

9.3 Energy Consumption

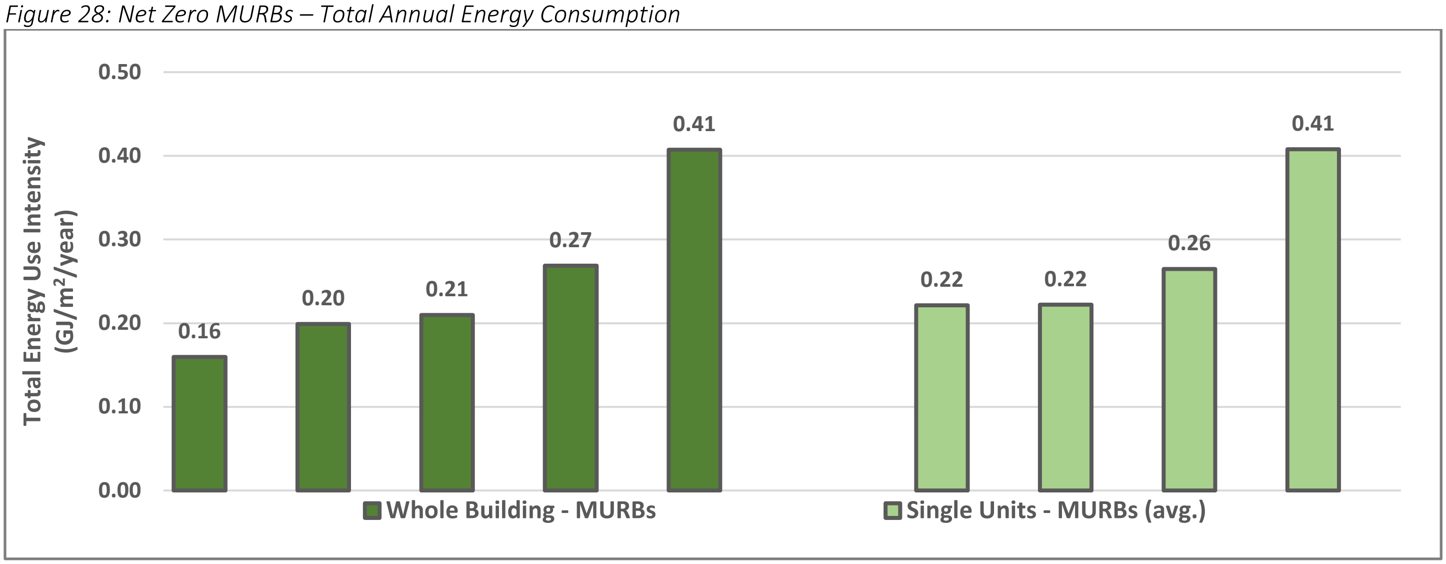
This section considers the energy consumption of the nine MURBs labelled. In Figure 27, energy consumption is shown both at the building level and at the dwelling unit level. Annual Energy Consumption is based on the energy required for space heating, space cooling, water heating, ventilation, and occupant loads (lighting, appliances, and plug loads), with a lower value being favourable. The CHBA Program has a modelled performance target of 0 GJ for the annual energy consumption, offset by the on-site renewable energy production.

Figure 27: Net Zero MURBs – Annual Energy Consumption



In Figure 28, Total Energy Use Intensity (TEUI), compares the total annual energy consumption of the dwelling unit to the size of the unit's heated floor area. TEUI includes the energy required for space heating, space cooling, domestic water heating, ventilation, and occupant load and divides the total by the heated floor area with a lower value indicating better performance.

Figure 28: Net Zero MURBs – Total Annual Energy Consumption



ANALYSIS

- The average total building annual energy consumption for all nine MURBs is 243 GJ/year.
- The average annual energy consumption per dwelling unit for all 80 MURB units is 27/3 GJ/year.
- The average TEUI for the five whole building modeled MURBs is 0.25 GJ/m^2/year.
- The average TEUI for the four single unit modeled MURBs is 0.28 GJ/m^2/year.

9.4 Airtightness

Airtightness is a measurement of how resistant the building, or dwelling unit is to air leakage. In this report, airtightness is measured in air changes per hour (ACH@50). For further detail about airtightness and the Program's applicable targets see section 7.3. For comparison purposes the buildings that were modeled using a whole building approach are shown on a different chart from those that modelled using the single unit approach.

Figure 29: Net Zero MURBs – Whole Building Airtightness

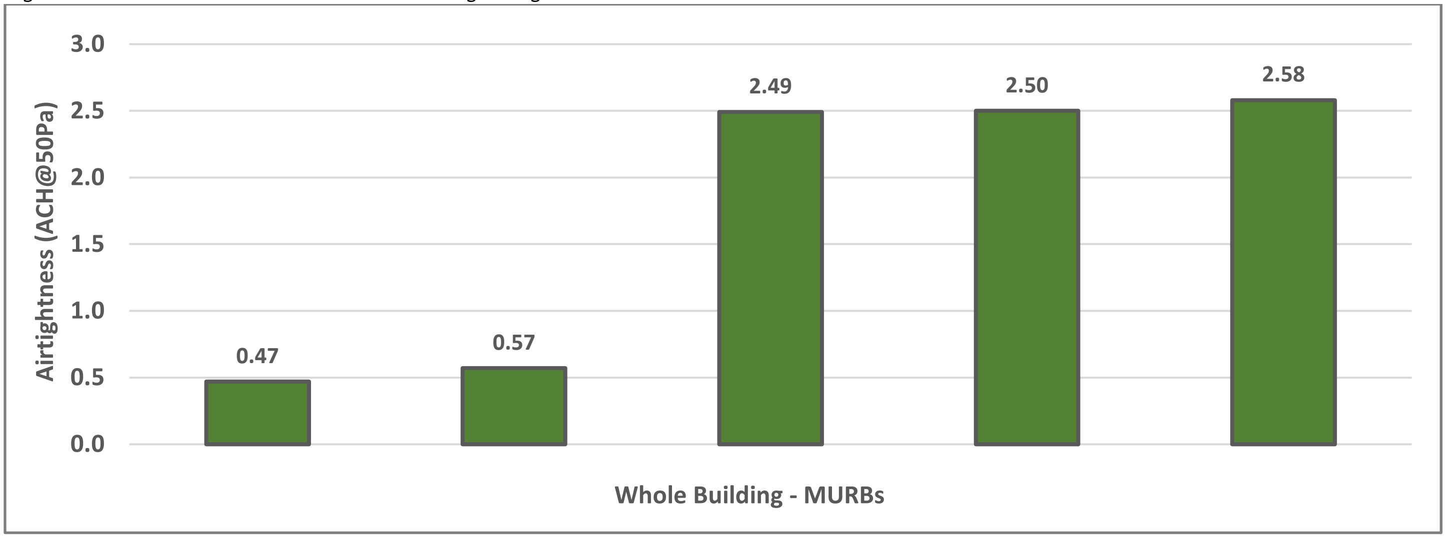
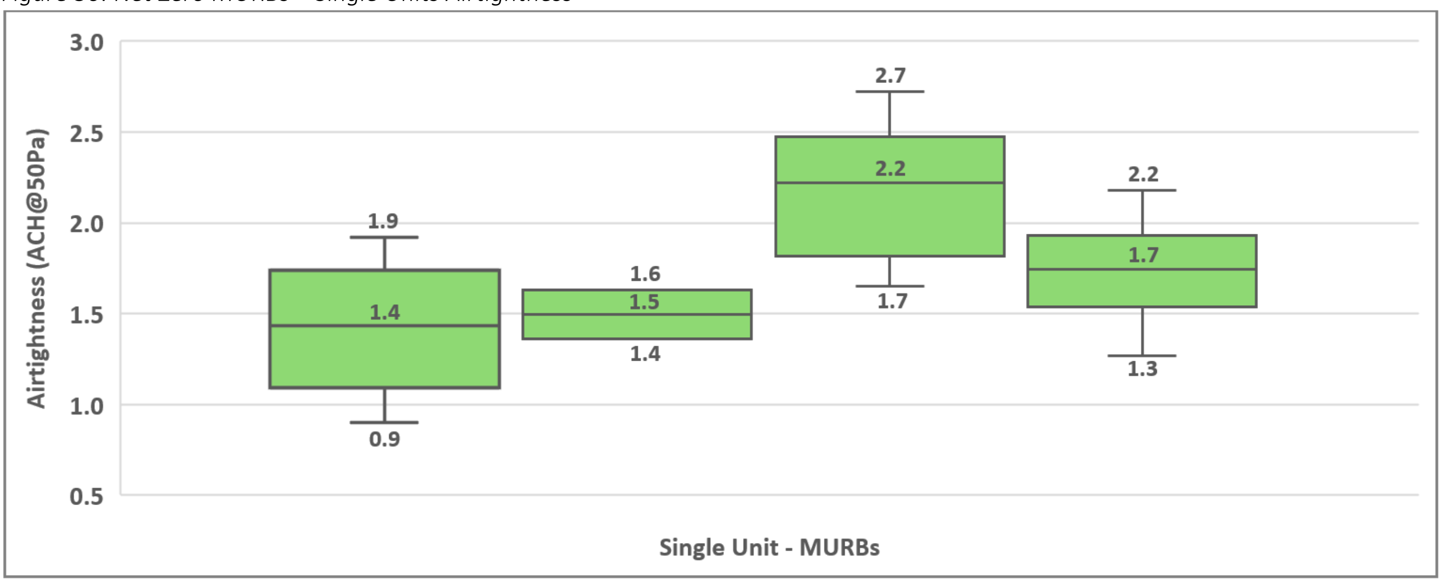


Figure 30: Net Zero MURBs – Single Units Airtightness



Note: *The homes that exceeded the ACH targets in Figures 29 and 30 achieved compliance using one of the other airtightness target metrics – Normalized Leakage Rate (NLR@50Pa) or Normalized Leakage Area (NLA@10Pa).*

ANALYSIS

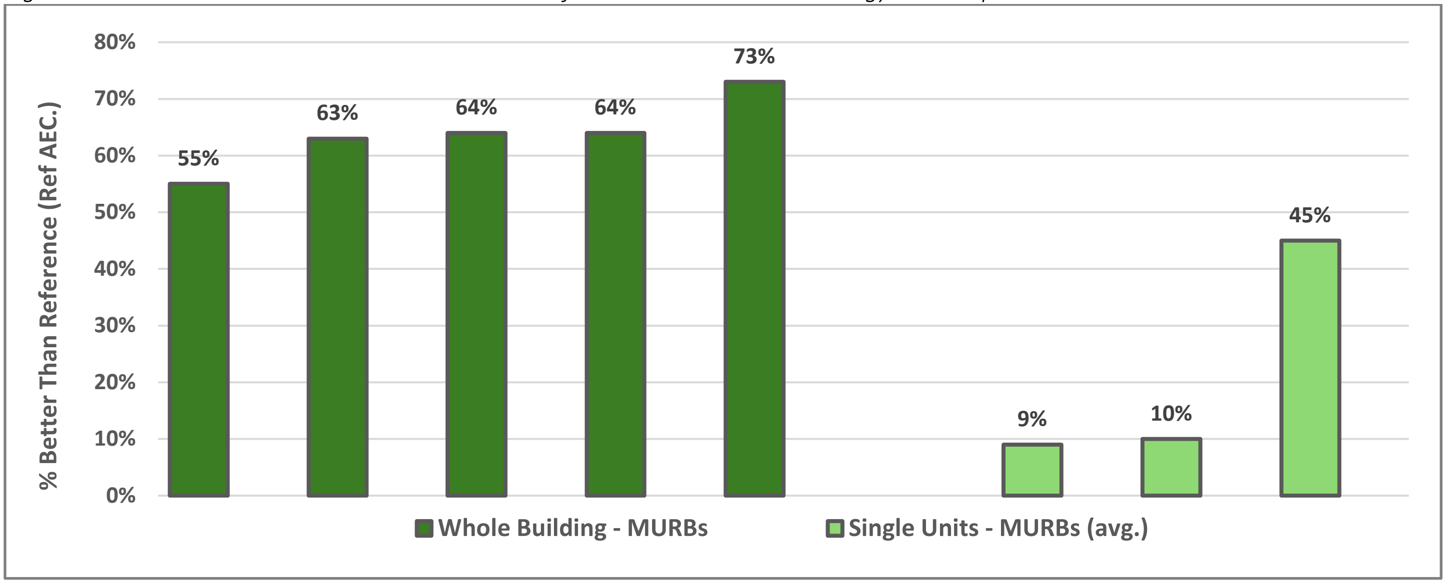
- The average airtightness for the five whole building modeled MURBs is 1.72 ACH@50Pa.
- The average airtightness for the four single unit modeled MURBs is 1.66 ACH@50Pa.

It can be challenging to achieve lower airtightness scores in MURBs when using the ACH@50pa measurement. This is because ACH@50Pa is a volumetric measurement, and comparable to other housing types MURB units typically are smaller volume. For this reason, several of the projects used the other airtightness target metrics to achieve compliance, either Normalized Leakage Rate (NLR@50Pa) or Normalized Leakage Area (NLA@10Pa).

9.5 Percent Better than Reference House – Annual Energy Consumption ("Ref. AEC")

Percent Better than Reference House—Whole House Energy Consumption is a measure of how much better the proposed house is in whole house energy consumption compared to its respective Reference House, which is a Code-minimum version of the proposed house. "Ref. AEC" is measured as a percentage (%) with a higher value indicating better performance. Ref. AEC includes the energy consumption of the home's space heating, space cooling, water heating, and ventilation and excludes the occupant baseloads (lights, appliances, plug loads) from both the proposed house and the Reference House.

Figure 31: Net Zero MURBs – Percent Better Than Reference House - Annual Energy Consumption



Note: *One building that was labelled during the Pilot did not have the reference house data appropriate to be included in this analysis because it was modelled in HOT2000 v10.51.*

ANALYSIS

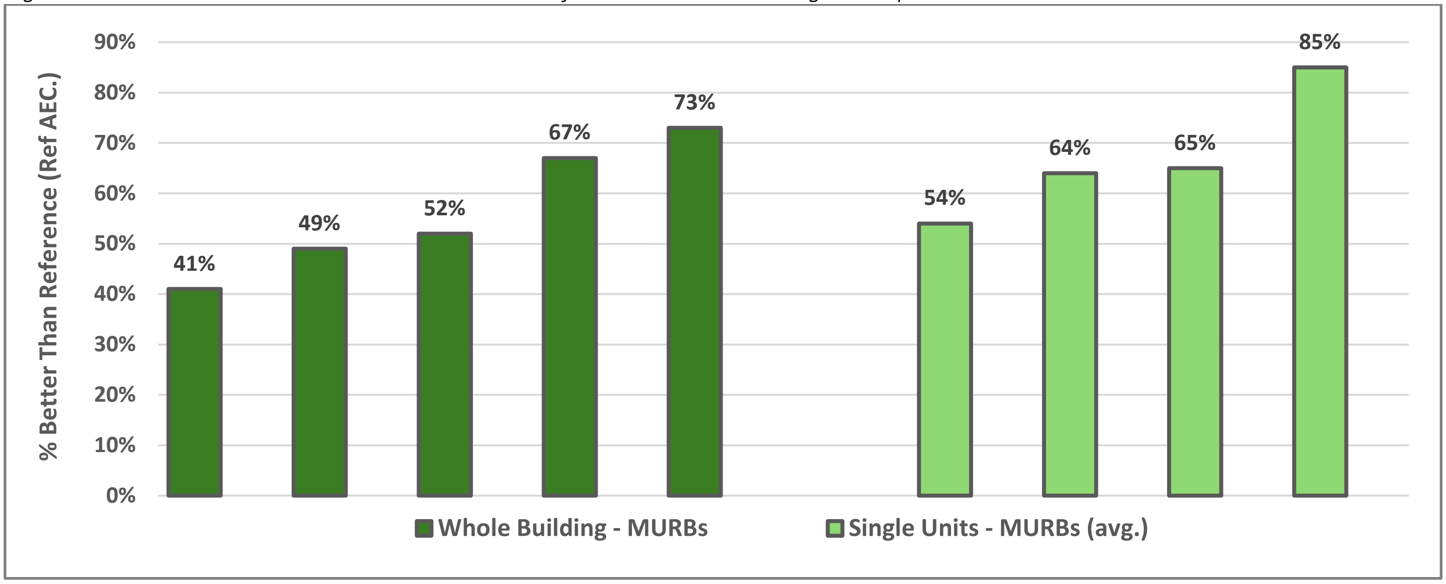
- The average for all eight MURBs is 48% better than "Ref. AEC."

Most of the buildings and units achieved a percent better than reference house—annual energy consumption of greater than 40%. Two of the buildings, did have average scores that were quite low, 9% and 10% respectively. This could be a for a variety of reasons and does not necessarily mean that the buildings are less efficient than another building, it simply means that they are less efficient when compared to their respective reference house. The reference house approach simply compares the building, or unit, to a hypothetical baseline code-minimum version of the proposed house. If the code-minimum reference house is already relatively efficient in size, shape, or mechanical selection, it can make it challenging to have a high percentage improvement over than reference baseline – therefore allowing for Net Zero and Net Zero Ready homes with relatively low scores.

9.6 Percent Better than Reference House – Building Envelope ("Ref. Env.")

Percent Better than Reference House—Building Envelope is a measure of how much better the proposed house is in building envelope compared to its respective Reference House, which is a Code minimum version of the proposed house. "Ref. Env" is measured as a percentage (%) with a higher value indicating better performance. The "Ref. Env." calculation compares the space heating energy requirements from the proposed house energy model and the Reference House energy model. The CHBA Program includes a performance target of minimum 33% better than its Reference House for building envelope.

Figure 32: Net Zero MURBs – Percent Better Than Reference House - Building Envelope



ANALYSIS

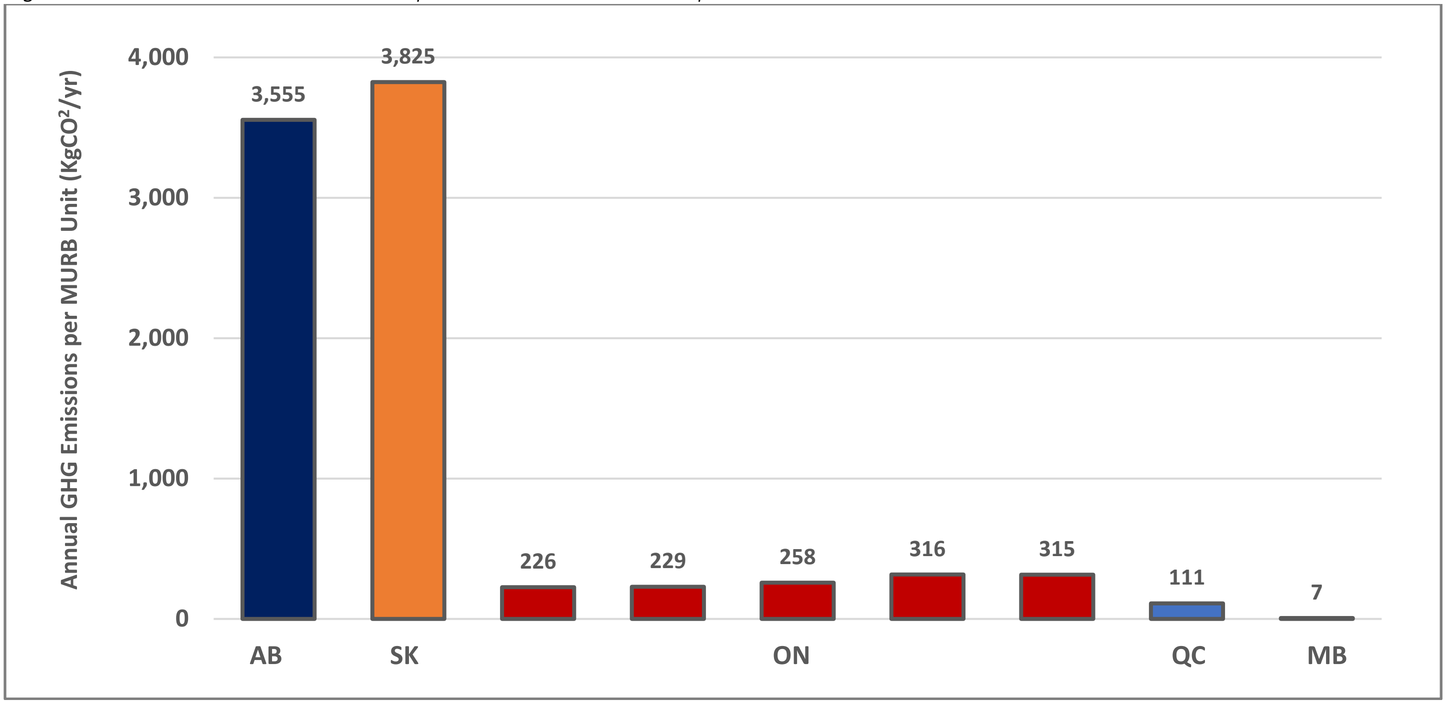
- The average for the five whole building modeled MURBs is 56% better than "Ref. Env.".
- The average for the four single unit modeled MURBs is 65% better than "Ref. Env.".

9.7 Annual Operational GHG Emissions

This section considers the annual green house gas (GHG) emissions from the operation of the buildings. The operational GHG emissions vary depending on the energy sources (electricity, natural gas, and propane) used to operate the homes as well as the provincial emission factors. Details on the operational GHG emissions calculation method can be found in Appendix A.

Figure 33 shows the annual GHG emissions per dwelling unit from each of the MURBs. The analysis does not consider GHG offsets from the on-site renewable energy installed on some of the Net Zero MURBs.

Figure 33: Net Zero MURBs – Annual Operational GHG Emissions per MURB Unit



ANALYSIS

As is the case in sections 8.1 of this report, it was found that the operational GHG's emitted from a building annually is highly dependant on two main variables - the location of the building (provincial emission factors), and the fuel sources used in the building. For this reason, it is difficult to fairly compare the operational GHG emissions of buildings from different provinces to one another.

10.0 RENOVATIONS

This section looks at the homes labelled under the Net Zero Renovations Program, which launched in October 2021. Nine homes have been labelled under the Net Zero Renovations Program: six Net Zero and three Net Zero Ready. Homes labelled as Net Zero Renovations meet the same performance level and same Technical Requirements as homes labelled under new Homes Program, with only four minor technical exceptions,, see Appendix B. This analysis compares the home before the renovation (“Pre-Reno”) to the home after the renovation (“Post-Reno”). The performance metrics used to evaluate these homes are:

- Energy Consumption Comparison
  - Annual energy consumption, measured in GJ/year
  - Total energy use intensity, measured in GJ/m^2/year (and ekWh/m^2/year)
  - Space heating energy use intensity, measured in GJ/year
- Building Heat Loss Comparison
  - Whole home heat loss, measured in GJ/year
  - Whole home heat loss intensity, measured in GJ/m^2/year
- Airtightness Comparison, measured in air changes per hour at 50 pascals (ACH@50)
- Annual Operational GHG Emissions Comparison, measured in tCO_2e/year

It’s important to note that some homes changed floor areas during the renovations, for example, by adding additional living space. Therefore, intensity performance metrics have been included to fairly consider floor area changes, such as total energy use intensity and whole home heat loss intensity.

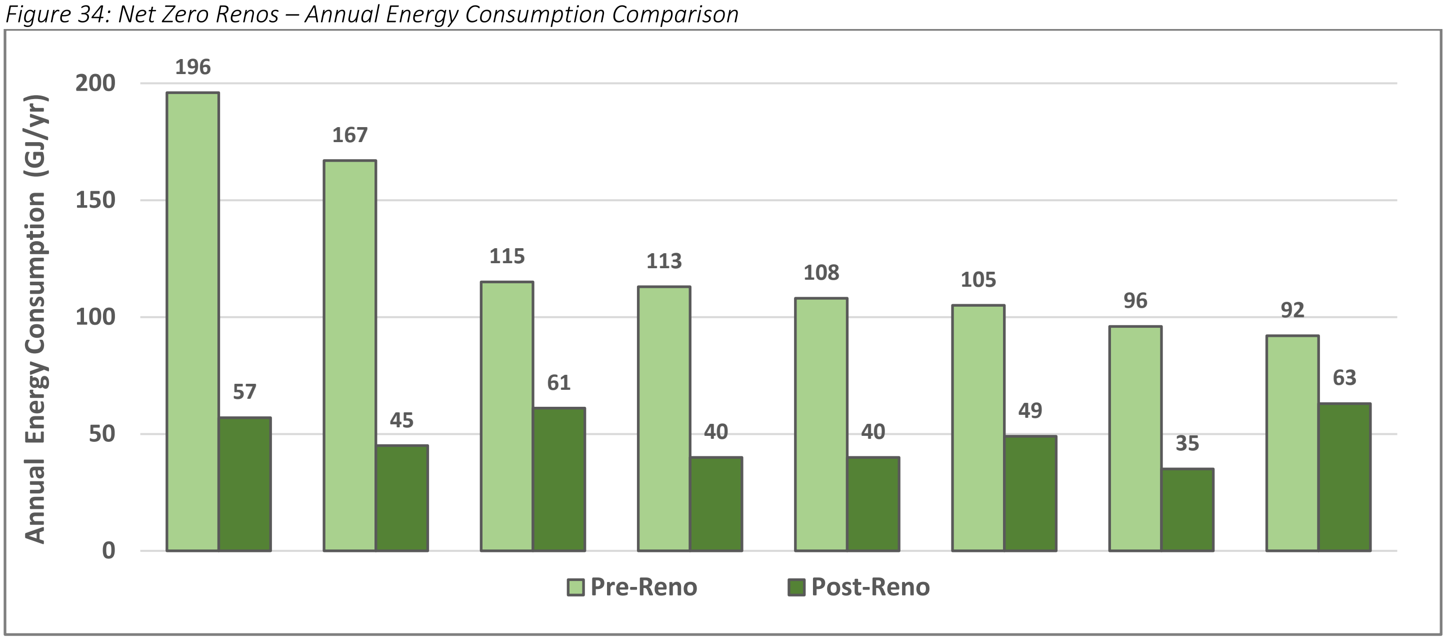
Note: *One of the nine homes labelled under the Net Zero Renovations Program did not have the appropriate information to be included in the report.*

10.1 Energy Consumption Comparison

ANNUAL ENERGY CONSUMPTION

Annual energy consumption is defined as the amount of energy required to operate the home on an annual basis. This includes energy required for space heating, space cooling, water heating, ventilation, and occupant loads (lighting, appliances, and plug loads). Annual energy consumption is measured in GJ/year with a lower value being favourable. Both the CHBA’s new Net Zero Homes Program and the Net Zero Renovations Program have a modelled performance target of 0 GJ for the annual energy consumption, offset by the on-site renewable energy production.

Figure 34: Net Zero Renos – Annual Energy Consumption Comparison

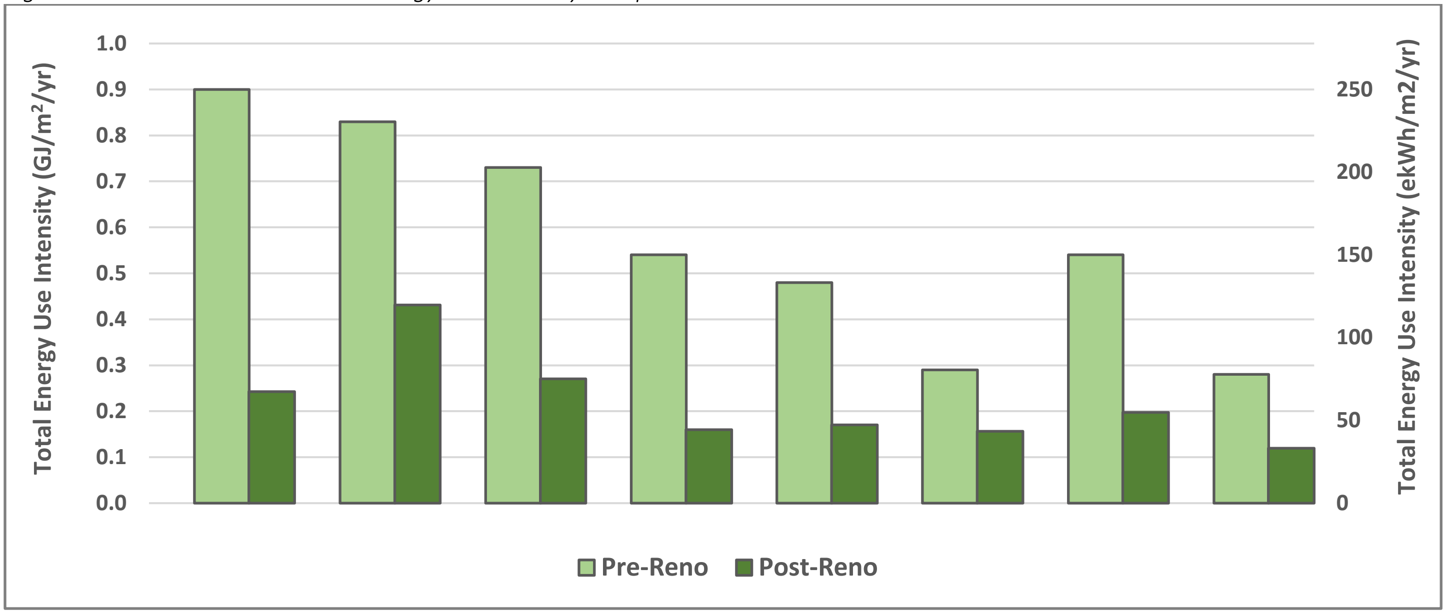


Note: *In Figure 34 above, the GJ/yr values reflect the energy consumption of the homes without the renewable energy generation.*

TOTAL ENERGY USE INTENSITY

Total Energy Use Intensity (TEUI) compares the total annual energy consumption of the home to the size of the home's heated floor area. TEUI includes the energy required for space heating, space cooling, domestic water heating, ventilation, and occupant load and divides the total by the heated floor area with a lower value indicating better performance. In Figure 35, TEUI is measured in Gigajoules on the left vertical axis (GJ/m^2/year) and equivalent kilowatt hours on the right vertical axis (ekWh/m^2/year).

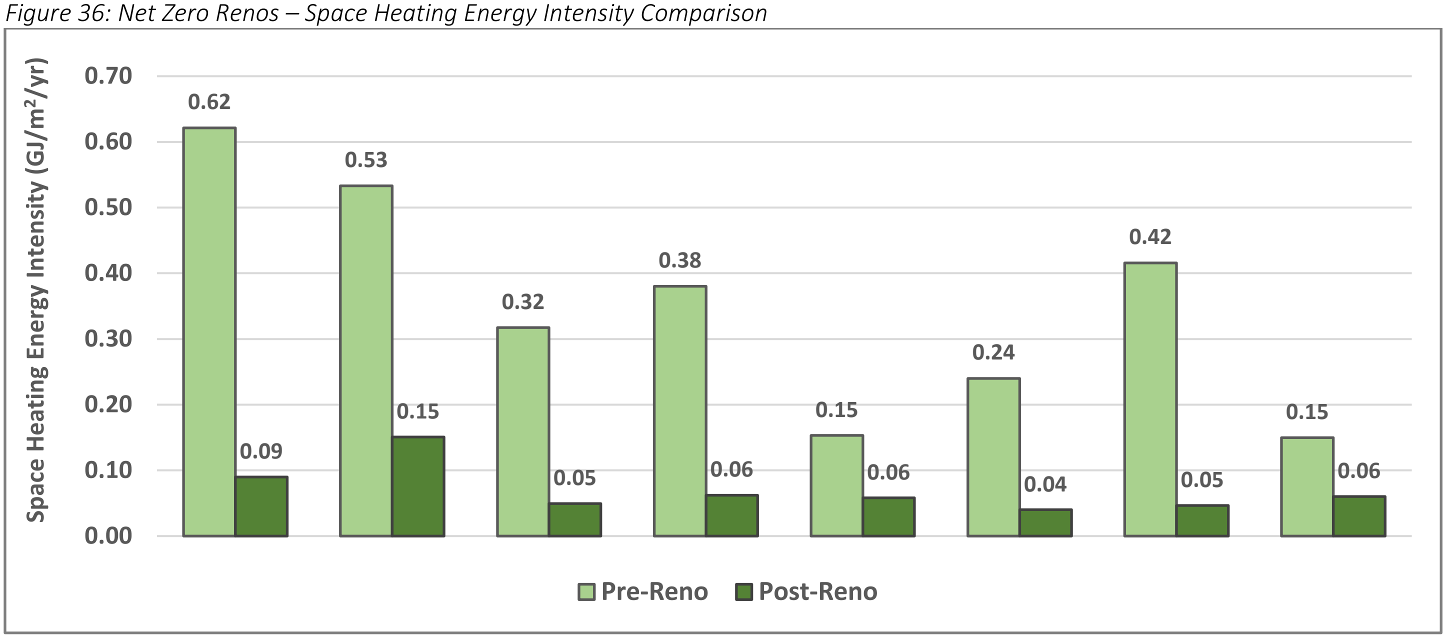
Figure 35: Net Zero Renos – Total Energy Use Intensity Comparison



SPACE HEATING ENERGY USE INTENSITY

This section compares the amount of energy required to heat the home prior to the renovation and after the renovation. Space heating energy use intensity is a standard metric comparing the modelled space heating energy use to the size of the home's heated floor area. Older homes that are poorly insulated and leaky require a large amount of energy to heat them.

Figure 36: Net Zero Renos – Space Heating Energy Intensity Comparison



ANALYSIS

- The average Post-Reno modelled annual energy consumption of a Net Zero Renovation is 49 GJ/year.
- The average decrease in annual energy consumption was 75 GJ/year, an average decrease of 60.5%.
- The average Post-Reno total energy use intensity was 0.22 GJ/m^2/year, an average decrease of 61.4%.
- The average Post-Reno space heating energy intensity was 0.07 GJ/m^2/year, an average decrease of 80%.

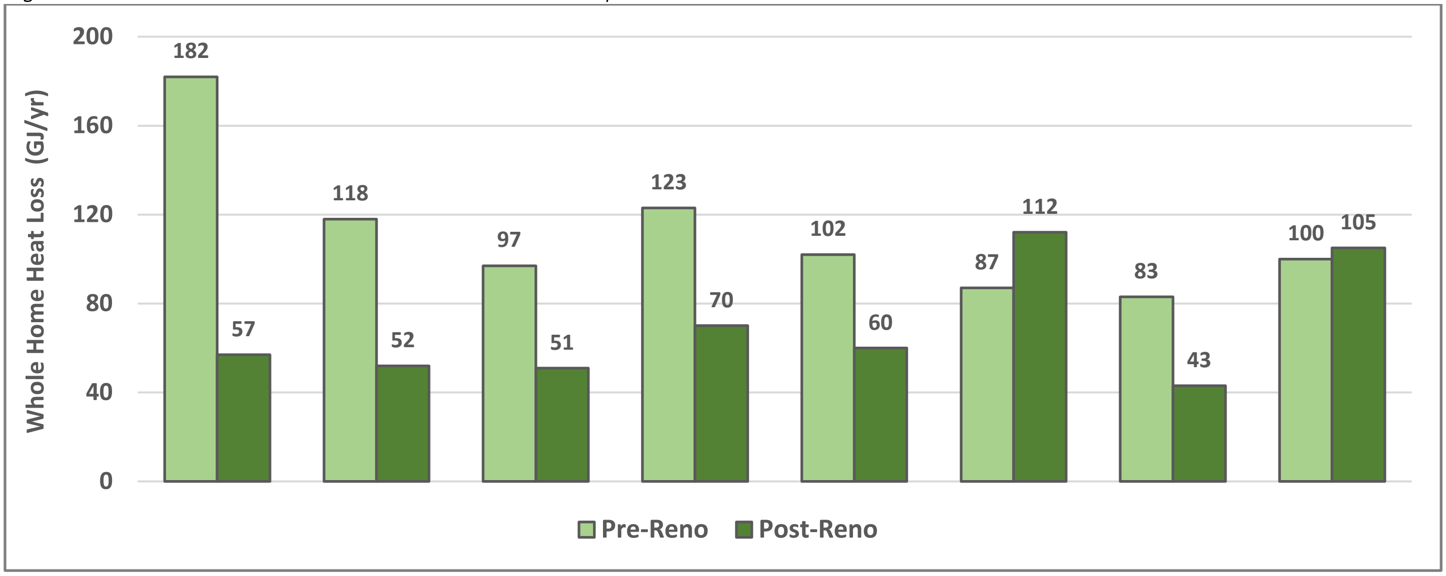
All eight Net Zero Renovations achieved comparable energy performance to that of the Net Zero new homes. Net Zero Renovations greatly reduce the amount of energy required to power the homes annually. **In some Net Zero Renovations the renovators not only increased the energy efficiency of the homes, but also increased the home's floor space.** As a result, energy intensity metrics are the strongest comparator between the pre-renovated home and the home post-renovated home, rather than just the total modelled annual energy consumption alone.

10.2 Building Heat Loss Comparison

WHOLE HOME HEAT LOSS

Whole home heat loss is defined as the total amount of heat lost from the home on an annual basis. This includes heat lost from air leakage and heat lost through the foundation, ceilings, walls, exposed floors and windows and doors. Whole home heat loss is measured in GJ/year with a lower value being favourable.

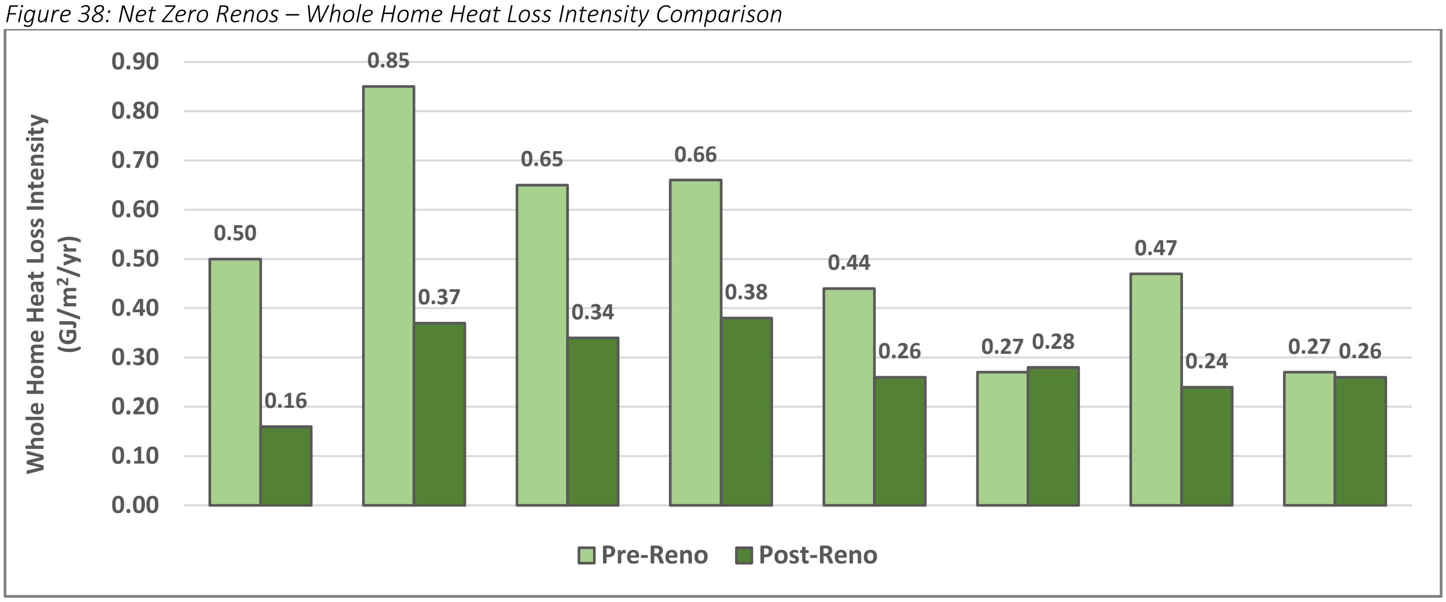
Figure 37: Net Zero Renos – Whole Home Heat Loss Comparison



WHOLE HOME HEAT LOSS INTENSITY

In this section the whole home heat loss is compared to the home's heated floor area. Whole home heat loss intensity includes the energy from the heat lost from air leakage and heat lost through the foundation, ceilings, walls, exposed floors and windows and doors and is measured in GJ/m²/year.

Figure 38: Net Zero Renos – Whole Home Heat Loss Intensity Comparison



ANALYSIS

- The average Post-Reno whole home heat loss was 69 GJ/year, an average decrease of 38%.
- The average Post-Reno whole home heat loss intensity was 0.29 GJ/m^2/year, an average decrease of 43%.

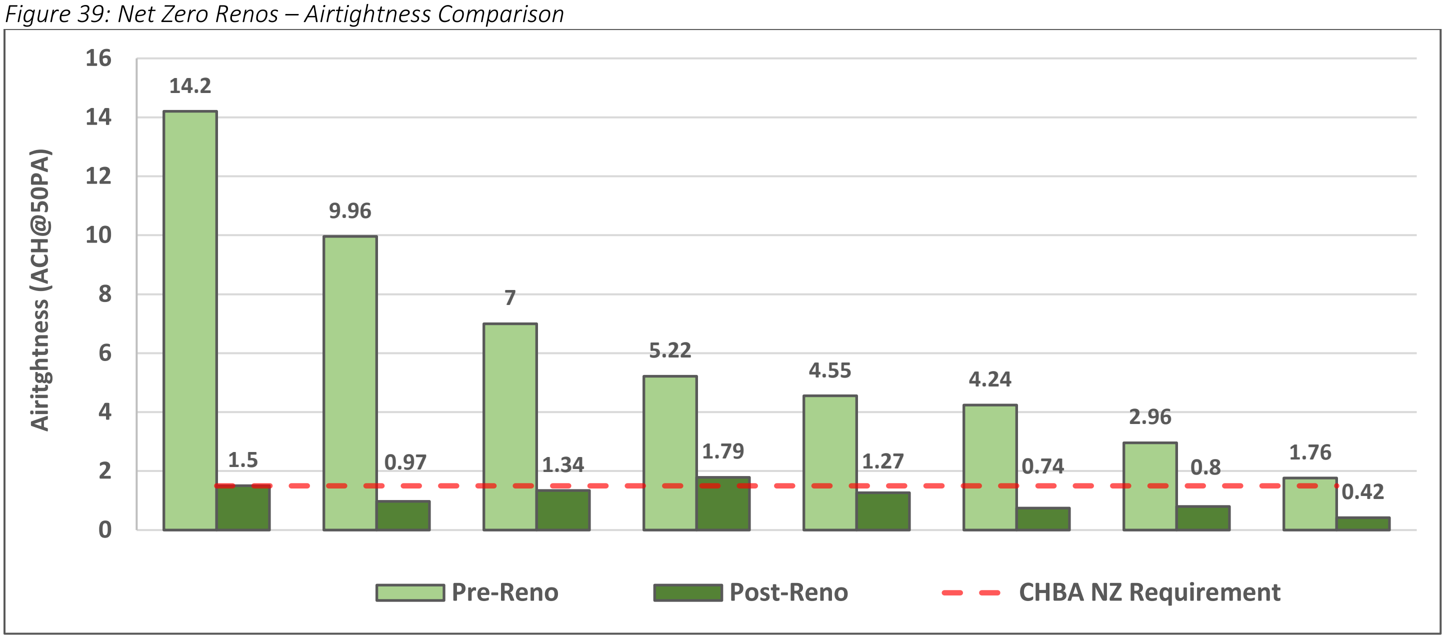
Building envelope improvements are a major factor in any deep energy renovations. In order to achieve net zero performance levels, it's important to greatly reduce the buildings whole home heat loss. The amount of energy saved by reducing the whole home heat loss depends greatly on the performance level that the building started at pre-renovation. These same envelope improvements will not only save energy, but they will also make the home more comfortable for the occupant.

10.3 Airtightness Comparison

AIRTIGHTNESS

Airtightness is a measurement of how resistant the dwelling unit is to inward and outward air leakage. Airtightness is measured in air changes per hour (ACH@50) with a lower value meaning better performance. The dwelling unit is depressurized (or pressurized) to 50 pascals with a fan typically positioned and enclosed in the front door frame. The volume of air passing through the fan at a constant pressure is recorded. This amount represents the amount of air escaping the dwelling unit. ACH measures the number of times the air is replaced in one hour compared to the volume of the dwelling unit, for example, an ACH@50 of 1, 2, and 0.5 means the amount of air replaced in one hour is the same, double and half (respectively) the volume of the unit being tested. The CHBA Program has a performance target of maximum 1.5 ACH@50 for detached homes and maximum 2.0 ACH@50 for attached homes. The Program also has airtightness targets using two additional recognized metrics: Normalized Leakage Area at 10 Pascals (NLA@10) and Normalized Leakage Rate at 50 Pascals (NLR@50). The Program requires that only one of these targets be met. **Net Zero Renovations must meet the same airtightness target as new Net Zero Homes.**

Figure 39: Net Zero Renos – Airtightness Comparison



Note: *The home that exceeded the 1.5 ACH@50Pa target in Figure 30 achieved compliance using one of the other airtightness target metrics – Normalized Leakage Rate (NLR@50Pa) or Normalized Leakage Area (NLA@10Pa).*

ANALYSIS

- The average Post-Reno airtightness achieved was 1.10 ACH@50Pa.
- The average decrease in airtightness was 5.13 ACH@50Pa, an average decrease of 82%.

While the percent decrease in airtightness achieved in renovations depends greatly on the pre-renovation airtightness level of the home, Net Zero Renovations achieve very similar airtightness levels as new Net Zero Homes. The average airtightness for all *new* Net Zero and Net Zero Ready Homes was 1.19 ACH@50Pa whereas the average of the eight homes labelled as Net Zero or Net Zero Ready *Renovations* was 1.10 ACH@50Pa.

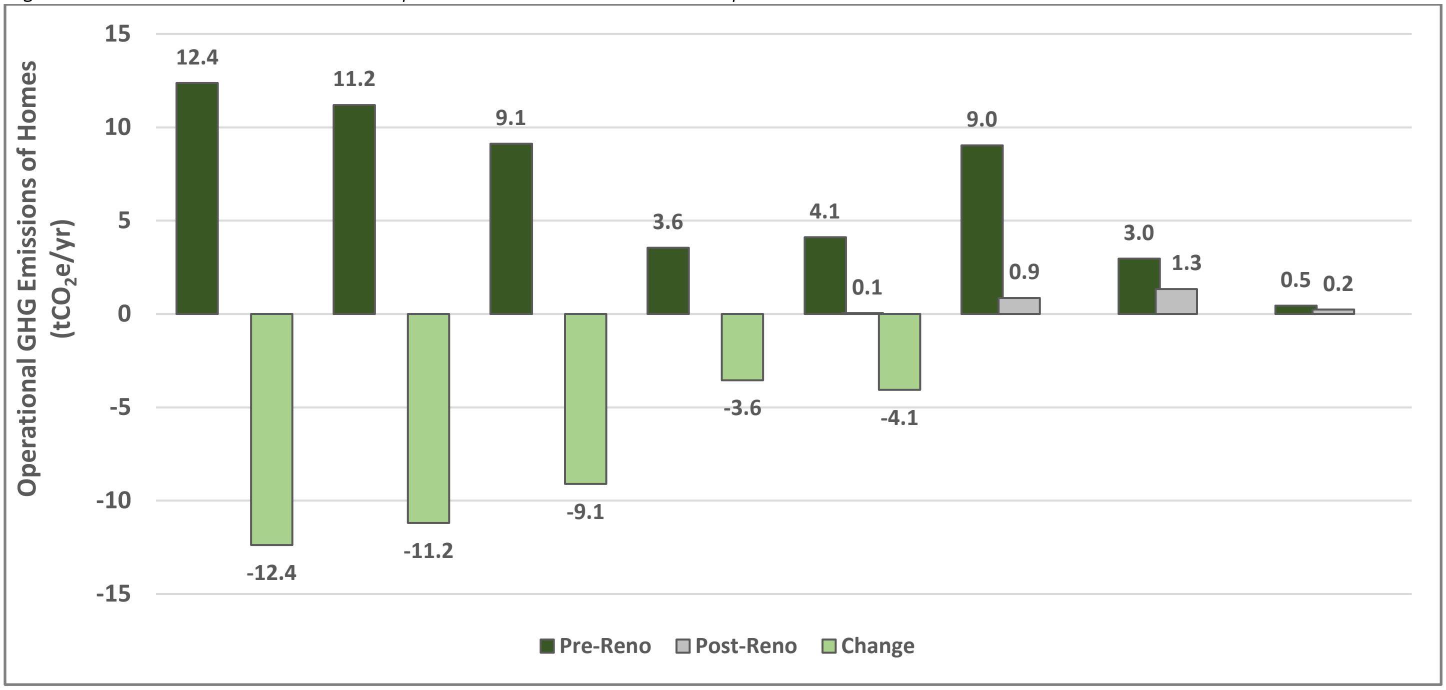
10.4 Annual Operational GHG Emissions Comparison

ANNUAL OPERATIONAL GHG EMISSIONS

This section considers the modeled annual operational GHG emissions of each home Pre-Reno versus Post-Reno. In a Net Zero or Net Zero Ready Renovation it is expected that the annual operational GHG emissions will be reduced when comparing the Pre-Reno home to the Post-Reno home. This section of the report uses the same methodology as was used in Section 8 to calculate operational GHG emissions. More details of the methodology can be found in Appendix A. This section *includes* the operational GHG emissions offset provided by solar photovoltaic systems which you will see in the first five Net Zero Renovations presented below.

Note: *The results below will vary slightly from the results indicated on the NRCan EnerGuide label for these specific projects. The variance is because the emission factors used in this report are from only the 2024 reported values in the most recent version of Environment Canada's National Inventory Report: Greenhouse Gas Sources and Sinks in Canada where as EnerGuide labels report the home's operational GHG emissions using averages over several years of reported emission factors, from the same Environment Canada reports.*

Figure 40: Net Zero Renos – Annual Operational GHG Emissions Comparison



ANALYSIS

- The lowest annual operational GHG emission reduction was 0.21 tonnes CO_2e/year. This represented an all-electric home in a province with a low emissions factor electricity grid.
- The highest annual operational GHG emission reduction was 12.37 tonnes CO_2e/year. This represented a home that converted from natural gas heating to all-electric and included on-site renewable energy.

Annual operational GHG emissions reductions can be very impactful from Net Zero Renovations. The range of GHG emissions reductions varies significantly with the different provincial emission factors and fuel sources before and after renovations. The inclusion of renewable energy is also a major factor determining the level of GHG emissions reduction, particularly in provinces with high emission factor grids.

Appendix A

OPERATIONAL GHG EMISSIONS CALCULATION METHODOLOGY

For the purpose of this report, the following emission factors were used to calculate the annual operational GHG emissions of the Net Zero and Net Zero Ready Homes labelled under the Program. Annual energy consumption by fuel source (electricity, natural gas, propane) was obtained from each home's HOT2000 model and the resulting energy consumption values were multiplied by the appropriate emission factors below to create an estimate of operational GHG emissions for each home. The emission factors used are from *Environment Canada's National Inventory Report – 2024 Edition*. The most recent reporting values are from the year 2022.

Province	Electricity $t/CO_2e/kWh$	Natural Gas $t/CO_2e/m^3$	Propane $t/CO_2e/L$
Newfoundland and Labrador	0.000017	0.001930355	0.001547859
Prince Edward Island	0.000002	0.001930355	
Nova Scotia	0.000660	0.001930355	
New Brunswick	0.000330	0.001930355	
Quebec	0.000001	0.001937355	
Ontario	0.000035	0.001932355	
Manitoba	0.000001	0.001926355	
Saskatchewan	0.000630	0.001931355	
Alberta	0.000470	0.001973355	
British Columbia	0.000014	0.001977355	
Yukon	0.000070	0.001977355	
Northwest Territories	0.000180	0.001977355	
Nunavut	0.000780	0.001977355	

Global Warming Potentials are obtained from:

Intergovernmental Panel on Climate Change IPCC Global Warming Potentials https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/quantification-guidance/global-warming-potentials.html (June 1, 2024)

Electricity emission factors for each province are from:

National Inventory Report (1990-2022): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC) Annex *13 - Electricity in Canada: Summary and Intensity*

Natural gas emission factors for each province are from:

National Inventory Report (1990-2022): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC),
Table A6.1-1 CO_2 Emission Factors for Marketable Natural Gas Liquids
Table A6.1-3 CH_4 and N_20 Emission Factors for Natural Gas

Propane emission factors for each province are from:

National Inventory Report (1990-2022): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC), Table A6.1-4 CO_2 Emission Factors for Natural Gas Liquids

Appendix B

CHBA NET ZERO RENOVATIONS PILOT – TECHNICAL REQUIREMENTS

The chart below describes the sections in the Net Zero Technical Requirements that were revised for the Net Zero Renovations Program. These four revisions were deemed suitable and effective by the Renovator Working Group, and by the renovators that participated in the Pilot. Version 1 of the Net Zero Renovations Program has maintained these four revisions.

Section	Exemption/Change	Reason
3.3 Opaque Assemblies	**Exemption** - There are no requirements for the slab to be insulated.	Insulation underneath the slab on a renovation was deemed impractical and cost prohibitive for many renovation projects.
3.3 Opaque Assemblies	**Exemption** – Rim joists in Net Zero Renovations do not need to match or exceed the thermal resistance levels of the walls above grade.	Rim joists may be inaccessible in some areas of renovations. The requirements from the new homes program could limit renovations from participation.
4.4 Solid Fuel Burning Appliances	**Change** – Fireplaces are not exempt from Net Zero Renovations although they must comply with the following requirements: (a) it shall be a solid fuel burning appliance certified to either CSA B415 or U.S. EPA wood-burning appliance standards 40 Code of Federal Regulations (CFR) Part 60 Subpart AAA, (b) have no barometric dampers, (c) home must undergo a depressurization test as per ERS Technical Procedures V15 with results showing a pressure difference of less than 5 pascals, and (d) CO alarms shall be installed as described.	Making fireplaces exempt from Net Zero Renovations could eliminate a large portion of candidates. Stringent sealing and testing requirements were put in place to mitigate the safety concerns with respect to back drafting and combustion appliances.
4.8 Air Distribution	**Change** - If the pre-renovation ductwork system is not completely replaced, then only accessible portions of ductwork must be sealed as per Section 4.8.2 provided each duct run can deliver the appropriate amount of air as calculated by CSA F280-12.	Renovations that do not completely replace ductwork may have issues sealing the entire duct runs as per section 4.8.2 because of limited duct accessibility.