CHBA NET ZERO HOME LABELLING PROGRAM
Summary Report – 2022

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, 2022, and the resulting performance metrics they achieved.

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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 about 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 and www.netzerohome.com.

The CHBA Net Zero Home Labelling Program (the Program) recognizes builders and service professionals who commit to its Administrative Requirements and the houses that meet the Technical Requirements. Alongside marketing and communication, education and finance initiatives, the Program remains one of the four Net Zero Energy Housing Council key priorities established to address industry-identified barriers to Net Zero/Ready Home construction.

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, 2022, as well as participation in the Net Zero Training courses. The analysis of the homes is separated into four building types: detached homes, attached homes, single unit multi-unit residential buildings, and whole building multi-unit residential buildings. Within these building types, trends from the data are presented in the categories: 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 carbon emissions. These performance metrics are based on the modelled values determined by the Qualified Net Zero Energy Advisor using the HOT2000 modeling software. The performance analysis in this report does not include data from the Net Zero and Net Zero Ready Renovations that have been labelled. The 2021 Summary Report provides an analysis on the six renovations labelled during that reporting period. There has not been a significant increase in renovations labelled since 2021. Future summary reports will include further analysis on renovations as the Programs grows.

Here are some highlights of this years' report content:

- 28 Net Zero Homes and 397 Net Zero Ready Homes were labelled in 2022, bringing the total to 1,186 homes labelled under the Program as of December 31, 2022.
- Homes have been labelled in 9 provinces and 5 climate zones.
- In total, there are 775 detached homes, 342 attached homes, 62 units contained in 6 multi-unit residential buildings, and 7 renovations.
- The majority (71%, 795/1,117) of detached and attached homes used above-grade walls with an RSI between 4.4 and 6.1 (R25-R35).
- The most common (66%, 740/1,117) 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 secondary heating source.
- The most common (63%, 692/1,093) fuel source configuration is "hybrid heating + gas DHW". Within this group of homes, the average modelled natural gas consumption is 355 m^3/year, and the average modelled electricity consumption is 9,682 kWh/year.
- The average annual energy consumption for all detached and attached homes is 47.4 GJ/year.
- In general, windows and doors represent the largest percentage (25% to 39%) of whole home heat loss.
- The average airtightness for detached homes was 1.0 ACH@50 and for attached homes was 1.3 ACH@50.
- The average calculated Total Energy Use Intensity (TEUI) for detached homes was 0.18 GJ/m^2/year (48.9 ekWh/m^2/year) and for 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 64.0% for detached homes and 60.4% for attached homes.
- The average percent better than reference – envelope was 51% for detached homes and 49% for attached homes.
- Operational carbon emissions of the homes were greatly dependent on the province in which the homes were located; on average, homes within the provinces of Alberta, Saskatchewan, and Nova Scotia emitted the most annual operational carbon emissions. Homes in Manitoba, Newfoundland & Labrador, British Columbia, and Ontario emitted the fewest annual operational carbon emissions.

We release a detailed report of this nature annually, presenting the highlights at the annual CHBA Spring Meetings 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 Carbon Emissions
Annual operational carbon emissions are a measure of the resulting greenhouse gases emitted from the energy consumed to power a home for one year. Operational carbon 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. Operational carbon emissions are the measure of the resulting greenhouse gas emissions produced from energy used to power the homes.

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, 2022, which includes participants and homes in the Pilot through to the end of Year 6 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

Homes labelled from 2017 to 2022 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 Qualified Net Zero Service Organization and delivered by a Qualified Net Zero Trainer.

Table 1: Number of Newly Trained Participants by Year

Program Year	Pilot	2017	2018	2019	2020	2021	2022	Total
Participants	261	190	82	71	338	397	407	1,746

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.

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	Total
Net Zero Home	26	9	8	106	31	28	28	236
Net Zero Ready Home	2	10	12	109	206	214	397	950
Total	28	19	20	215	237	242	425	1,186

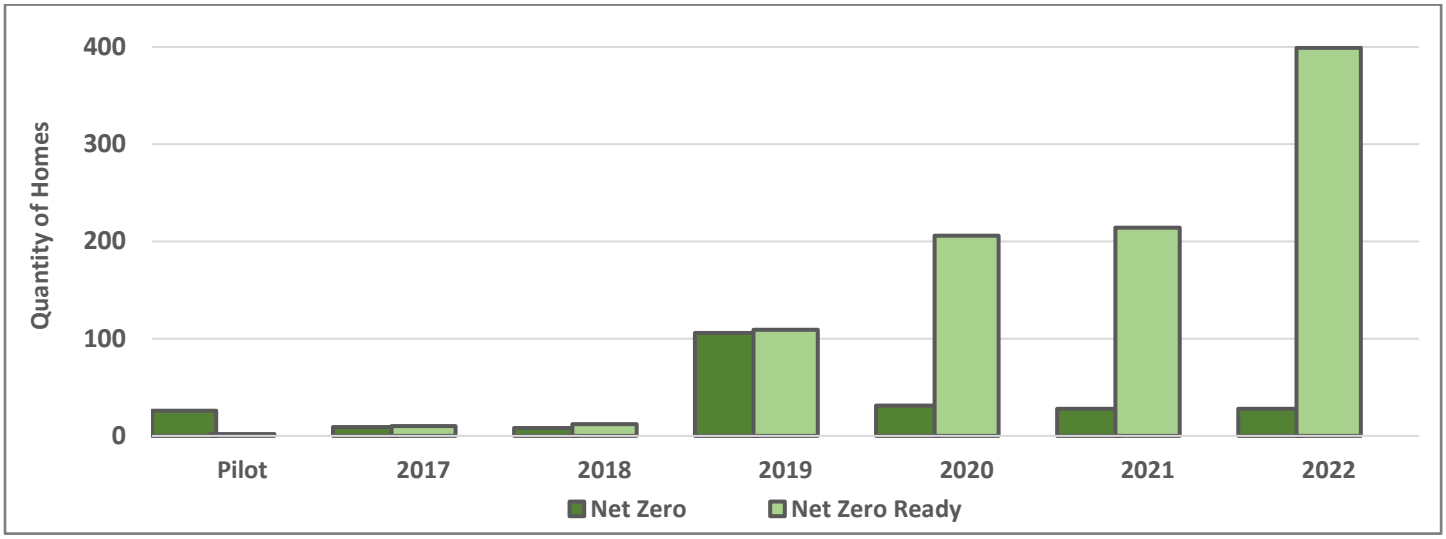

Figure 1: Number of Qualified Net Zero and Net Zero Ready Homes by Year

Table 3: Type of Homes by Province

Province	Houses (Detached + Attached)	MURBS (Units)	Renovations	Total
Alberta	49	16	3	68
British Columbia	37	0	2	39
Manitoba	1	0	0	1
New Brunswick	14	0	0	14
Newfoundland & Labrador	2	0	0	2
Northwest Territories	0	0	0	0
Nova Scotia	14	0	0	14
Nunavut	0	0	0	0
Ontario	990	28	2	1,020
PEI	0	0	0	0
Quebec	0	6	0	6
Saskatchewan	10	12	0	22
Yukon	0	0	0	0
Total	1,117	62	7	1,186

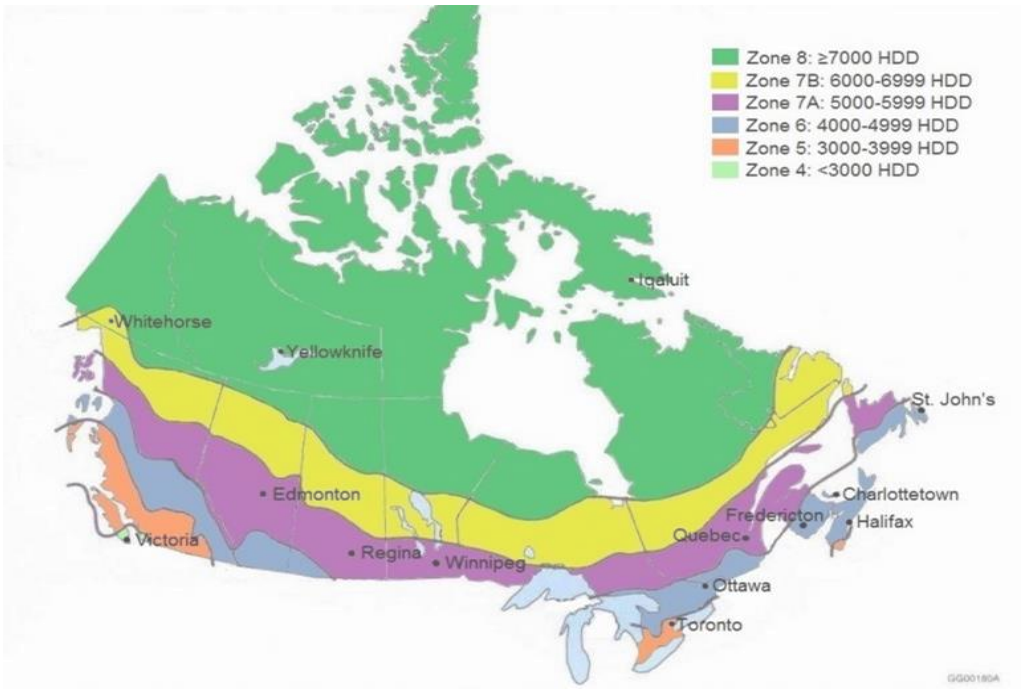

Figure 2: Climate Zone Map of Canada (source: Natural Resource Council of Canada, colour coding by NAIMA Canada).

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

Type of Homes	Qty. per Climate Zone				
	4	5	6	7a	7b
Detached Home	11	370	348	45	1
Attached Home	3	243	84	12	0
Single Unit - MURB	0	0	6	16	0
Whole Building - MURB	0	28	0	12	0
Renovation	1	0	3	3	0
Subtotal	**15**	**641**	**440**	**88**	**1**
Total	**1,186**				

Note: The 'Whole Building – MURB' row includes 40 dwelling units within 4 different buildings.

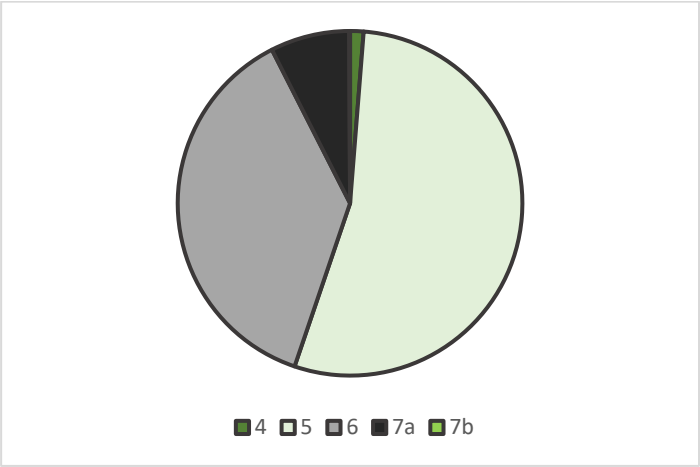

Figure 3: Distribution of Homes by Climate Zone

ANALYSIS

There has been a significant amount of program uptake since 2019. In 2022, the number of homes labelled had a 76% increase over the year previous. In 2022, the program's first home was labelled in climate zone 7b. There has become a clear trend towards homes labelling as Net Zero Ready as apposed to Net Zero. 80% of labelled homes to-date are Net Zero Ready Homes.

4.0 ENVELOPE

This section explores the envelope assemblies used by the 1,179 Net Zero and Net Zero Ready New Homes labelled under the Program up to December 31, 2022. This section does not include labelled renovations.

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,
- Single unit – multi-unit residential building (MURB), and
- Whole building – multi-unit residential building (MURB).

Note: *This report contains data from four projects under the home type Whole Building – MURB. It should be noted that each MURB was very different. The number of units per building is as follows: 3 units, 10 units, 12 units, and 15 units.*

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.

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	182	212	2,2281	**4.88 [27.7]** 3.52 [20.0] 7.33 [41.6]	**10.65 [60.5]** 5.21 [29.6] 17.97 [102.0]	**4.22 [24.0]** 0.00 [0] 8.57 [48.7]
Detached ≥2,600 ft^2 <4,000 ft^2	4,5,6,7a, 7b	489	288	3,119	**4.74 [26.9]** 3.98 [22.6] 9.22 [52.4]	**10.39 [59.0]** 6.98 [39.6] 16.19 [91.9]	**3.84 [21.8]** 0.00 [0] 9.16 [52.0]
Detached ≥4,000 ft^2	4,5,6,7a	104	500	5,386	**5.17 [29.4]** 3.66 [20.8] 9.76 [55.4]	**10.51 [59.7]** 6.01 [34.12] 22.94 [130.3]	**4.41 [25.0]** 0.00 [0] 8.01 [45.5]
Attached	4,5,6,7a	342	194	2,086	**4.90 [27.8]** 3.54 [20.1] 8.74 [49.6]	**10.18 [57.8]** 6.39 [36.3] 15.78 [89.6]	**4.06 [23.05]** 0.00 [0] 6.81 [38.7]
Single Unit MURB	6, 7a	22	94	1,012	**3.30 [18.7]** 1.00 [5.7] 4.89 [27.8]	**5.12 [29.1]** 6.22 [35.3] 10.35 [58.8]	N/A
Whole Building MURB	5,7a	4 (40 units)	853	9,181	**5.23 [29.7]** 5.18 [29.4] 5.33 [30.3]	**9.26 [52.6]** 8.58 [48.7] 10.32 [58.6]	**2.91 [16.5]** 3.70 [21.0] 3.99 [22.7]

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 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 [11]	5.57 [31.6]	8.24 [46.8]	4.64 [26.4]
5 [370]	4.50 [25.6]	10.39 [59.0]	4.31 [24.5]
6 [348]	5.05 [28.7]	10.48 [59.5]	3.92 [22.3]
7a [45]	5.64 [32.0]	11.48 [65.2]	5.45 [31.0]

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 [3]	5.88 [33.4]	8.84 [50.2]	4.74 [26.9]
5 [243]	4.86 [27.6]	9.85 [55.9]	4.31 [24.5]
6 [84]	5.01 [28.5]	10.33 [58.7]	4.56 [25.9]
7a [12]	4.72 [26.8]	11.51 [65.4]	5.86 [33.3]

4.1 Above-Grade Wall Assemblies

This section considers the effective thermal resistance of above-grade wall assemblies. The 775 detached homes as well as the 342 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. Note that MURBs were not included in this subsection because the sample size currently remains small and therefore is statistically less significant. The charts below show the minimum, average, and maximum values reported.

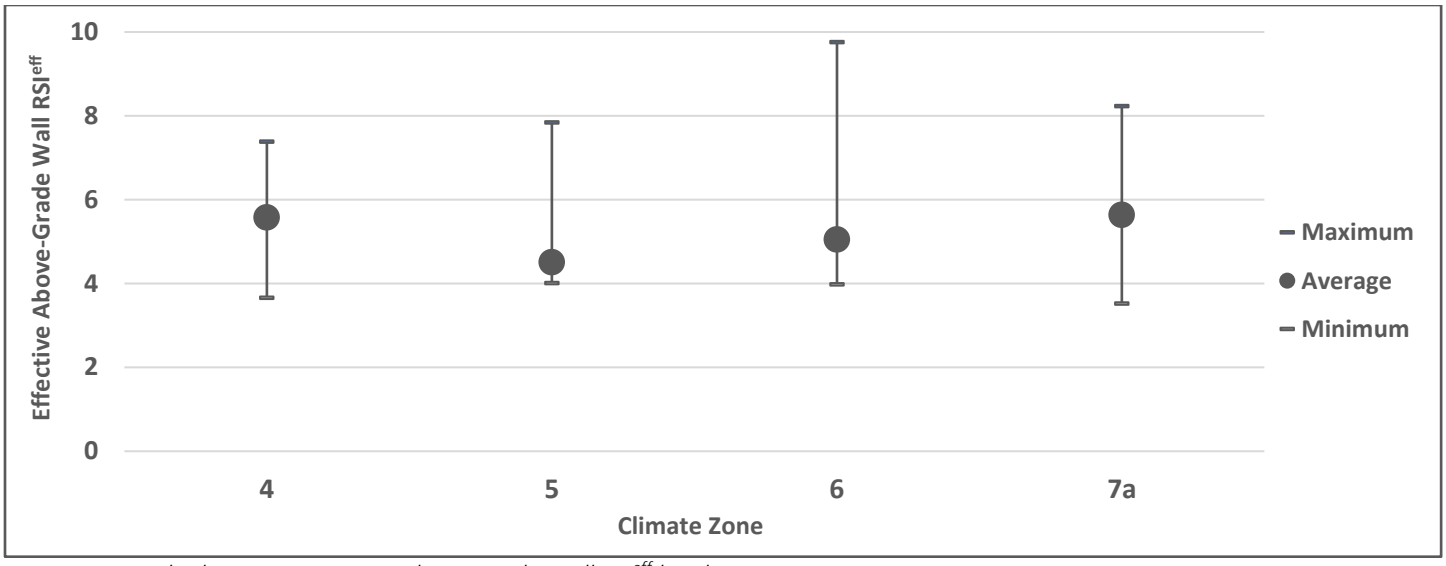

Figure 4: Detached Homes - Average Above-Grade Wall RSI^{eff} by Climate Zone

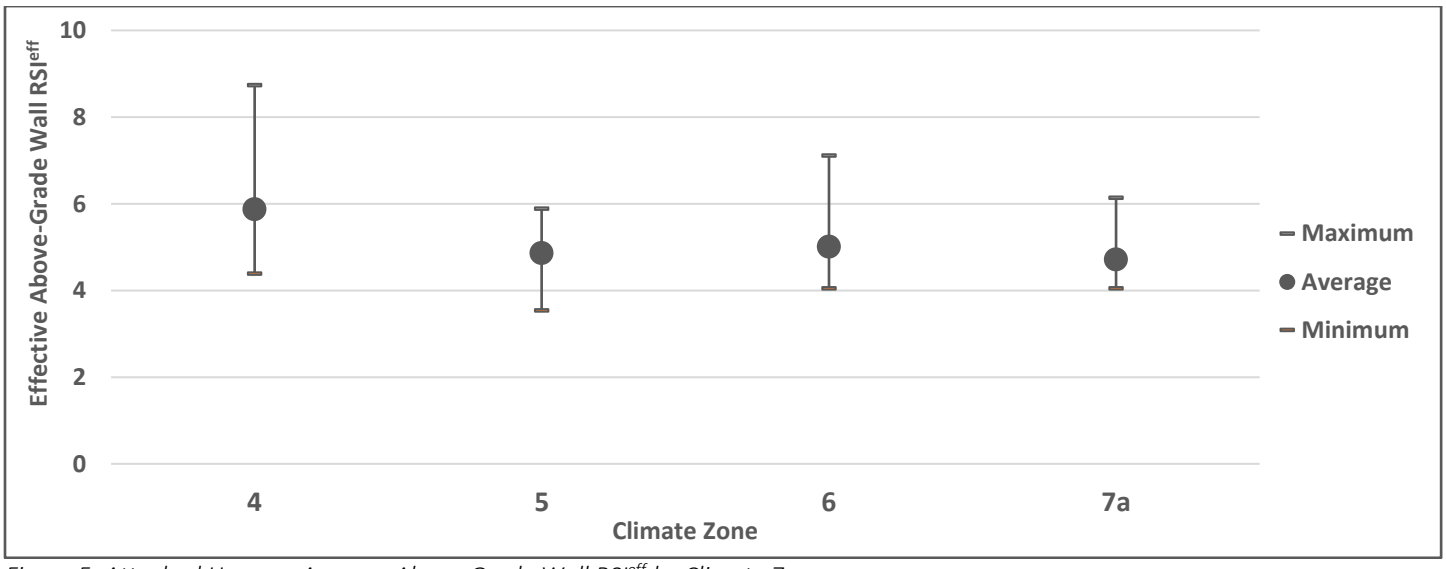

Figure 5: Attached Homes - Average Above-Grade Wall RSI^{eff} by Climate Zone

4.2 Ceiling Assemblies

This section considers the effective thermal resistance of ceiling assemblies. The 775 detached homes as well as the 342 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. Note that MURBs were not included in this subsection because the sample size remains statistically less significant. The charts below show the minimum, average, and maximum values reported.

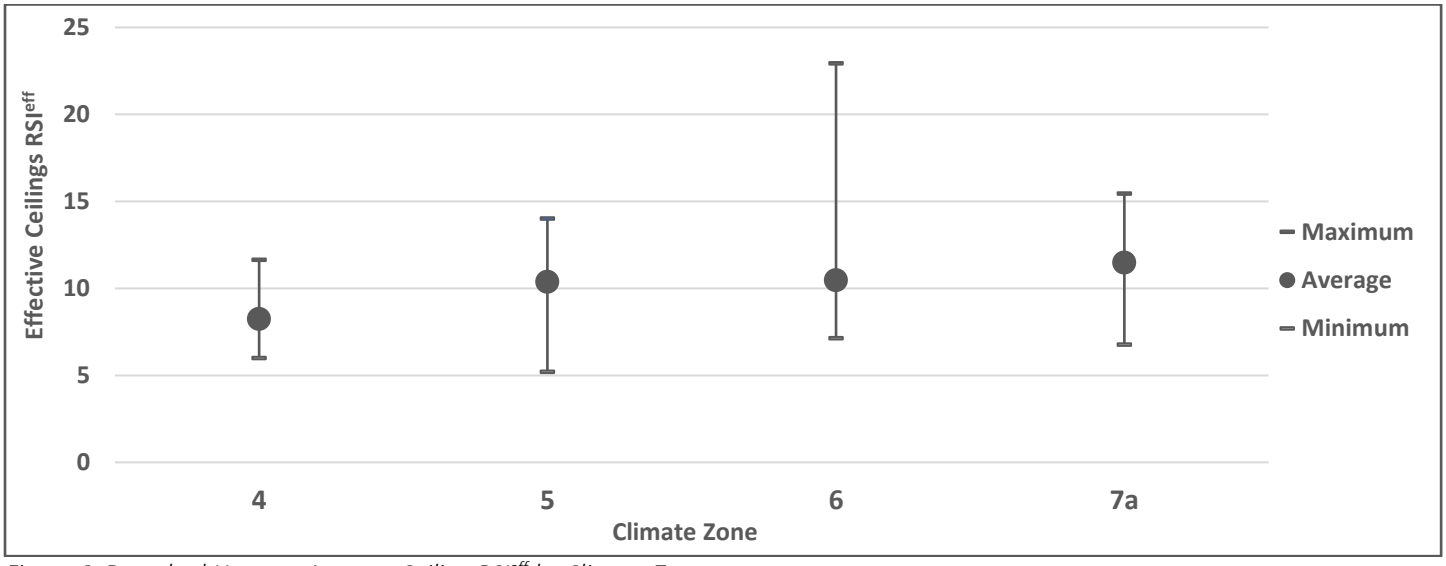

Figure 6: Detached Homes - Average Ceiling RSI^{eff} by Climate Zone

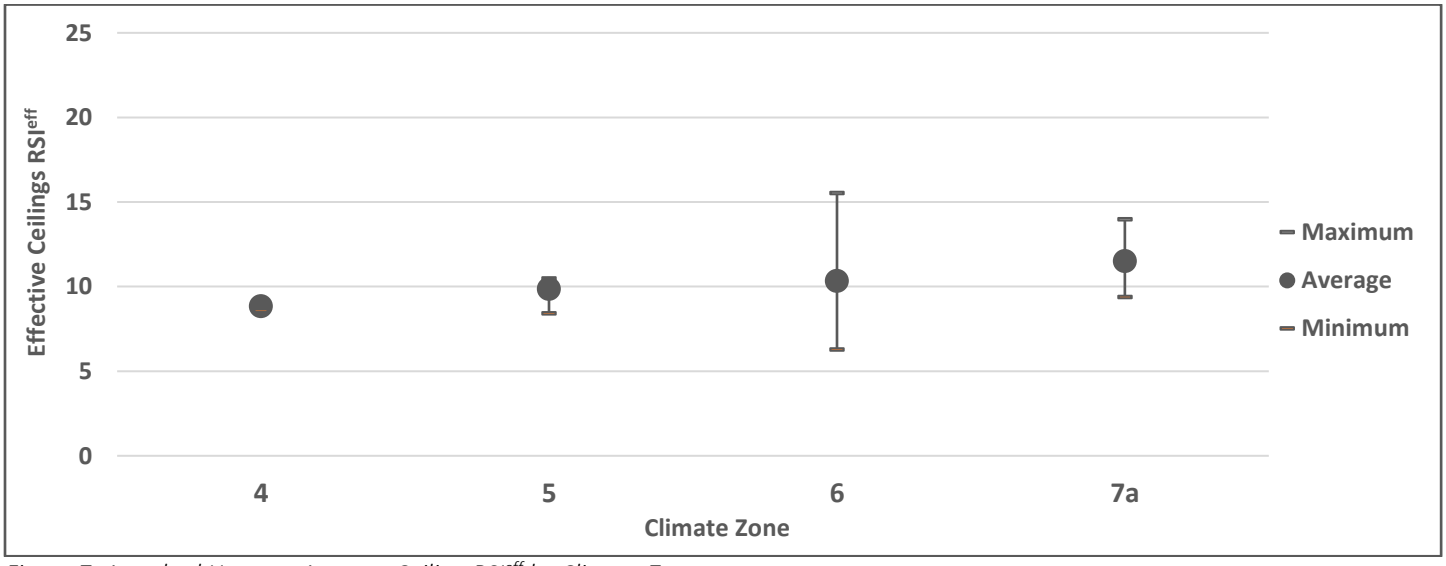

Figure 7: Attached Homes - Average Ceiling RSI^{eff} by Climate Zone

Analysis

- 77% (599/775) of detached homes used effective thermal resistance of wall assemblies of ≥ RSI 4.4 [R25].
- 84% (288/342) of attached homes used effective thermal resistance of wall assemblies of ≥ RSI 4.4 [R25].
- 90% (702/775) of detached homes used effective thermal resistance of ceiling assemblies of ≥ RSI 9.7 [R55].
- 92% (315/342) of attached homes used effective thermal resistance of ceiling assemblies of ≥ RSI 8.8 [R50].

In general, 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 1,117 attached and detached homes labelled under the Program.

- **Dual fuel space heating source:** 74% (825/1,117 homes)
- **Only electric space heating source:** 26% (288/1,117 homes)
- **Only gas space heating source:** <1% (4/1,117 homes)

99% of homes in the Program installed a heat pump for space heating and cooling, therefore only 1% of homes were required to perform the space cooling threshold calculation. Of the homes that installed heat pumps, 91% used air-source heat pumps (ASHP), 9% used ground-source heat pumps (GSHP), and 1 home installed a water-source heat pump (WSHP).

Note: *The five homes in the row titled 'Other' used the following heating system configurations.*
- *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.*

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	2	0	0	10	0	0	690	7	**709**
ASHP + Electric Furnace	32	14	1	2	0	4	183	2	**238**
ASHP + Electric Baseboards	4	12	0	1	2	10	15	1	**45**
Combo/Domestic Hot Water	9	6	0	0	0	0	6	0	**21**
Natural Gas Furnace	0	1	0	0	0	0	3	0	**4**
Ground Source Heat Pump System	2	0	0	1	0	0	92	0	**95**
Other	0	4	0	0	0	0	1	0	**5**
Total	**49**	**37**	**1**	**14**	**2**	**14**	**990**	**10**	**1,117**

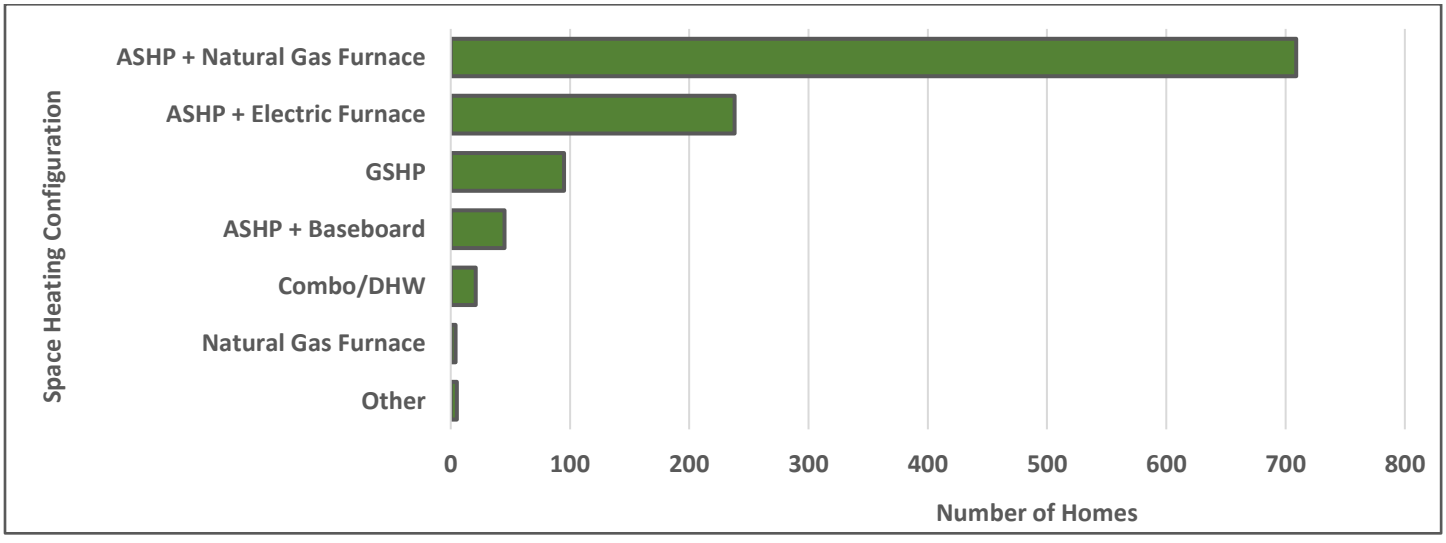

Figure 8: Space Heating Configuration

5.2 Water Heating

This section looks at the water heating systems used in the 1,117 attached and detached homes labelled under the Program.

- Natural gas water heating: 72% (803/1,117 homes)
- Electric water heating: 28% (309/1,117 homes)
- Solar water heating: <1% (3/1,117 homes)
- Propane water heating: <1% (2/1,117 homes)

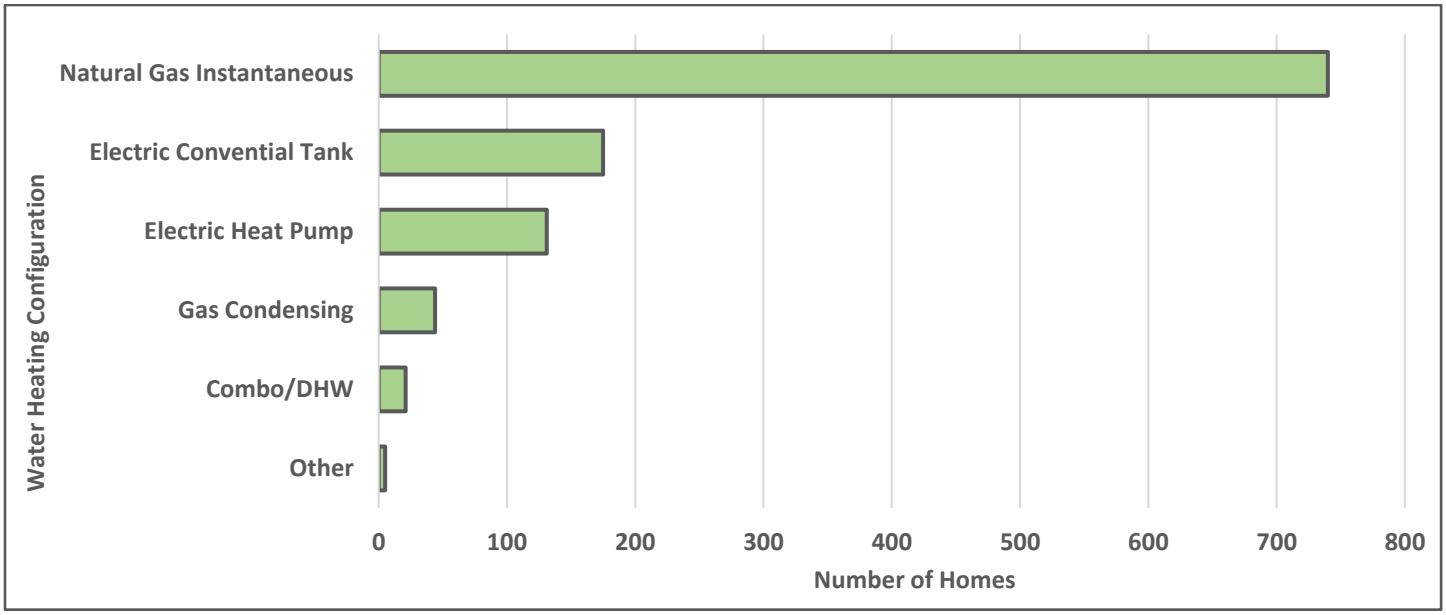

Figure 9: Water Heating Configuration

5.3 Ventilation

This section looks at the efficiency of the mechanical ventilation system used in the 1,117 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 an HRV or ERV installed for mechanical ventilation, per the Program Technical Requirements.

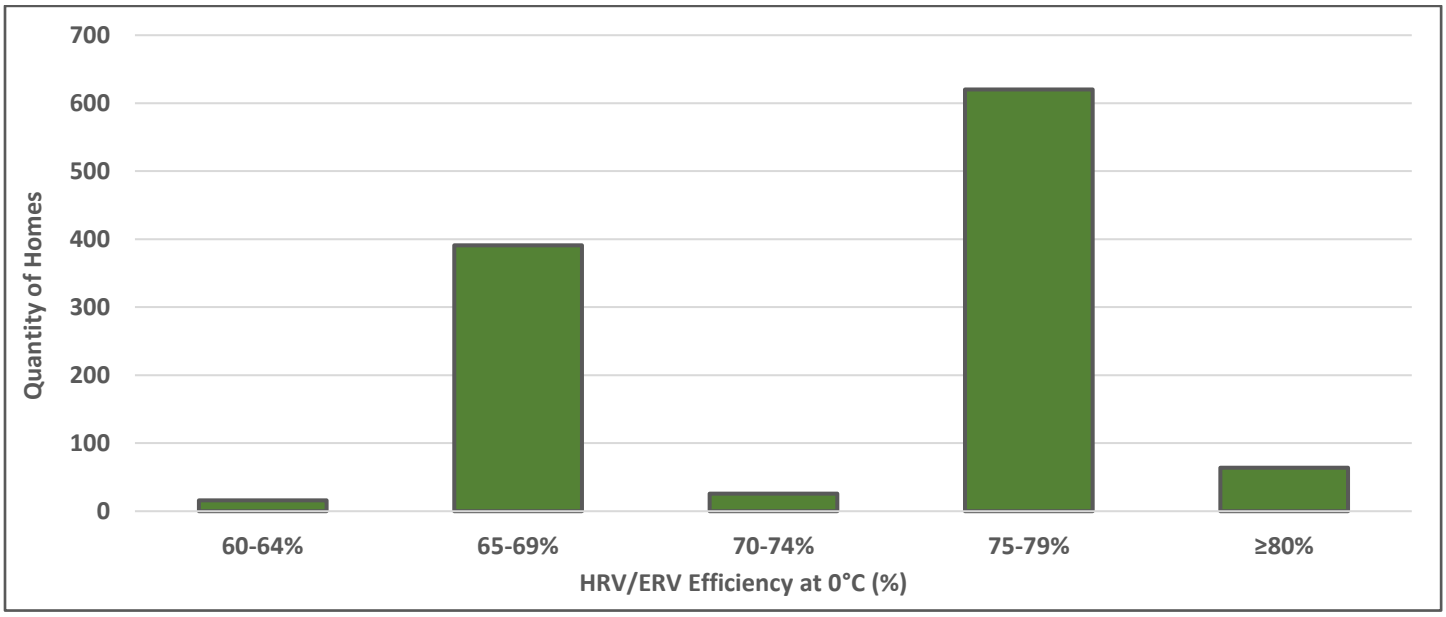

Figure 10: HRV/ERV Efficiency at 0°C

Analysis

- 63% (709/1,117) of homes used an air-source heat pump with a back up natural gas furnace for space heating.
- 66% (740/1,117) of homes used a tankless natural gas instantaneous water heater.
- 61% (684/1,117) of homes used an HRV/ERV with an efficiency of 75% at 0°C or greater.

The large majority of Net Zero and Net Zero Ready Homes 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 backup 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). Most homes use an HRV or ERV with a sensible heat-recovery efficiency (at 0°C) of either 67% or 75%. Both efficiency values are very readily available in the market and exceed the minimum requirement of the Program.

6.0 FUEL SOURCE

This section looks at the fuel source configurations used in the 1,117 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 back up conventional furnace. In the category names, "Hybrid Heating" denotes a home that used an electric primary with a natural gas back up system, where as "All-Electric Heating" indicates a home that uses an electric primary and an electric back up heating system.

Note: *Figure 11 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. 24 homes were not included in the chart below as they did not conform to the categories selected[3]. 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*

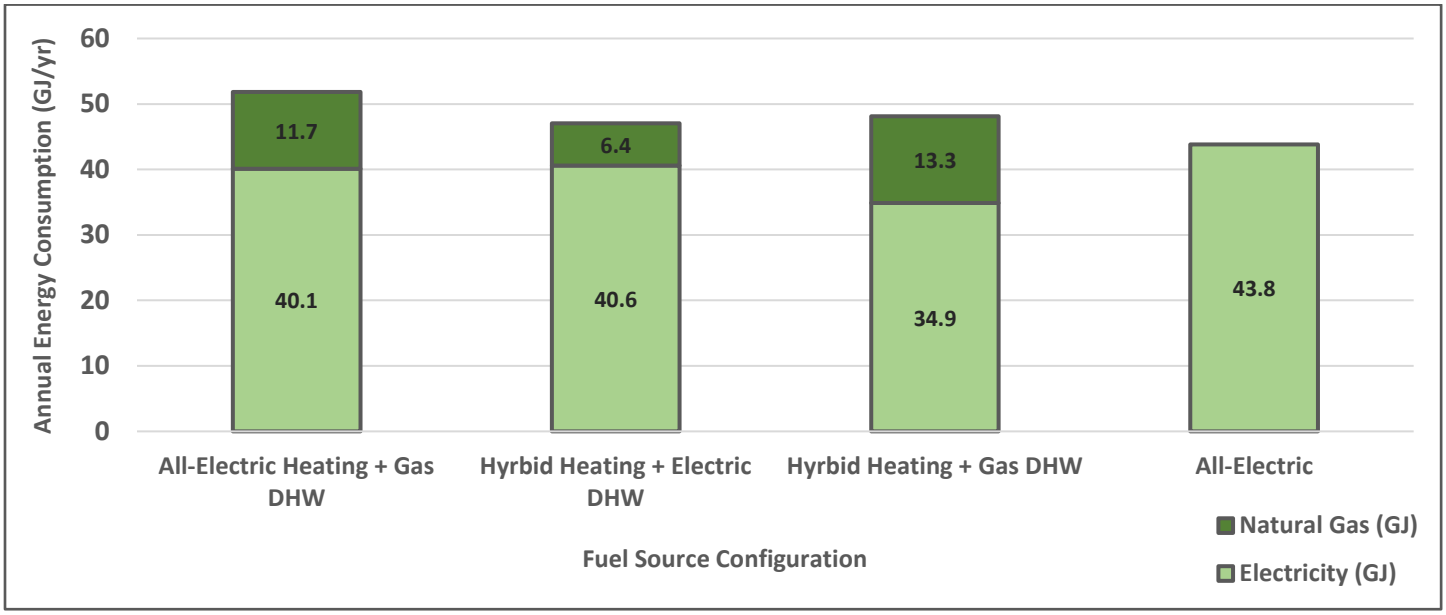

Figure 11: Fuel Source Consumption Comparison by System Configuration

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	Climate Zones
All-Electric Heating + Gas DHW	314	11,140	111	285 m^2	4[4], 6[107]
Hybrid Heating + Electric DHW	173	112,278	37	333m^2	5[4], 6[26], 7a[7]
Hybrid Heating + Gas DHW	355	9,682	692	276 m^2	4[1], 5[461], 6[218], 7a[12]
All-Electric	0	12,172	253	225m^2	4[8], 5[147], 6[67], 7a[30], 7b[1]

[3] *- 17 homes did not have the appropriate information to be used in this comparison.*
- 3 homes use solar water heating and were not considered in this comparison.
- 3 homes use propane for heating and/or DHW and were not considered in this comparison.
- 1 home uses only a natural gas furnace for space heating and a heat pump water heater and therefore did not fit in a category.

Analysis

All-Electric Heating + Gas DHW

- 89% (99/111) of homes used a GSHP + electric furnace for space heating and a natural gas instantaneous water heater.
- 86% (95/111) of homes were modelled to consume less than 310 m^3 of natural gas annually.
- All 111 homes were located in the same development.

Hybrid Heating + Electric DHW

- 89% (33/37) of homes used an ASHP + natural gas furnace for space heating and a heat pump hot water heater.
- 73% (27/37) of homes were modelled to consume less than 200 m^3 of natural gas annually.

Hybrid Heating + Gas DHW

- 97% (668/692) of homes used an ASHP + natural furnace and an instantaneous condensing water heater.
- 68% (469/692) of homes were modelled to consume between 300 m^3 and 400 m^3 of natural gas annually.
- 99% (659/668) of the homes using this configuration are located in Ontario.

All-Electric

- 84% (211/253) of homes used an ASHP + electric furnace for space heating.
- 64% (156/253) used a conventional tank for water heating. 38% (97/253) of homes used a heat pump water heater.
- 81% (205/253) of all-electric homes were modelled to consume less than 50 GJ/year (13,889 kWh/year) in electricity.
- 70% (176/253) of all-electric homes are located in Ontario. 11% (29/253) are in Alberta. 10% (26/253) are in British Columbia.

Many different reasons influence why builders choose these fuel source configurations for their Net Zero and Net Zero Ready Homes. Some examples are homeowner goals, cost, availability, and utility policy. The majority of labelled homes use 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),
- 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.*	Ref AEC[4] ***Avg.*** *Min.* *Max.*	Ref Env[5] ***Avg.*** *Min.* *Max.*
Detached <2,600 ft^2	119	212	2,281	**44.6** 30.9 69.0	**48.0** 22.9 81.3	**1.02** 0.37 1.79	**0.22** 0.14 0.63	**62.9** 21.1 83.0	**55.5** 33.0 89.7
Detached ≥2,600 ft^2 <4,000 ft^2	489	288	3,119	**48.9** 31.1 82.7	**61.0** 38.8 123.0	**1.02** 0.28 1.76	**0.17** 0.09 0.30	**63.5** 27.7 86.9	**49.9** 33.0 88.7
Detached ≥4,000 ft^2	104	500	5,386	**61.9** 31.9 130.8	**104.5** 42.3 227.6	**1.01** 0.21 2.00	**0.13** 0.06 0.25	**68.4** 29.4 85.0	**51.2** 33.3 84.1
Attached	342	194	2,086	**42.2** 27.2 99.7	**37.3** 18.9 101.3	**1.30** 0.46 3.25	**0.23** 0.13 0.45	**60.4** 11.6 86.7	**59.0** 33.2 86.9
Single Unit MURB	22	94	1,012	**25.5** 19.8 35.1	**25.6** 12.5 55.1	**1.44** 0.90 1.92	**0.33** 0.17 0.53	N/A	**69.8** 33.2 93.3
Whole Building MURB	4	853	9,182	**245.1** 69.7 353.2	**249.2** 76.5 378.5	**2.0** 0.47 2.58	N/A	**65.9** 63.2 67.3	**52.2** 41.0 67.3

[4] *19 Detached homes, 6 attached homes, and all 6 Single Unit - MURBs did not have this calculation ("Ref AEC").*
[5] *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, offset by the on-site renewable energy production.

Note: *2 homes were removed from Figure 12 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.*

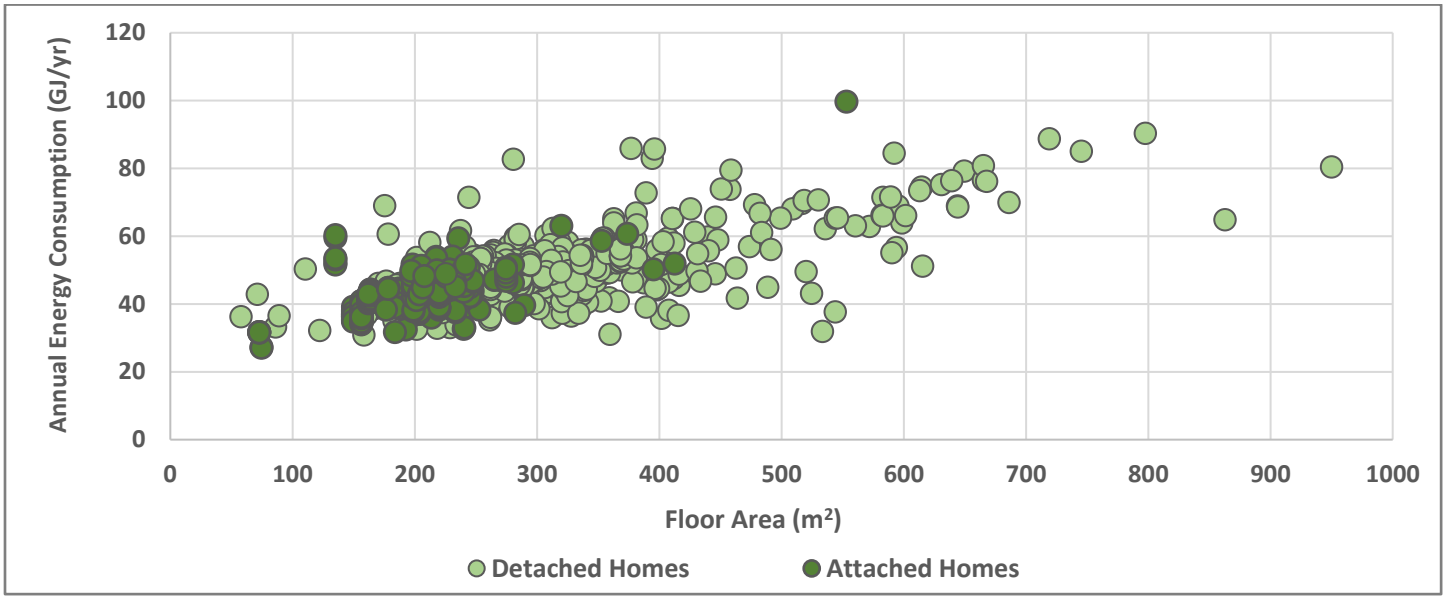

Figure 12: Annual Energy Consumption by Floor Area

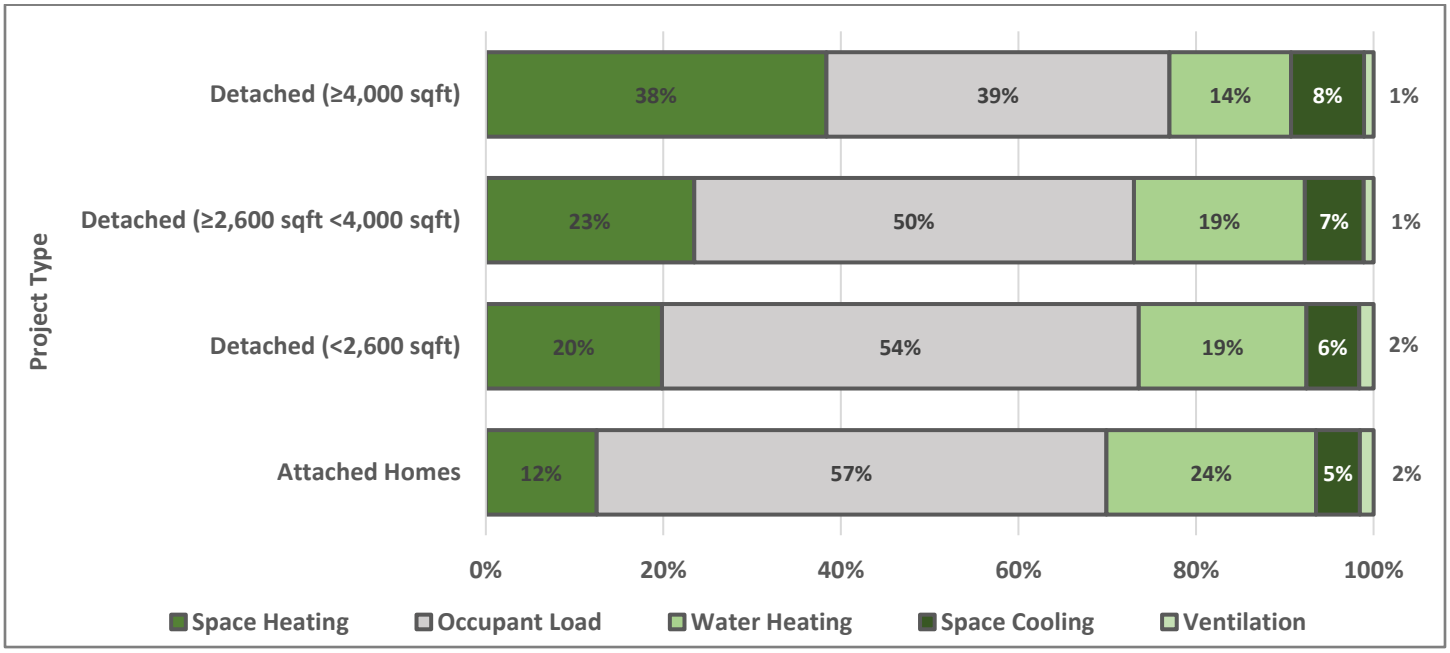

Figure 13: Average Load Distribution of Annual Energy Consumption by Floor Area

AVERAGE ANNUAL ENERGY CONSUMPTION BY FLOOR AREA

- Attached Homes = 42.2 GJ/year
- Detached Homes <2,600 ft^2 = 44.6 GJ/year
- Detached Homes ≥2,600 ft^2 and <4,000 ft^2 = 48.9 GJ/year
- Detached Homes ≥4,000 ft^2 = 61.9 GJ/year

- 89% (539/608) of detached homes with a heated floor area less than 4,000 ft^2 were modelled to have a total energy consumption of less than 52 GJ/year.
- 80% (272/342) of attached homes were modelled to have an annual energy consumption of less than 45 GJ annually.

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.

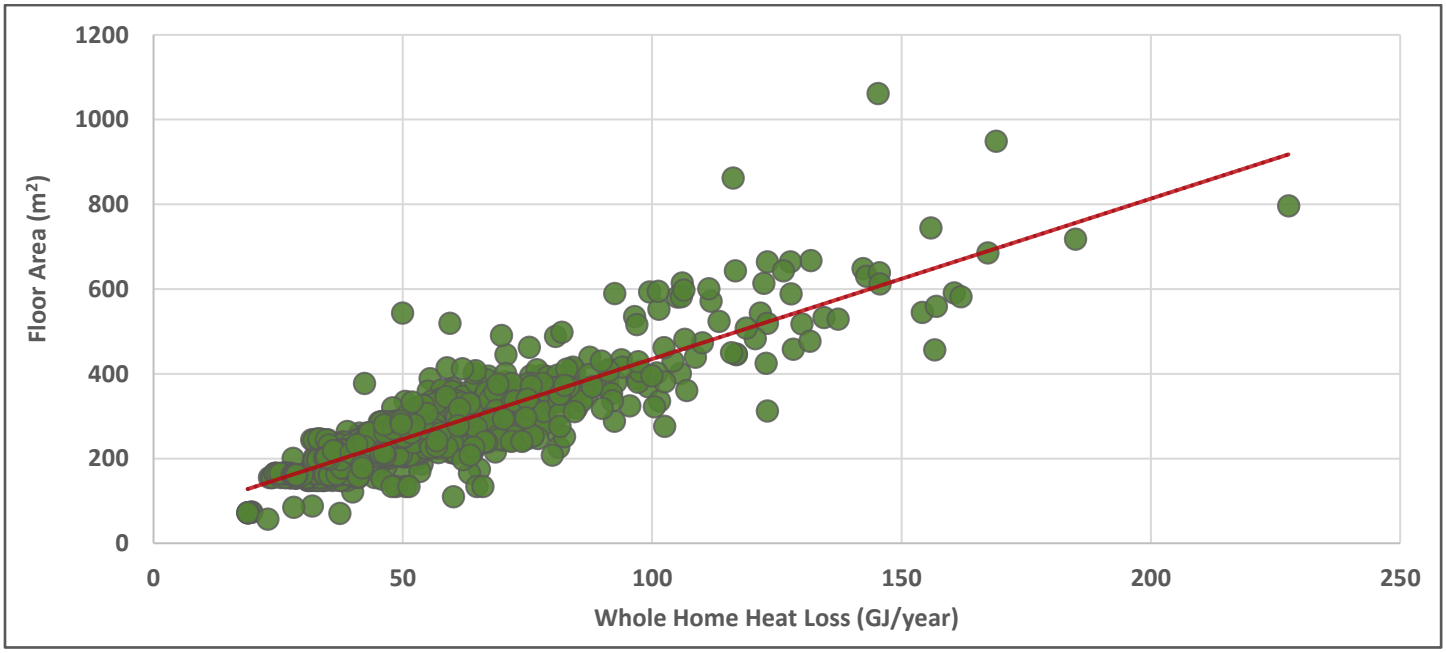

Figure 14: Whole Home Heat Loss by Floor Area

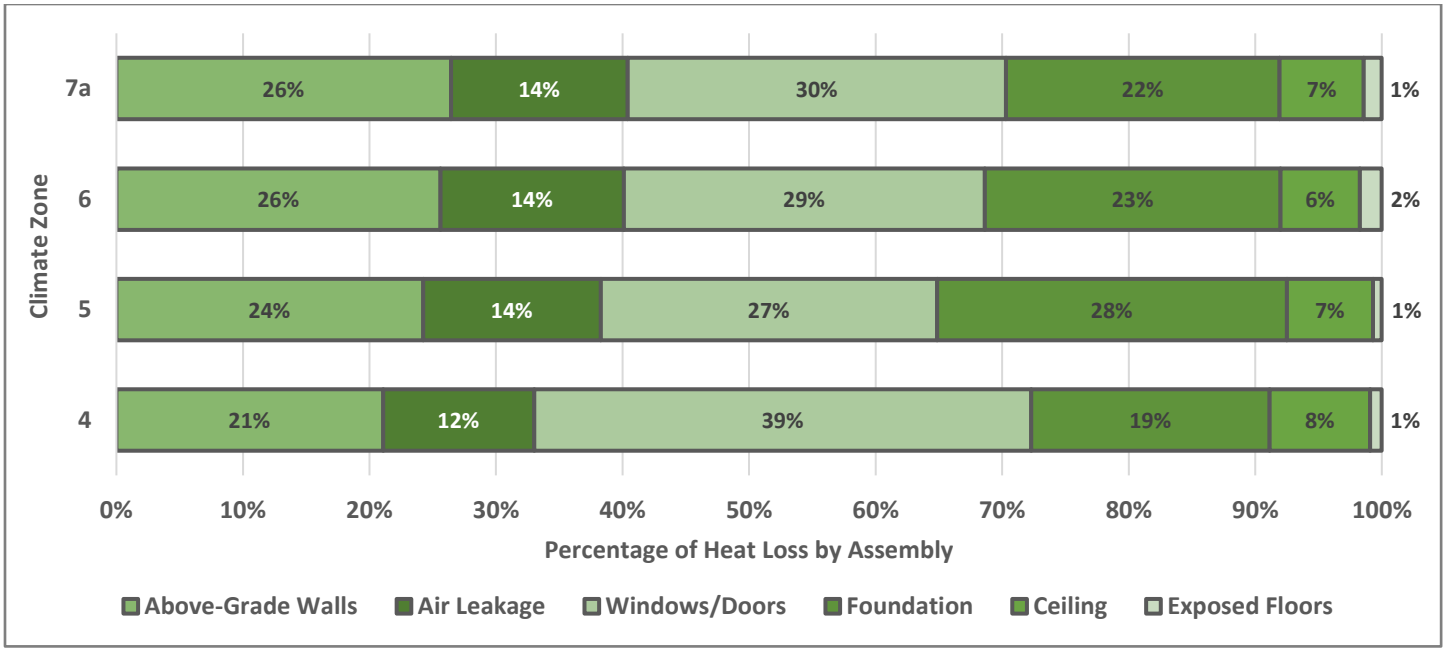

Figure 15: Detached Homes – Assembly Distribution of Whole Home Heat Loss by Climate Zone

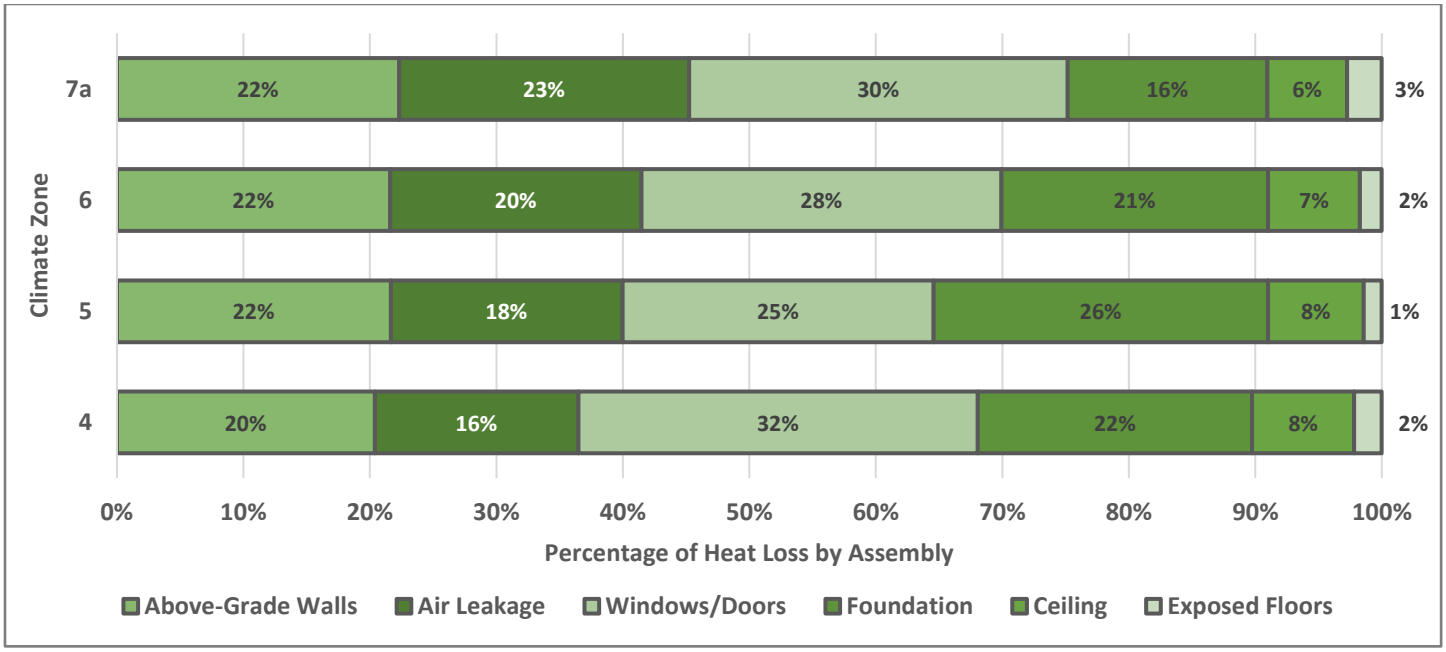

Figure 16: Attached Homes – Assembly Distribution of Whole Home Heat Loss by Climate Zone

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.

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 (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.

Note: *The homes that exceeded the ACH targets in Figure 17 achieved compliance using one of the other airtightness target metrics – Normalized Leakage Rate (NLR@50Pa) or Normalized Leakage Area (NLA@10Pa).*

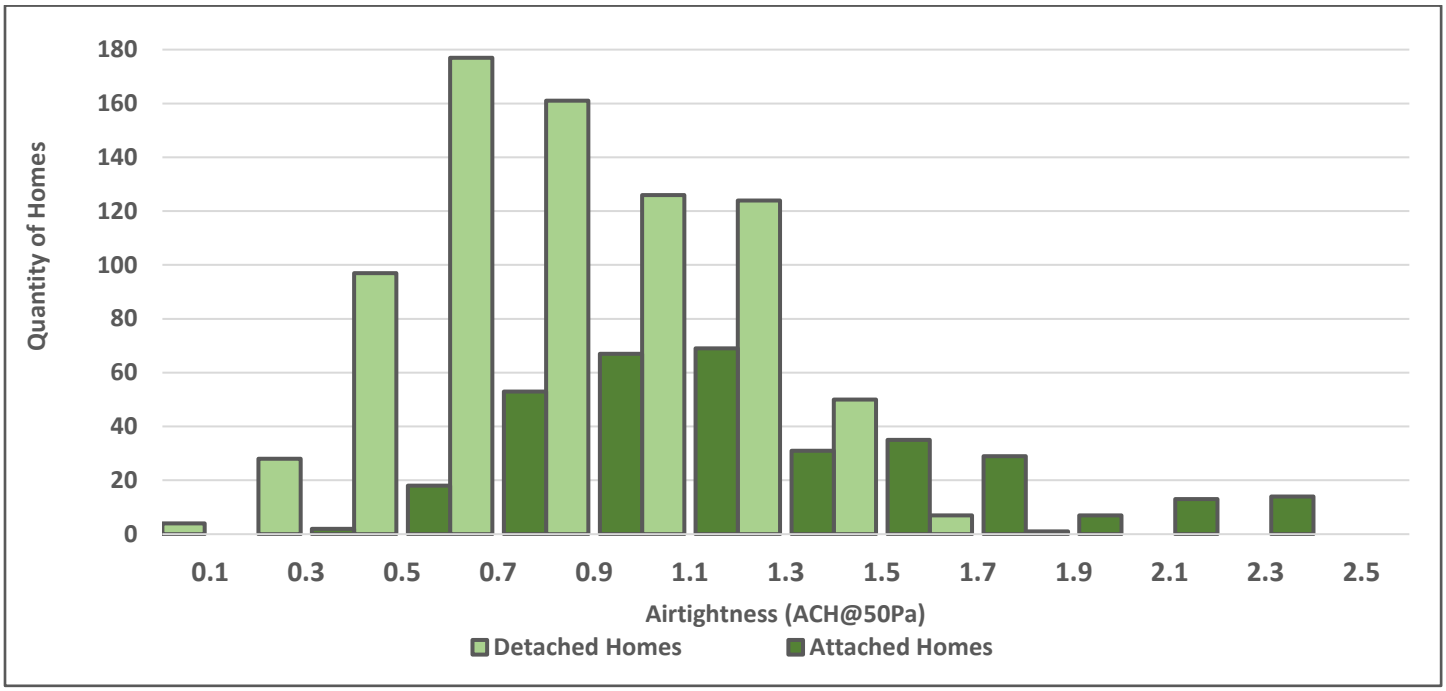

Figure 17: Distribution of Airtightness by ACH@50

Analysis

- The average airtightness of all 775 detached homes is 1.0 ACH@50Pa.
- The average airtightness of all 342 attached homes is 1.3 ACH@50Pa.
- The overall airtightness average for detached and attached homes is 1.1 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.

7.4 Total Energy Use Intensity (TEUI)

Total Energy Use Intensity is a standard metric comparing the estimated annual energy consumption of the home to the size of the home's heated floor area. TEUI is measured in Gigajoules on the vertical axis (GJ/m^2/year). 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. The CHBA Program does *not* have a performance target for TEUI.

Note: *4 homes were removed from Figure 18 as outliers. 3 homes had very large floor area relative to the other homes: 1,249 m^2, 1,135 m^2, and 1,037 m^2. 1 home had a very high TEUI of 0.91 GJ/m^2/year relative to the other homes, likely because of its very small floor area of 87 m^2.*

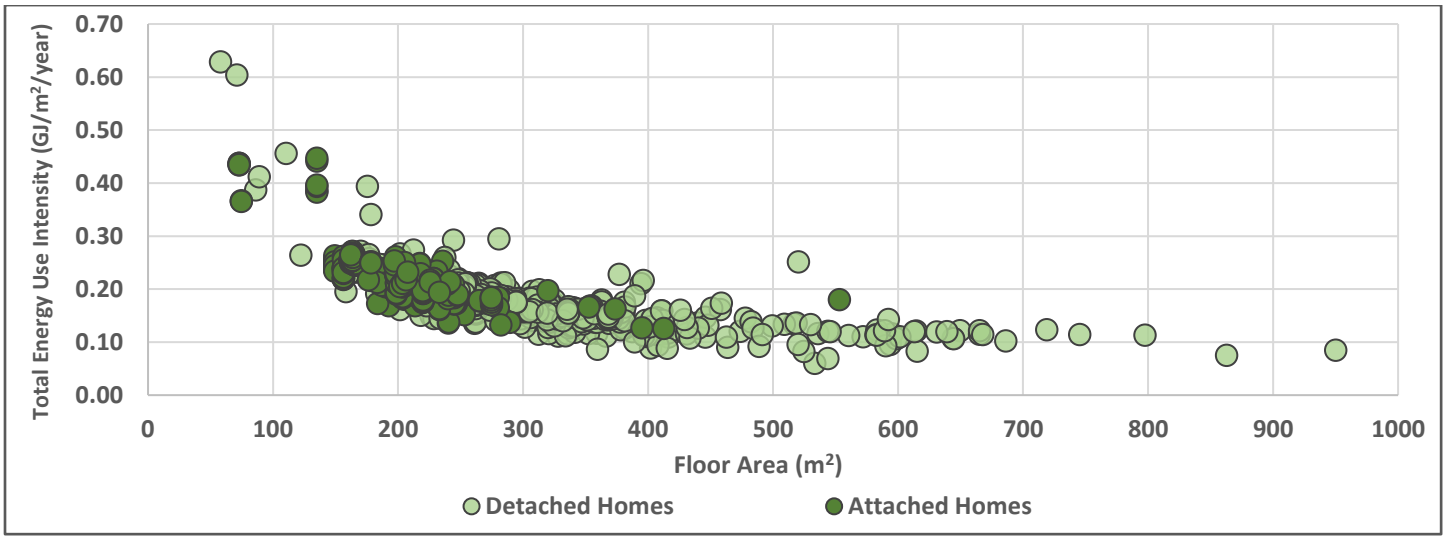

Figure 18: Total Energy Use Intensity by Floor Area

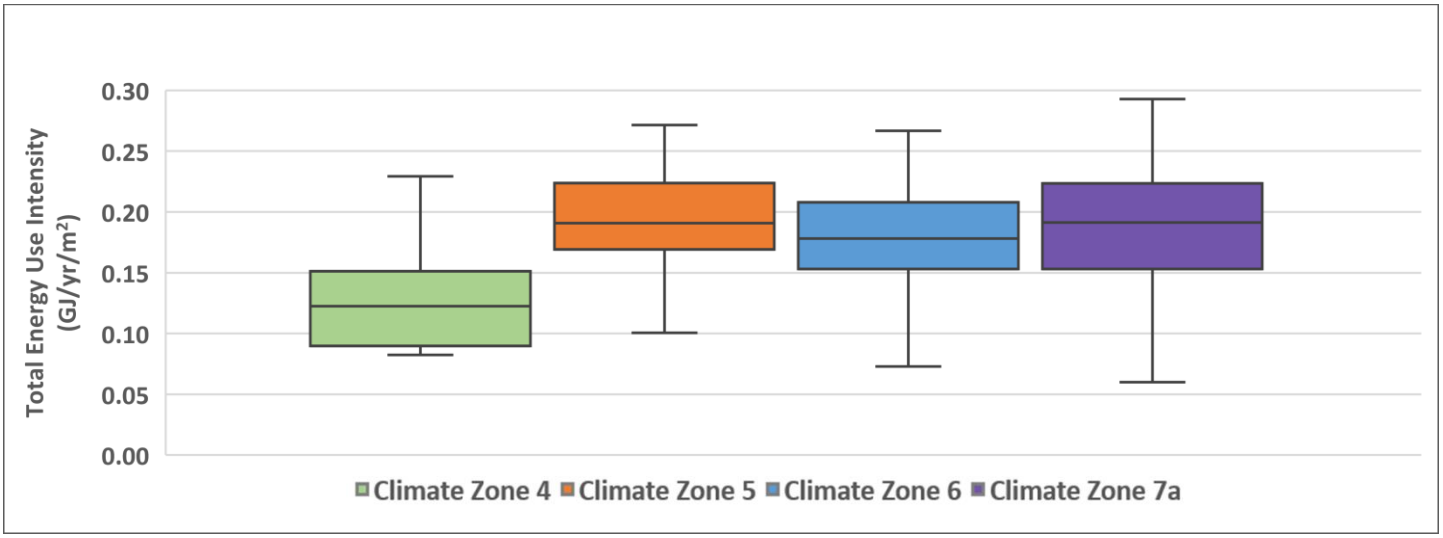

Figure 19: Distribution of Total Energy Use Intensity by Climate Zone

AVERAGE BY CLIMATE ZONE

- Climate Zone 4 = 0.13 GJ/m^2/year.
- Climate Zone 5 = 0.20 GJ/m^2/year.
- Climate Zone 6 = 0.18 GJ/m^2/year.
- Climate Zone 7a = 0.21 GJ/m^2/year.

Analysis

In general, TEUI increases marginally from warmer climate zones to colder climate zones because of the additional space heating load. Smaller homes often have a higher TEUI than larger homes. A smaller heated floor area can impact the ability of a home to achieve a low TEUI.

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.

Note: *Only 1,092 detached and attached homes have this calculation because it was included in the updated version of HOT2000, v11.*

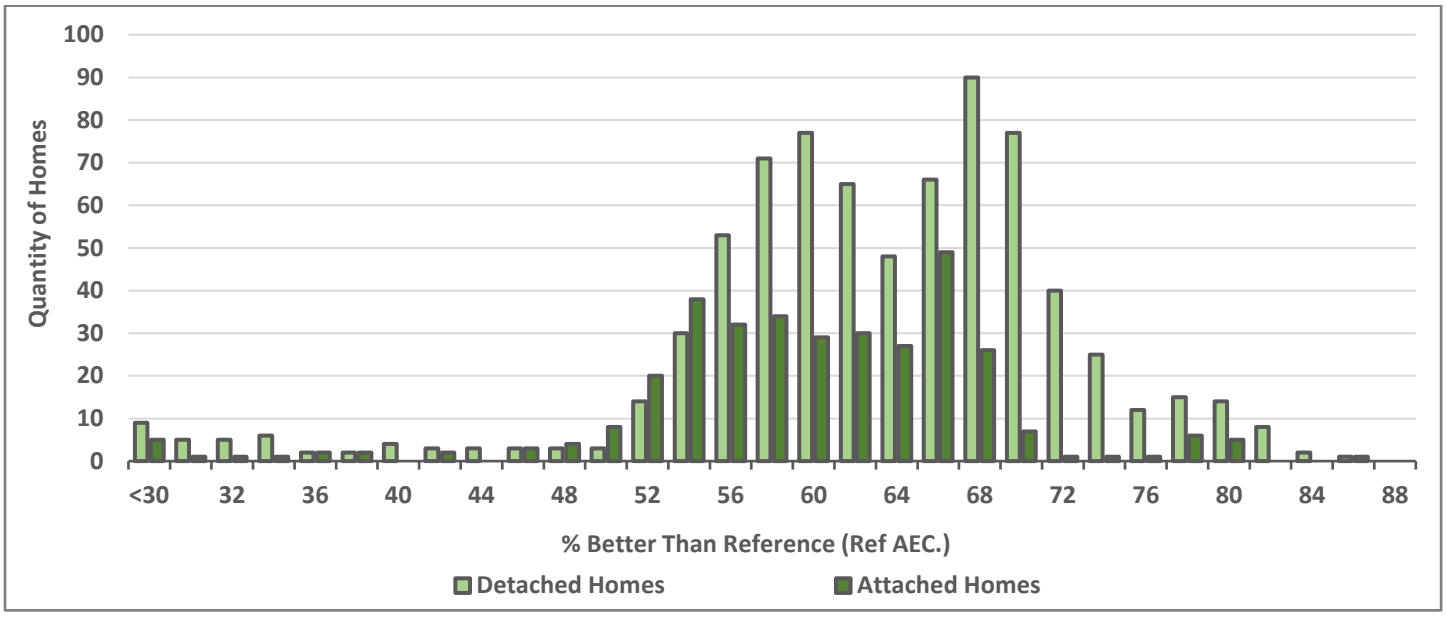

Figure 20: Distribution of Percent Better Than Reference House - Annual Energy Consumption

ANALYSIS

- The average for all 756 detached homes is 64.0% better than "Ref. AEC".
- The average for all 336 attached homes is 60.4% better than "Ref. AEC".

The majority (66%) of Net Zero and Net Zero Ready Homes achieved between 60% and 86% 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.

Note: *Only 771 detached homes have this calculation because it was included in the updated version of HOT2000, v11.*

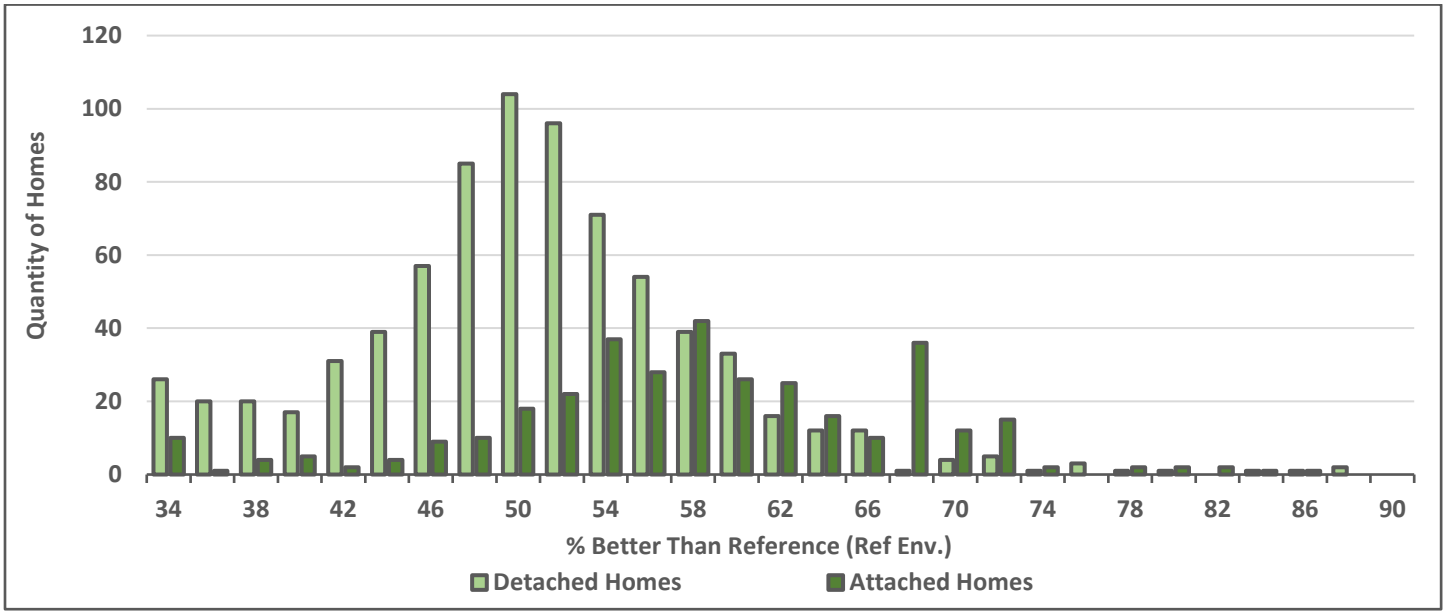

Figure 21: Distribution of Percent Better Than Reference House - Building Envelope

ANALYSIS

- The average for all 771 detached homes is 51% better than "Ref. Env."
- The average for all 342 attached homes is 49% 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. Most (77%) detached homes achieve a building envelope between 45% and 65% better than the reference house, and most (76%) attached homes achieve a building envelope between 50% and 70% better than the reference house.

8.0 OPERATIONAL CARBON EMISSIONS

This section considers the annual carbon emissions from the modeled operation of the 1,117 detached and attached homes labelled under the Program as of December 31, 2022. The operational carbon 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 carbon emissions calculation methodology can be found in Appendix A.

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

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

Note: *3 homes from the Pilot were excluded from this section as they did not have the appropriate data to calculate carbon emissions.*

Table 11: Annual Operational Carbon Emission of Homes by Province

Project Location	Climate Zone(s)	# of Labels	Avg. Area m^2	Avg. Area ft^2	Total Operational Carbon $kgCO_2e$/year			Operational Carbon Intensity $kgCO_2e/m^2$/year		
					Avg.	Min.	Max.	Avg.	Min.	Max.
Alberta	6,7a	49	277	2,977	**6,637**	4,637	11,220	**27.1**	16.4	47.3
British Columbia	4,5,6	37	349	3,760	**345**	12.0	3,523	**0.93**	0.03	7.63
Manitoba	7a	1	239	2,573	**22.4**	22.4	22.4	**0.09**	0.09	0.09
New Brunswick	6	14	299	3,215	**3,721**	2,977	4,386	**13.1**	7.43	18.7
Newfoundland & Labrador	6	2	441	4,744	**275**	258	291	**0.65**	0.53	0.77
Nova Scotia	6	14	172	1,847	**6,778**	4,984	9,732	**59.1**	15.3	115.3
Ontario	5,6	990	265	2,848	**819**	3	5,549	**3.16**	0.02	12.8
Saskatchewan	7a,7b	10	262	2,825	**9,168**	6,628	15,987	**37.9**	24.1	66.7

8.1 Annual Operational Carbon Emissions

This section considers total annual operational carbon emitted as well as annual operational carbon emissions intensity based on heated floor area. It does not consider carbon offsets from the on-site renewable energy installed on some homes. Figure 22 shows the average annual operational carbon emissions of the Net Zero and Net Zero Ready Homes labelled within each province and Figure 23 shows the same data normalized by the homes' heated floor area.

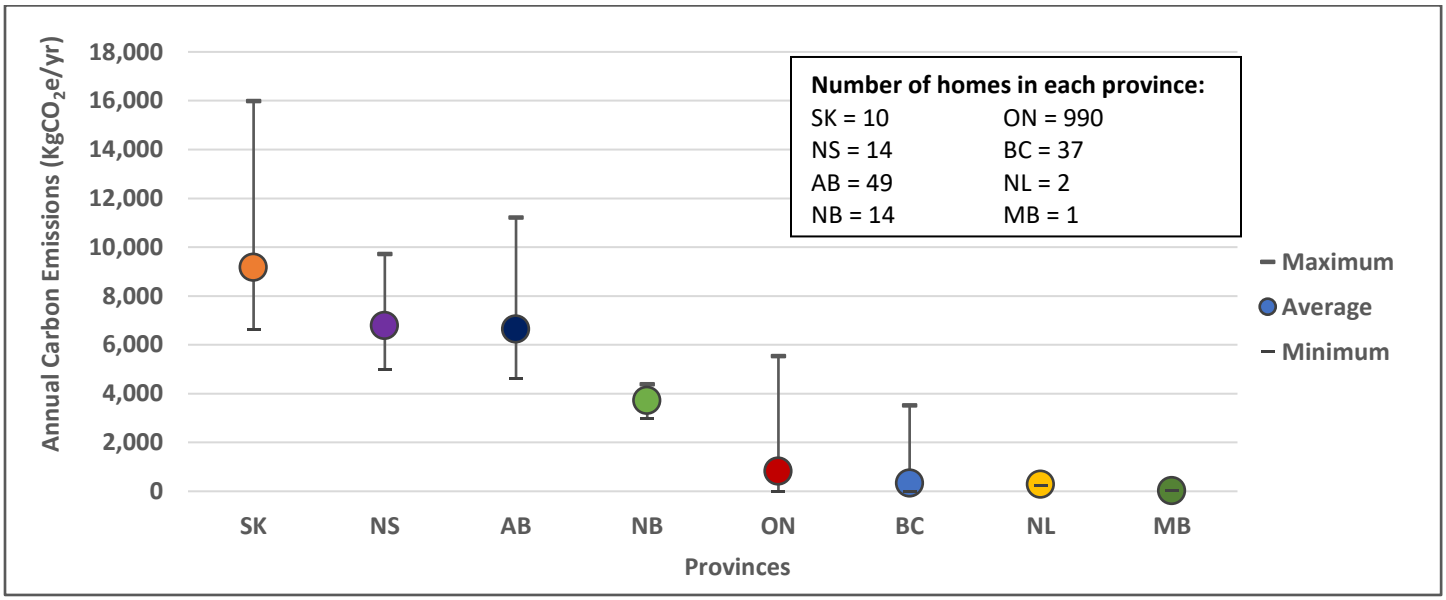

Figure 22: Average Annual Operational Carbon Emissions of Homes by Province

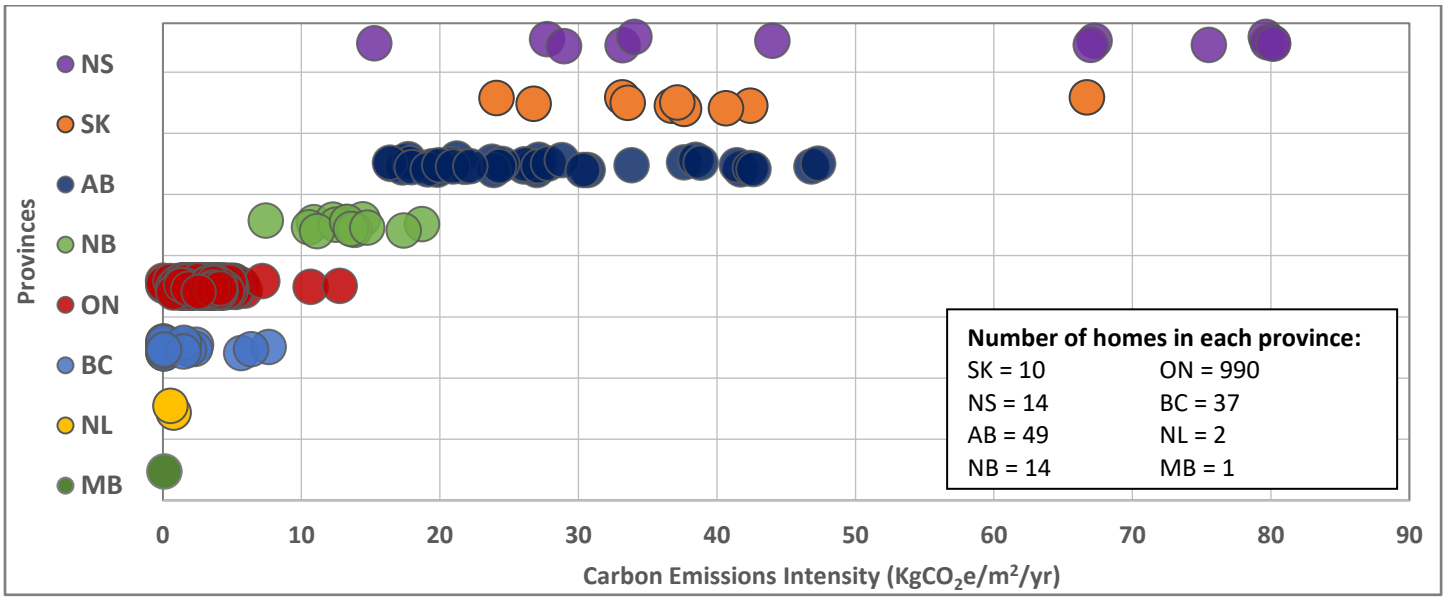

Figure 23: Annual Operational Carbon Emissions Intensity of Homes by Province

ANALYSIS

Annual operational carbon 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 carbon emissions offsets from homes with renewables installed. This is done so that Net Zero Ready Homes can be compared to Net Zero Homes. With carbon emissions offsets included Net Zero Homes would have substantially lesser operational carbon 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 carbon emissions avoidance in comparison to the same home in a province with a lower grid emission intensity.

Appendix A

OPERATIONAL CARBON EMISSIONS CALCULATION METHODOLOGY

For the purpose of this report, the following emission factors were used to calculate the annual operational carbon 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 carbon emissions for each home. The emission factors used are from *Environment Canada's National Inventory Report – 2023 Edition*. The most recent reporting values are from the year 2021.

Province	Electricity $t/CO_2e/kWh$	Natural Gas $t/CO_2e/m^3$	Propane $t/ CO_2e/L$
Newfoundland and Labrador	0.000016	0.001930355	0.001547859
Prince Edward Island	0.000003	0.001930355	
Nova Scotia	0.000660	0.001930355	
New Brunswick	0.000290	0.001930355	
Quebec	0.000001	0.001937355	
Ontario	0.000028	0.001932355	
Manitoba	0.000002	0.001926355	
Saskatchewan	0.000670	0.001931355	
Alberta	0.000510	0.001973355	
British Columbia	0.000014	0.001977355	
Yukon	0.000070	0.001977355	
Northwest Territories	0.000170	0.001977355	
Nunavut	0.000800	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 (May 1, 2023)

Electricity emission factors for each province are from:

National Inventory Report (1990-2021): 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 (1990-2021): 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 (1990-2021): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC), Table A6.1-4 CO_2 Emission Factors for Natural Gas Liquids