CHBA NET ZERO HOME LABELLING PROGRAM
Summary Report – 2021

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, 2021, 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 1.4 million jobs
- Paying more than $95.6 billion in wages
- Generating $182.7 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 9,000 companies across Canada, CHBA members include home 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 is helping 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. Now expanding to renovations, multi-unit residential construction and neighbourhoods, the program has labelled over 750 homes across Canada and continues to grow, while also informing best practices in energy efficiency for all homes. 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, 2021, 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, multi-unit residential buildings—single unit, and multi-unit residential buildings—whole building (see 2.0 Definitions). 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. This report also includes an analysis of the six homes labelled under the Net Zero Renovations Pilot which concluded in March 2021.

Here are some highlights of the report content:

- 212 Net Zero Ready Homes and 25 Net Zero Homes were labelled in 2021, bringing the total to 758 homes labelled under the Program as of December 31, 2021.
- Homes have been labelled in 9 provinces and 4 climate zones.
- In total, there are 463 detached homes, 249 attached homes, and 46 units contained in 5 multi-unit residential buildings.
- The majority (62%, 439/712) of detached and attached homes used above-grade walls with an RSI between 4.4 and 5.3 (R25-R30).
- For detached and attached homes the most common (84%, 598/712) ceiling RSI was between 8.9 and 11.4 (R50-R60).
- The most common 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 (62%, 444/712).
- In total, the majority of Net Zero Homes (79%, 162/205) used an all-electric fuel source configuration and the majority of Net Zero Ready Homes (82%, 455/553) used a dual fuel source configuration.
- Most of the detached homes (82%, 382/463) achieved a modelled annual energy consumption of between 40 and 60 GJ/year and most attached homes (91%, 226/249) achieved between 30 and 50 GJ/yr.
- On average, the assembly within homes that accounts for the most whole home heat loss is through the windows and doors.
- The average airtightness for detached homes was 0.98 ACH@50 and for attached homes was 1.28 ACH@50.
- The average calculated Total Energy Use Intensity (TEUI) for detached homes was 0.16 GJ/m^2/year (43.6 ekWh/m^2/year) and for attached homes was 0.21 GJ/m^2/year (59.1 ekWh/m^2/year).
- The average percent better than reference – annual energy consumption was 67.9% for detached homes and 62.8% for attached homes.
- The average percent better than reference –envelope was 52.7% for detached homes and 61.3% 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 least annual operational carbon emissions.
- On average, Net Zero Renovations achieved very similar performance levels to that of new Net Zero Homes.
- The average decrease in modelled annual energy use for Net Zero Renovations was 81 GJ/year.
- The average decrease in whole home heat loss intensity for Net Zero Renovations was 0.26 GJ/m^2/year.
- The average achieved airtightness for Net Zero Renovations was 1.24 ACH@50Pa.

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. In this report, vertically attached houses commonly called "stacked" townhouses are categorized in the multi-unit residential building types defined below.

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 that the home has met the Technical Requirements, including the energy performance rating using Natural Resources Canada's (NRCan's) EnerGuide Rating System (ERS), and that the home has been 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 that the home has met the Technical Requirements, including the energy performance rating using NRCan's EnerGuide Rating System (ERS), and that the home 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
The number of degrees of temperature difference on any one day between a given base temperature and a mean daytime outside temperature. The base temperature is 18°C. The sum of all daily degree days over the heating season indicates the relative severity of the winter for a specific location.

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 modeled 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 gases 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. This building type could include buildings commonly called stacked townhouses.

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 buildings 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. This building type could include buildings commonly called duplexes or stacked townhouses.

3.0 PROGRAM TO DATE

This section provides an overall evaluation of Program activity and uptake as of December 31, 2021, which includes participants and homes in the Pilot through to the end of Year 4 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

Homes labelled from 2017 to 2021 were qualified under Version 1 of the Technical Requirements. 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, Energy Advisors 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 of 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	Total
Participants	261	190	82	71	338	397	1339

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	Total
Net Zero Home	26	9	8	107	30	25	205
Net Zero Ready Home	2	10	12	109	208	212	553
Total	**28**	**19**	**20**	**216**	**238**	**237**	**758**

Note: *1 Net Zero Home, reflected in Table 2, was added retroactively and labelled in 2019.*

Table 3: Number of Homes by Province/Territory

Province	Net Zero	Net Zero Ready	Total
Alberta	31	9	40
British Columbia	15	15	30
Manitoba	1	0	1
New Brunswick	2	11	13
Newfoundland & Labrador	0	2	2
Northwest Territories	0	0	0
Nova Scotia	10	2	12
Nunavut	0	0	0
Ontario	138	502	640
PEI	0	0	0
Quebec	6	0	6
Saskatchewan	2	12	14
Yukon	0	0	0

Figure 1: Climate Zone Map of Canada (source: Natural Research Council Canada, colour coding by NAIMA Canada).

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

Type of House	Qty. per Climate Zone			
	4	5	6	7a
Detached Homes	8	235	189	31
Attached Homes	2	187	50	10
Single Unit - MURB	0	0	6	0
Whole Building - MURB	0	28	0	12
Subtotal	10	450	245	53
Total	758			

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

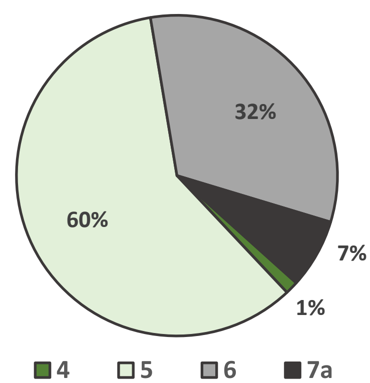

Figure 2: Distribution of Homes by Climate Zone

ANALYSIS

There has been a significant amount of program uptake in the past two years. In 2021, the Program labelled nearly the same number of homes as was labelled in the year 2020. Homes have now been labelled in most provinces and most climate zones across the country. Homes have not yet been labelled in Prince Edward Island or in the territories. No homes have been labelled in climate zone 7b or 8 yet.

4.0 ENVELOPE

This section explores the envelope assemblies used by the 758 Net Zero and Net Zero Ready New Homes labelled under the Program up to December 31, 2021. This section does not include labelled renovations.

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

- Detached homes less than 2,600 ft^2 in floor area,
- Detached homes greater than 2,600 ft^2 and less than 4,000 ft^2 in floor area,
- Detached homes greater than 4,000 ft^2 in floor area,
- Attached homes,
- Single unit – multi-unit residential buildings, and
- Whole building – multi-unit residential buildings.

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.*

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	5,6,7a	119	210	2,255	**4.97 [28.2]** 4.19 [23.8] 7.33 [41.6]	**10.71 [60.8]** 5.21 [29.6] 17.97 [102]	**4.40 [25.0]** 0.00 [0] 7.40 [42.0]
Detached ≥2,600 ft^2 <4,000 ft^2	4,5,6,7a	265	293	3,157	**4.88 [27.7]** 3.98 [22.6] 9.22 [52.4]	**10.42 [59.2]** 6.98 [39.6] 16.19 [91.9]	**4.32 [24.5]** 0.00 [0] 9.16 [52.0]
Detached ≥4,000 ft^2	4,5,6,7a	79	508	5,470	**5.32 [30.2]** 3.86 [21.9] 9.76 [55.4]	**10.68 [60.6]** 7.15 [40.6] 22.94 [130]	**4.51 [25.6]** 0.00 [0] 8.01 [45.5]
Attached	4,5,6,7a	249	186	2,003	**5.01 [28.5]** 4.05 [23.0] 8.74 [49.6]	**10.04 [57.0]** 6.39 [36.3] 15.78 [89.6]	**3.98 [22.6]** 0.00 [0] 6.15 [34.9]
Single Unit MURB	6	6	101	1,084	**4.80 [27.3]** 4.66 [26.5] 4.89 [27.8]	**8.22 [46.7]** 6.27 [35.6] 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]

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	[8]	5.91 [33.6]	8.92 [50.6]	4.33 [24.6]
5	[235]	4.53 [25.7]	10.37 [58.9]	4.24 [24.1]
6	[189]	5.32 [30.2]	10.59 [60.1]	4.30 [24.4]
7a	[31]	6.05 [34.3]	11.92 [67.7]	5.80 [32.9]

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	[2]	6.62 [37.6]	8.92 [50.6]	5.03 [28.6]
5	[187]	5.01 [28.4]	9.83 [55.8]	3.98 [22.6]
6	[50]	5.09 [28.9]	10.62 [60.3]	4.28 [24.3]
7a	[10]	4.44 [25.2]	11.29 [64.1]	2.20 [12.5]

4.1 Above-Grade Wall Assemblies

This section considers the effective thermal resistance of above-grade wall assemblies. The 463 detached homes as well as the 249 attached homes are evaluated by climate zone. The evaluation measures an assembly's 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.

Note: *Each bar in Figures 3 to 6 below represents 100% of the homes in the indicated climate zone, therefore the bars are not weighted the same as one another.*

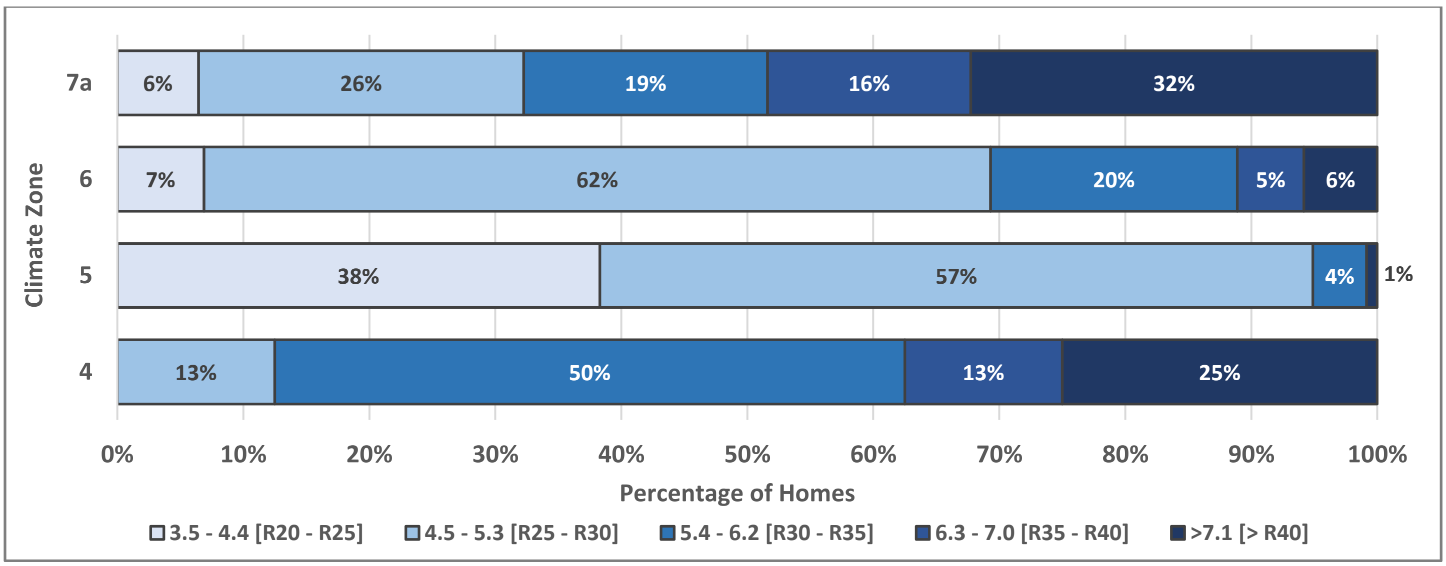

Figure 3: Detached Homes - Distribution of Above-Grade Wall RSI^{eff} by Climate Zone

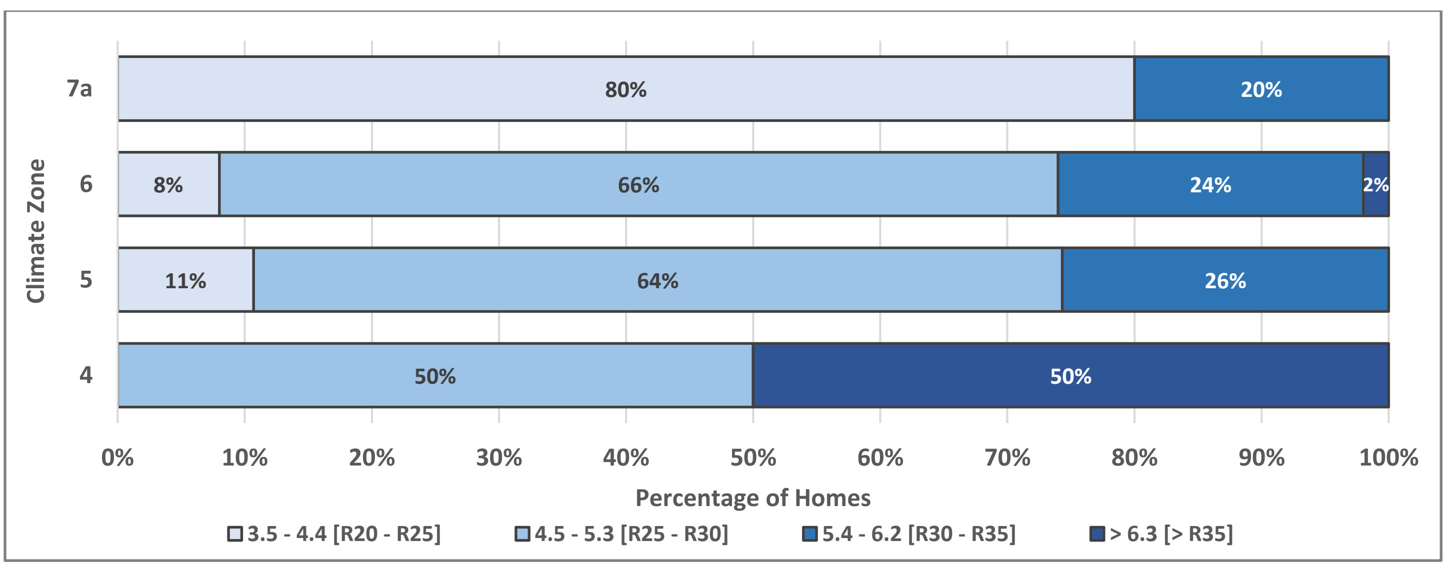

Figure 4: Attached Homes - Distribution of Above-Grade Wall RSI^{eff} by Climate Zone

4.2 Ceiling Assemblies

This section considers the effective thermal resistance of ceiling assemblies. The 463 detached homes as well as the 249 attached homes are evaluated by climate zone. The evaluation measures an assemby's 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.

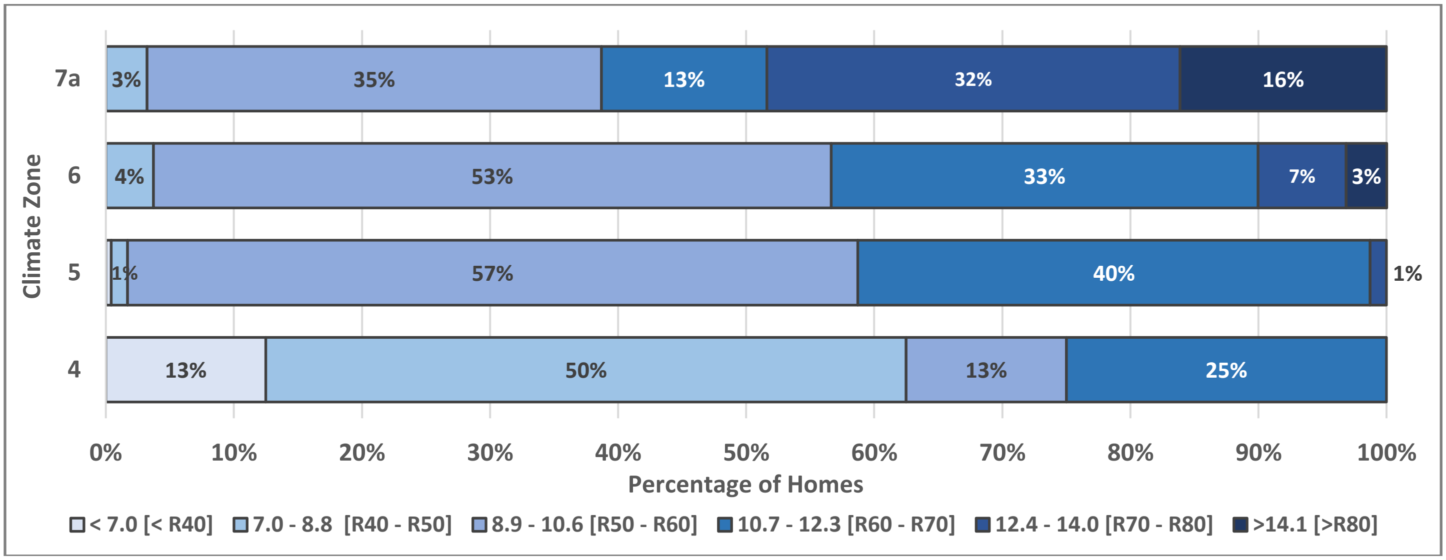

Figure 5: Detached Homes - Distribution of Ceiling RSI^{eff} by Climate Zone

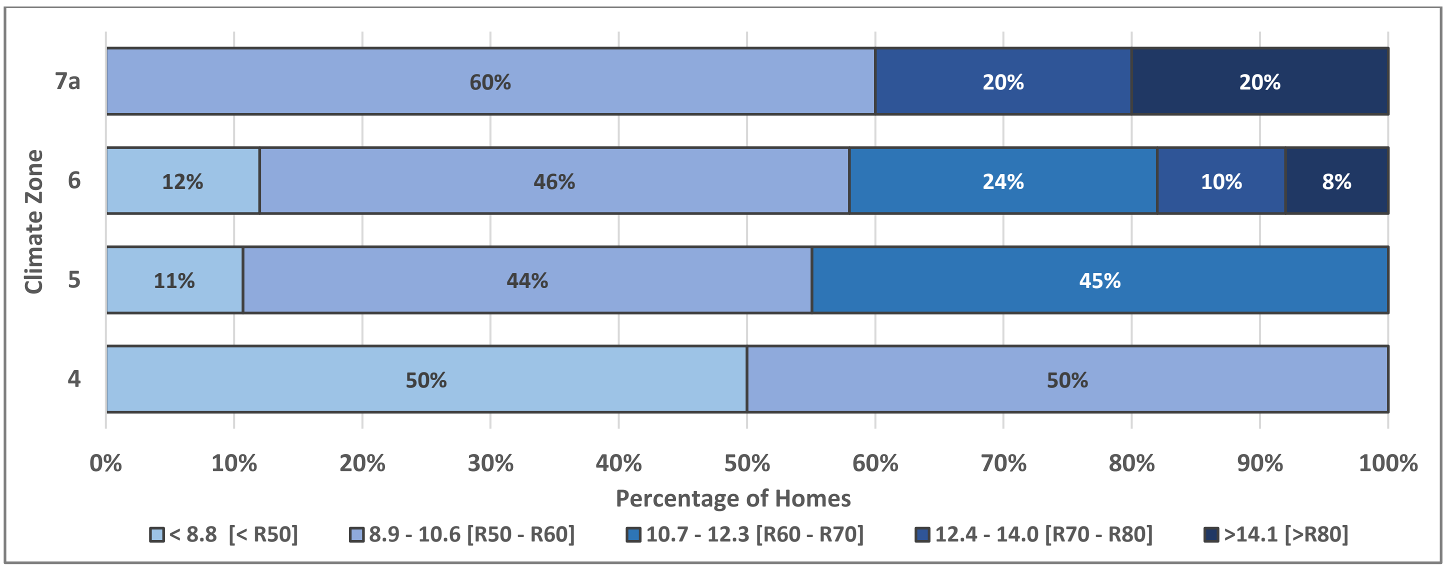

Figure 6: Attached Homes - Distribution of Ceiling RSI^{eff} by Climate Zone

Analysis

- 82% (381/463) of detached homes used effective thermal resistance of wall assemblies of ≥ RSI 4.4 [R25].
- 88% (218/249) of attached homes used effective thermal resistance of wall assemblies of ≥ RSI 4.4 [R25].
- 88% (409/463) of detached homes used effective thermal resistance of ceiling assemblies of ≥ RSI 9.7 [R55].
- 56% (140/249) of attached homes used effective thermal resistance of ceiling assemblies of ≥ RSI 9.7 [R55].

In general, homes built within colder climate zones are constructed with higher levels of insulation in both their wall assemblies and their ceiling assemblies. In climate zone 7a, the homes' wall assemblies averaged an RSI 6.1 [R34] and the homes' ceiling assemblies averaged an RSI 11.9 [R68].

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 and Cooling

This section looks at the space heating and cooling systems used in the 712 attached and detached homes labelled under the Program.

- Dual fuel space heating source: 65% (459/712 homes)
- Only electric space heating source: 34% (245/712 homes)
- Only gas space heating source: <1% (6/712 homes)

Only 15 homes in the program did not elect to install an air-source heat pump (ASHP) and therefore only those homes were required to perform the space cooling threshold calculation. ASHPs provide both space heating as well as space cooling so the homes that installed an ASHP would not have required a stand-alone space cooling system.

Note: *The four 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: 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	0	0	0	9	0	0	433	2	**444**
ASHP + Electric Furnace	25	12	1	2	0	2	157	0	**199**
ASHP + Electric Baseboards	4	9	0	1	2	10	11	0	**37**
Combo/Domestic Hot Water	9	5	0	0	0	0	4	0	**18**
Natural Gas Furnace	0	1	0	0	0	0	3	0	**4**
Ground Source Heat Pump System	2	0	0	1	0	0	3	0	**6**
Other	0	3	0	0	0	0	1	0	**4**
Total	**40**	**30**	**1**	**13**	**2**	**12**	**612**	**2**	**712**

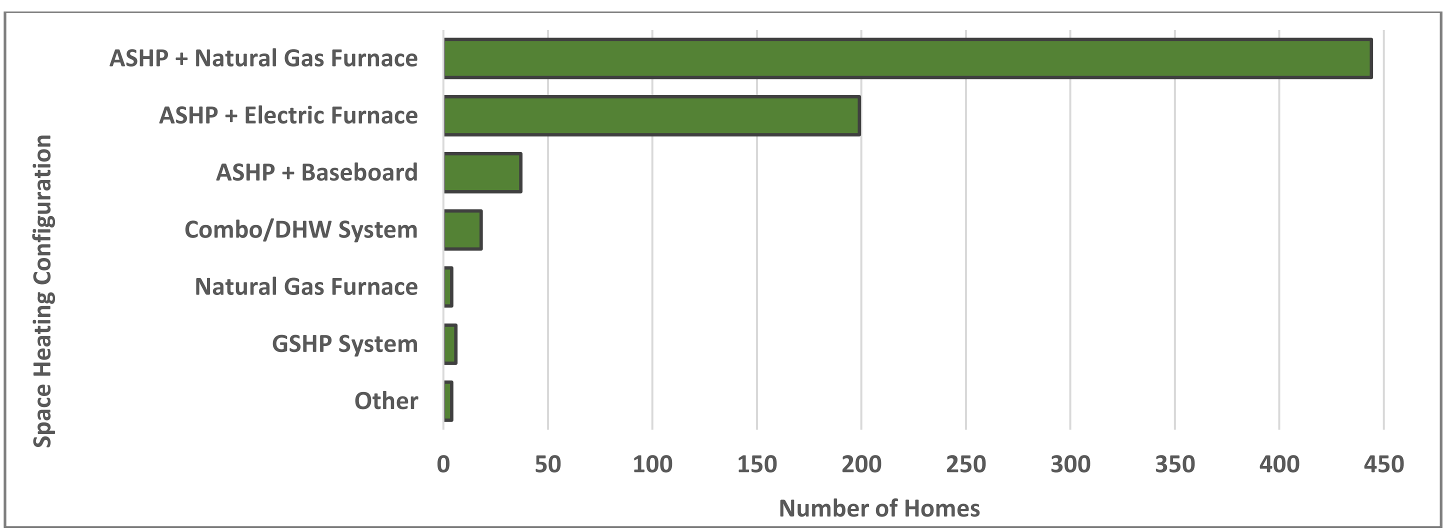

Figure 7: Space Heating Configuration

5.2 Water Heating

This section looks at the water heating systems used in the 712 attached and detached homes labelled under the Program.

- Natural gas water heating: 63% (449/712 homes)
- Electric water heating: 36% (257/712 homes)
- Solar water heating: <1% (3/712 homes)
- Propane water heating: <1% (3/712 homes)

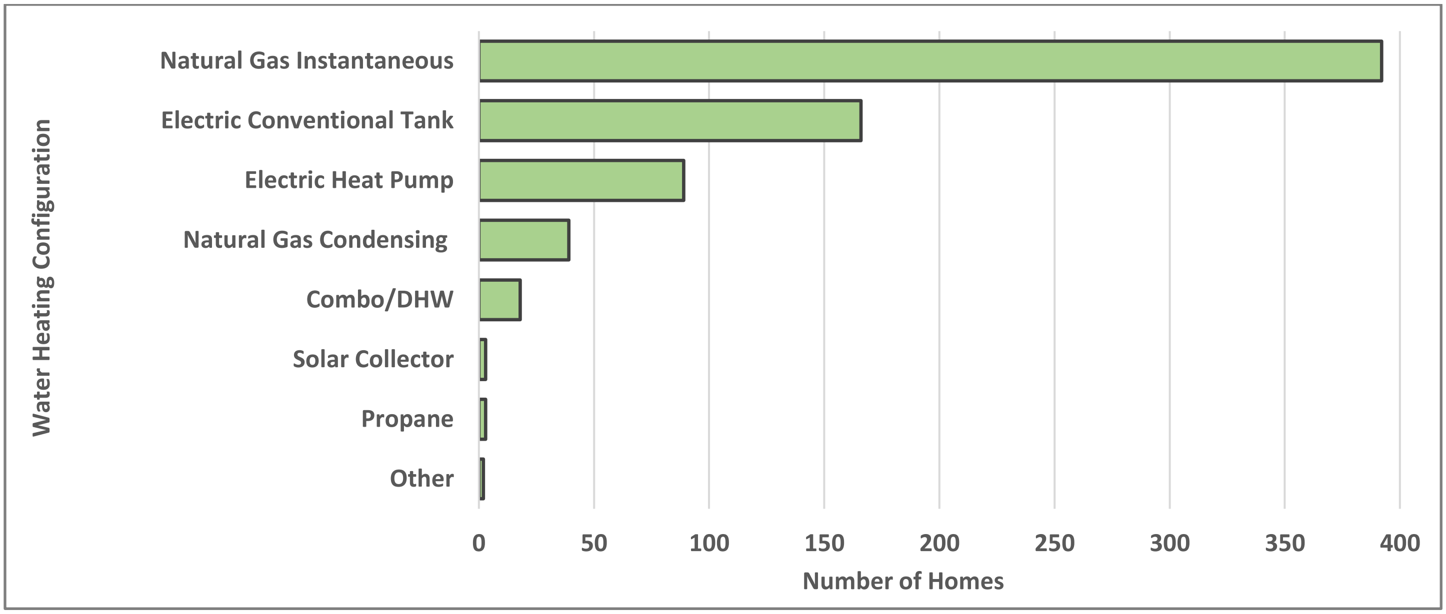

Figure 8: Water Heating Configuration

5.3 Ventilation

This section looks at the efficiency of the mechanical ventilation system used in the 712 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.

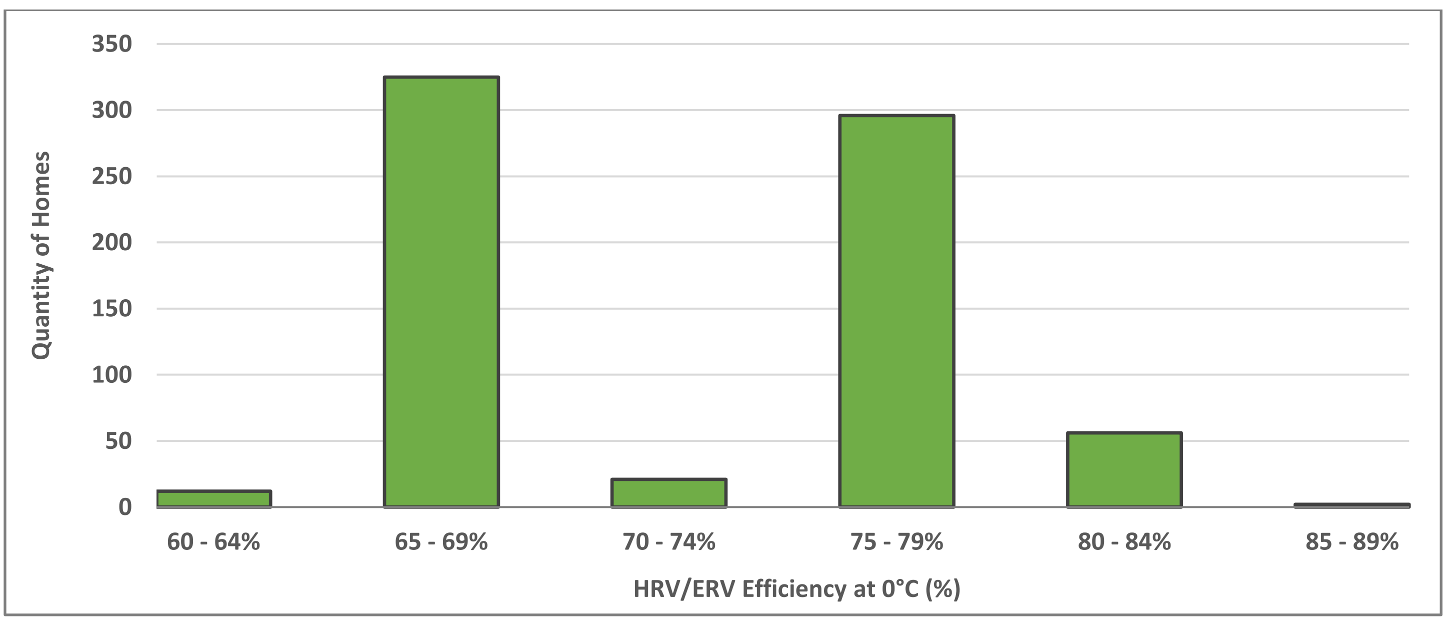

Figure 9: HRV/ERV Efficiency at 0°C

Analysis

- 62% (444/712) of homes used an air-source heat pump with a back up natural gas furnace for space heating.
- 55% (392/712) of homes used a tankless natural gas instantaneous water heater.
- 41% (293/712) of homes used an HRV/ERV with an efficiency of 75% at 0°C.
- 42% (299/712) of homes used an HRV/ERV with an efficiency of 67% at 0°C.

The large majority of Net Zero and Net Zero Ready homes install an air-source heat pump in combination with a conventional backup heating source such as an electric or natural gas furnace. This results in most homes using a combination of electricity and gas for space conditioning.

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).

Mechanical ventilation is most often achieved using an HRV/ERV with a sensible heat-recovery efficiency (at 0°C) of 67% or 75%. Both efficiency values are very common and readily available in the market.

6.0 FUEL SOURCE

This section looks at the fuel source configuration used in the 758 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. In the categories below, "all-electric" means that the home uses only electricity, and "dual source" means that the home uses electricity and either natural gas or propane. 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.

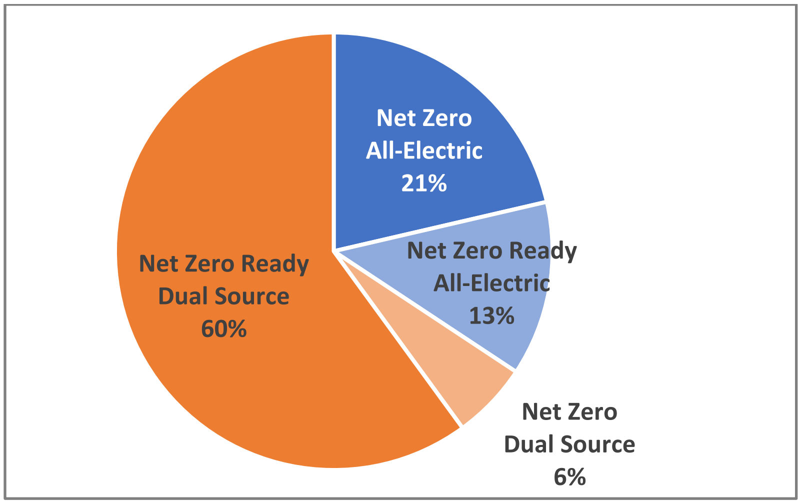

Figure 10: Fuel Source of Net Zero and Net Zero Ready Homes

Table 9: Fuel Source of Net Zero and Net Zero Ready Homes by Province

Project Location	# of Labels	Percent Net Zero [#]	Percent Net Zero Ready [#]	Percent All-Electric [#]	Percent Dual Source [#]
Alberta	40	78% [31]	23% [9]	78% [31]	23% [9]
British Columbia	30	50% [15]	50% [15]	77% [23]	23% [7]
Manitoba	1	100% [1]	0% [0]	100% [1]	0% [0]
New Brunswick	13	15% [2]	85% [11]	31% [4]	69% [9]
Newfoundland & Labrador	2	0% [0]	100% [2]	100% [2]	0% [0]
Nova Scotia	12	83% [2]	17% [10]	100% [12]	0% [0]
Ontario	640	22% [138]	78% [502]	28% [181]	72% [459]
Quebec	6	100% [6]	0% [0]	100% [6]	0% [0]
Saskatchewan	14	14% [2]	86% [12]	0% [0]	100% [14]

Analysis

The CHBA Net Zero Home Labelling Program is fuel-agnostic. Builders have the choice to use whichever fuel source they choose as long as the home can be modelled to offset the total estimated annual energy using renewable energy. Many different reasons influence why builders choose the fuel sources that they do for their Net Zero and Net Zero Ready Homes. Some examples are cost, availability, homeowner goals, etc. The majority of Net Zero Ready Homes continue to use natural gas as a backup source of heating in addition to the primary source, typically an electric air-source heat pump. This report considers this configuration type "dual source". Alternately, most Net Zero Homes use only electricity as a fuel source.

7.0 PERFORMANCE

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

- Annual energy consumption, measured in 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	Climate Zone(s)	# 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[1] Avg. Min. Max.	Ref Env[2] Avg. Min. Max.
Detached <2,600 ft^2	5,6,7a	119	210	2,255	**42.8** 30.9 58.2	**47.1** 28.0 81.3	**1.00** 0.37 1.71	**0.21** 0.14 0.62	**67.0** 34.4 83.0	**55.8** 36.9 75.3
Detached ≥2,600 ft^2 <4,000 ft^2	4,5,6,7a	265	293	3,157	**47.6** 31.1 82.7	**60.3** 38.8 123.0	**0.97** 0.28 1.76	**0.16** 0.09 0.29	**67.5** 27.9 86.9	**51.7** 33.2 88.7
Detached ≥4,000 ft^2	4,5,6,7a	79	508	5,470	**61.2** 35.8 130.8	**105.0** 42.3 227.6	**0.99** 0.21 1.50	**0.12** 0.06 0.25	**70.6** 41.7 85.0	**51.1** 33.3 84.1
Attached	4,5,6,7a	249	186	2,003	**41.0** 27.2 99.7	**35.8** 18.9 101.3	**1.28** 0.46 3.25	**0.23** 0.13 0.45	**63.3** 31.5 86.7	**61.3** 38.2 86.9
Single Unit MURB	6	6	101	1,084	**20.9** 19.8 21.5	**24.4** 19 26.6	**1.47** 1.36 1.63	**0.07** 0.05 0.11	N/A	**85.3** 77.6 93.3
Whole Building MURB	5,7a	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

[1] 19 Detached homes, 6 attached homes, and all 6 Single Unit - MURBs did not have this calculation ("Ref AEC").

[2] 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.

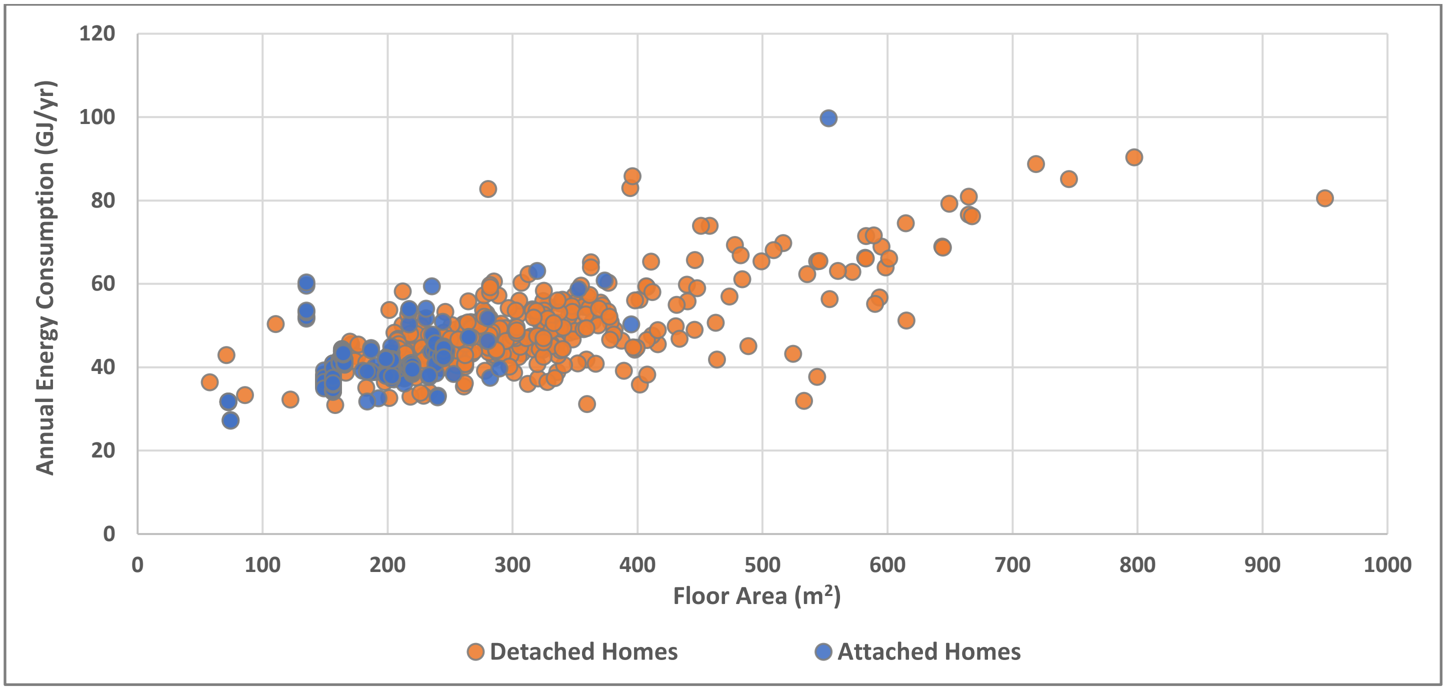

Figure 11: Annual Energy Consumption by Floor Area

Note: *2 homes were removed from Figure 11 as outliers. One home has a very high floor area - 1062 m^2, and one home has a very high modelled annual energy consumption – 130.8 GJ/year.*

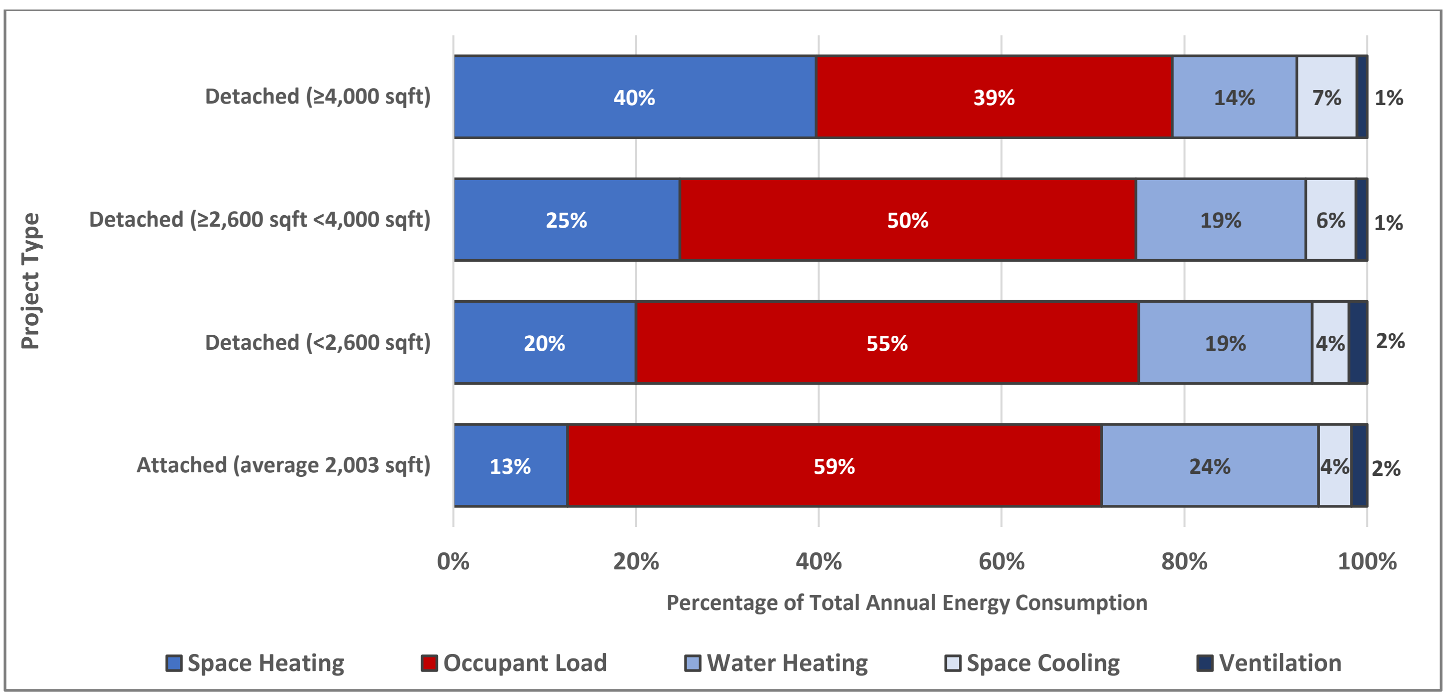

Figure 12: Average Load Distribution of Annual Energy Consumption by Floor Area

AVERAGE ANNUAL ENERGY CONSUMPTION BY FLOOR AREA

- Attached Homes = 41.0 GJ/year
- Detached Homes <2,600 ft^2 = 42.8 GJ/year
- Detached Homes ≥2,600 ft^2 and <4,000 ft^2 = 47.6 GJ/year
- Detached Homes ≥4,000 ft^2= 61.2 GJ/year

Analysis

- 84% (387/463) of detached homes were modelled to have an annual energy consumption of less than 55 GJ annually.
- 89% (222/249) 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 linearly 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 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.

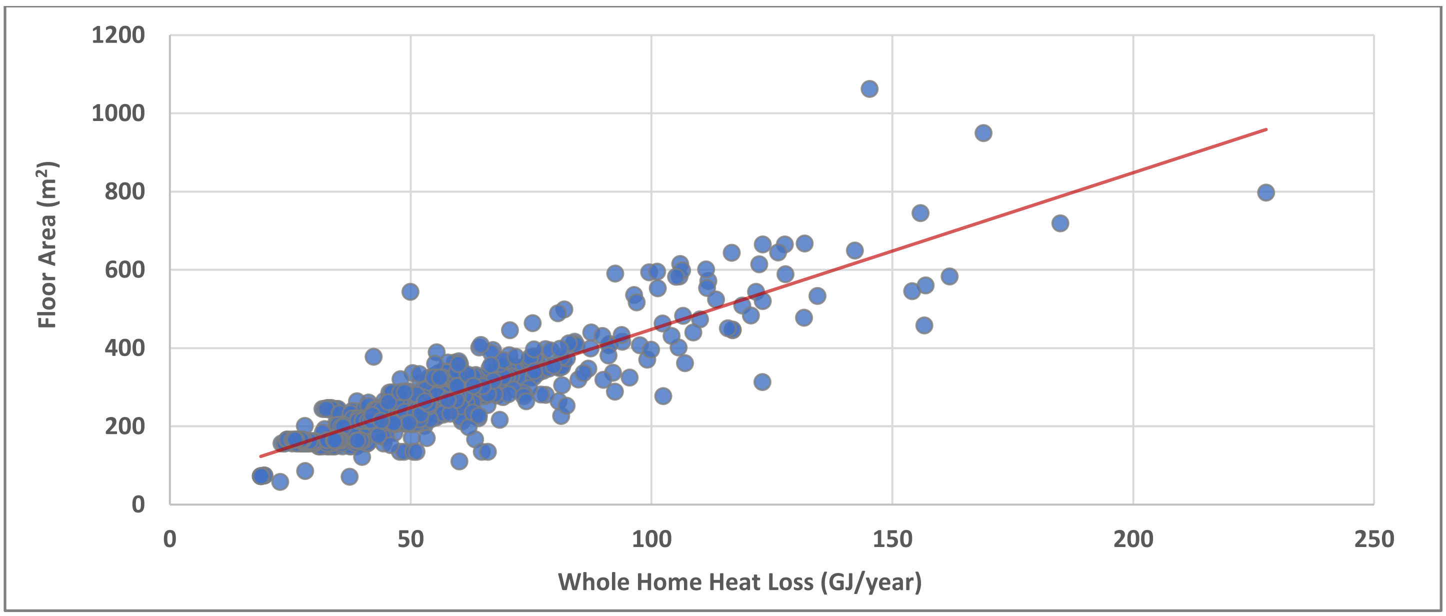

Figure 13: Whole Home Heat Loss by Floor Area

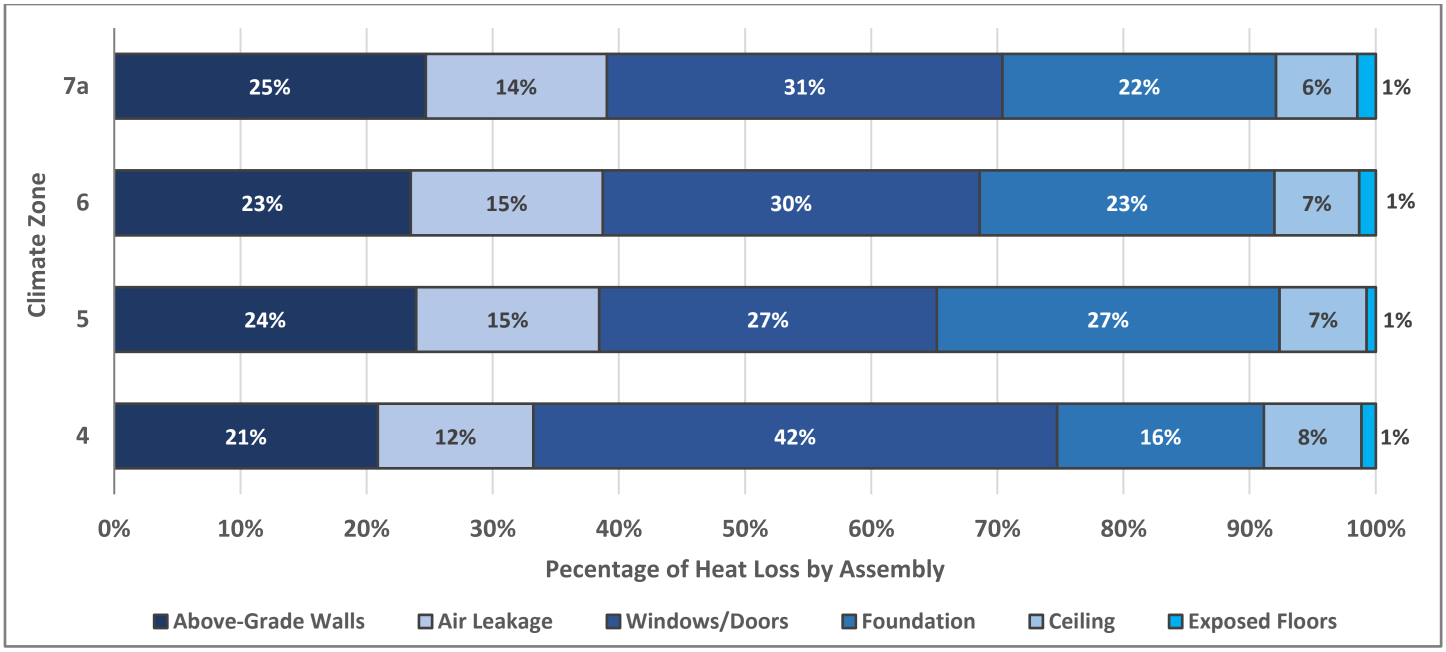

Figure 14: Detached Homes – Assembly Distribution of Whole Home Heat Loss by Climate Zone

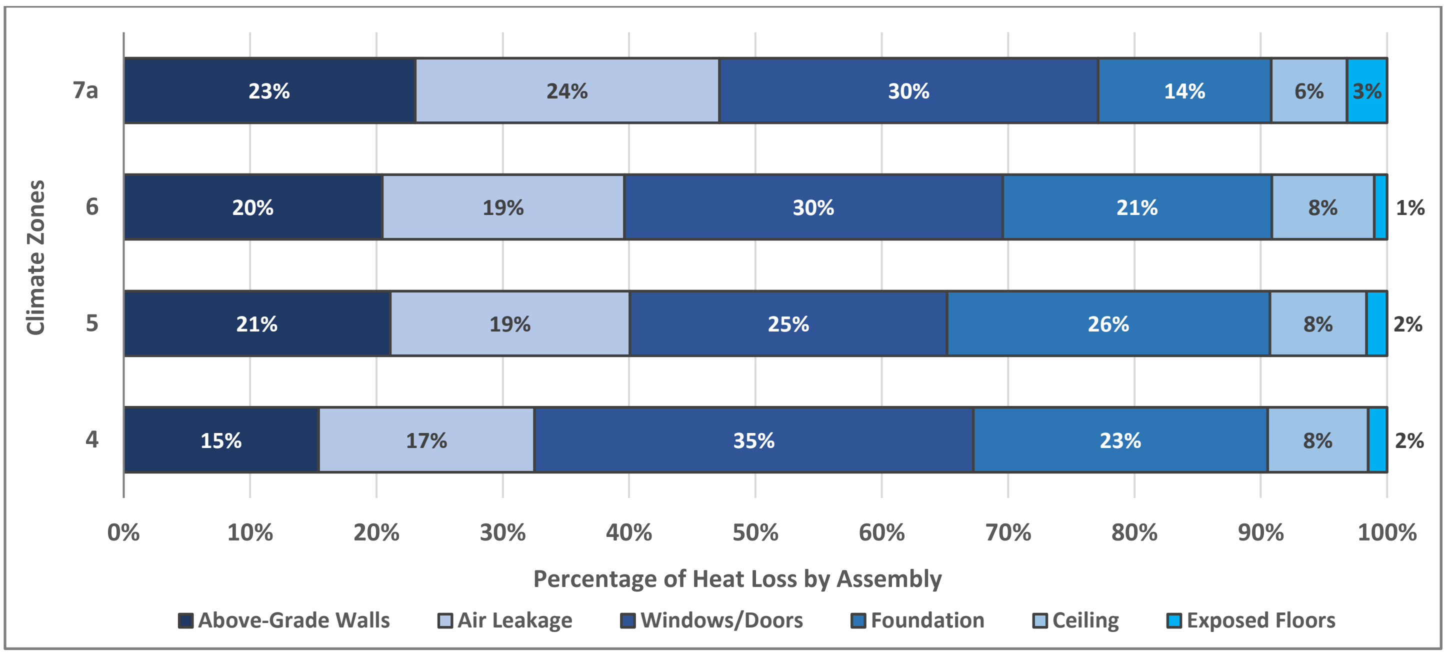

Figure 15: Attached Homes – Assembly Distribution of Whole Home Heat Loss by Climate Zone

DETACHED HOMES - AVERAGE WHOLE HOME HEAT LOSS

- Climate Zone 4 = 74.5 GJ/year
- Climate Zone 5 = 57.0 GJ/year
- Climate Zone 6 = 71.9 GJ/year
- Climate Zone 7a = 75.0 GJ/year

ATTACHED HOMES - AVERAGE WHOLE HOME HEAT LOSS

- Climate Zone 4 = 49.5 GJ/year
- Climate Zone 5 = 33.1 GJ/year
- Climate Zone 6 = 40.7 GJ/year
- Climate Zone 7a = 58.7 GJ/year

Analysis

- 73% (337/463) of detached homes were modelled to have a whole home heat loss of less than 70 GJ annually.
- 82% (205/249) of attached homes were modelled to have a whole home heat loss of less than 40 GJ annually.

There is a clear relationship between the heat lost through the building envelope and the size of the home. Larger homes lose more heat through their envelope. The local climate also impacts the amount of heat lost through the building envelope as well as the amount of heat lost through different envelope 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 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, or 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 16 achieved compliance using one of the other airtightness target metrics – Normalized Leakage Rate (NLR@50Pa) or Normalized Leakage Area (NLA@10Pa).*

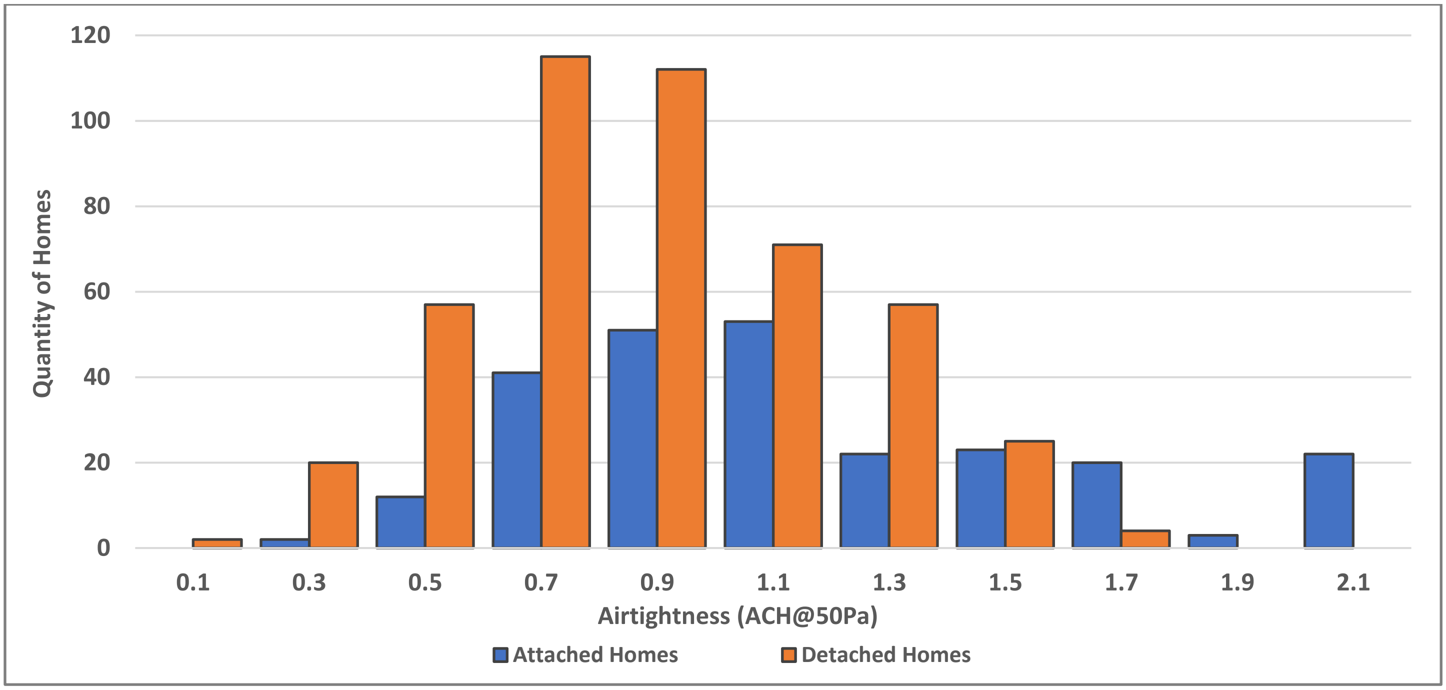

Figure 16: Distribution of Airtightness by ACH@50

Analysis

- The average airtightness of all 463 detached homes is 0.98 ACH@50Pa.
- The average airtightness of all 249 attached homes is 1.28 ACH@50Pa.
- The overall airtightness average for detached and attached homes is 1.09 ACH@50Pa.

The airtightness of the detached homes shows a clear trend of builders aiming for 1.0 ACH@50Pa or less. Attached homes don't trend as clearly as detached homes, although most achieve between 0.7 and 1.3 ACH@50Pa.

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 left vertical axis (GJ/m^2/year) and equivalent kilowatt hours on the right vertical axis ($ekWh/m^2$/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 17 as outliers. 3 homes had very large floor area: 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, likely because of its very small floor area of 87m^2.*

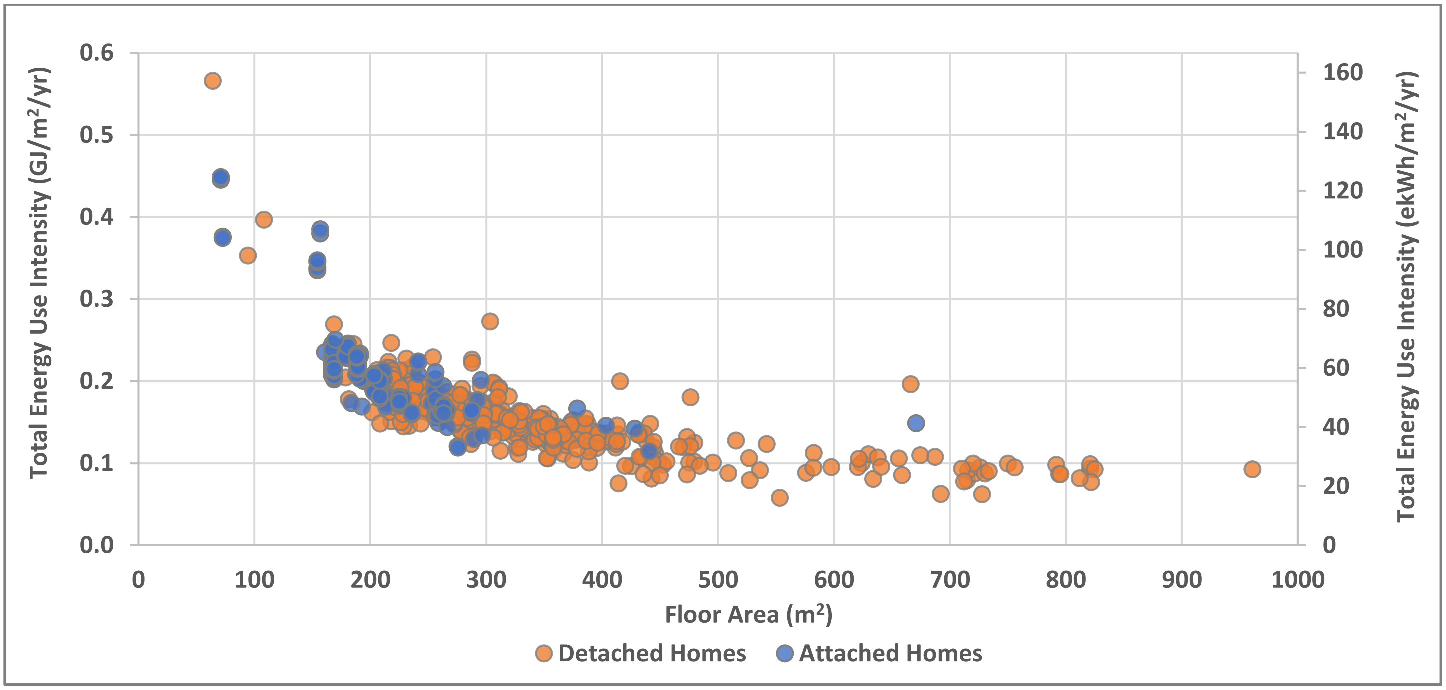

Figure 17: Total Energy Use Intensity by Floor Area

DETACHED HOMES - AVERAGE BY CLIMATE ZONE

- Climate Zone 4 = 0.08 GJ/m^2/year.
- Climate Zone 5 = 0.16 GJ/m^2/year.
- Climate Zone 6 = 0.15 GJ/m^2/year.
- Climate Zone 7a = 0.16 GJ/m^2/year.

ATTACHED HOMES - AVERAGE BY CLIMATE ZONE

- Climate Zone 4 = 0.16 GJ/m^2/year.
- Climate Zone 5 = 0.21 GJ/m^2/year.
- Climate Zone 6 = 0.20 kWh/m^2/year.
- Climate Zone 7a = 0.27 kWh/m^2/year.

Analysis

Smaller heated floor areas can impact the ability of a home to achieve a low TEUI. On average, TEUI increases marginally from warmer climate zones to colder climate zones. Smaller homes, such as attached homes, typically have a higher TEUI than larger homes.

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 the area of 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 highest step in the BC Energy Step Code does not include a "Ref. AEC" target, however, the second highest step in the BC Energy Step Code includes a "Ref. AEC" target of 40% better as a compliance path.

Note: *Only 689 detached and attached homes have this calculation because it was included in the updated version of HOT2000.*

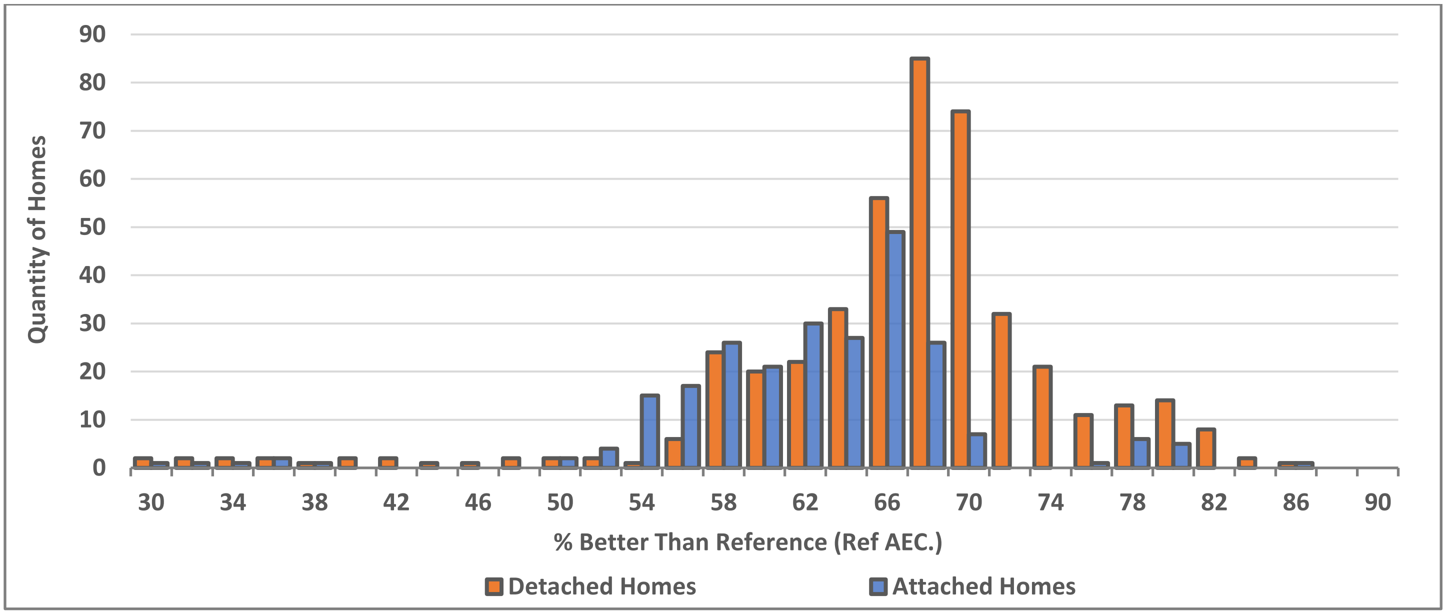

Figure 18: Distribution of Percent Better Than Reference House - Annual Energy Consumption

ANALYSIS

- The average for all 444 detached homes is 67.9% better than "Ref. AEC".
- The average for all 245 attached homes is 62.8% better than "Ref. AEC".

The majority, (72%) of Net Zero and Net Zero Ready homes achieve between 60% and 75% better than the reference house for annual energy consumption.

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

DEFINITION

Percent Better than Reference House—Building Envelope is a measure of how much better the house that is to be built ("the proposed house") performs theoretically in the area of building envelope compared to its respective "reference house", which is created in the modelling platform with the geometry and mechanical system of the proposed house and prescriptive minimum code requirements. "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: *3 detached homes were excluded from this section as they were modelled under the previous version of HOT2000 which did not include this calculation.*

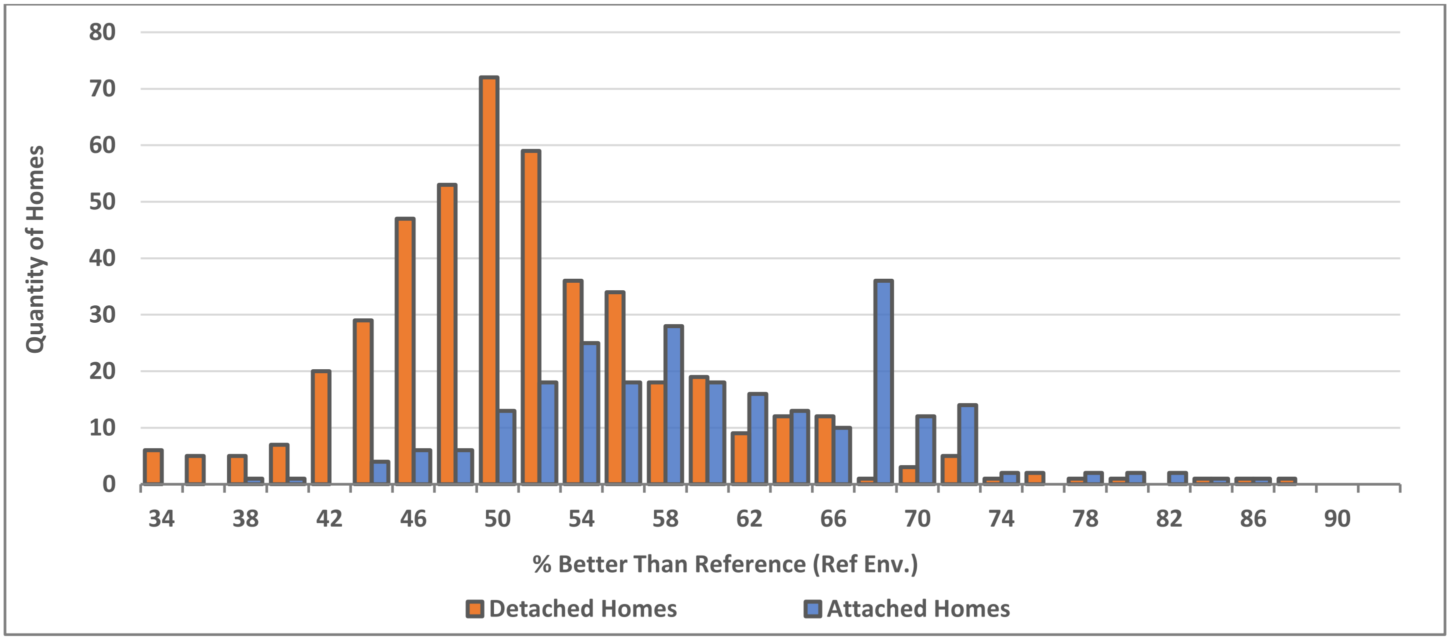

Figure 19: Distribution of Percent Better Than Reference House - Building Envelope

ANALYSIS

- The average for all 460 detached homes is 52.7% better than "Ref. Env."
- The average for all 249 attached homes is 61.3% 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 (73%) detached homes achieve a building envelope between 45% and 60% better than the reference house, and most (78%) 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 712 detached and attached homes labelled under the Program as of December 31, 2021. 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 calculation methodology can be found in Appendix A.

Three metrics are used to analyze operational carbon emissions in this report:

- Annual operational carbon emissions, measured in $kgCO_2e$/year
- Annual operational carbon emissions intensity, measured in $kgCO_2e/m^2$/year
- Total net operational carbon emissions offset by renewables, measured in $tonnesCO_2e$/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	40	282	3,033	**7,910**	5,364	12,979	**31.6**	18.96	53.22
British Columbia	4,5,6	30	355	3,822	**437**	63	3,578	**1.2**	0.15	7.74
Manitoba	7a	1	239	2,573	**13**	13	13	**0.05**	0.05	0.05
New Brunswick	6	13	301	3,235	**3,696**	2,977	4,386	**13.0**	7.43	18.69
Newfoundland & Labrador	6	2	441	4,744	**412**	388	437	**0.98**	0.80	1.15
Nova Scotia	6	12	165	1,774	**6,636**	5,059	9526	**61.2**	15.48	117.0
Ontario	5,6	609	261	2,814	**745**	79	5,526	**2.9**	0.36	12.68
Saskatchewan	7a	2	169	1,814	**6,539**	6,479	6,599	**43.9**	29.11	58.69

8.1 Annual Operational Carbon Emissions

This section considers total annual operational carbon emitted and does not consider carbon offsets from the on-site renewable energy installed on some homes. Figure 20 shows the average annual operational carbon emissions of the Net Zero and Net Zero Ready Homes labelled within each province and Figure 21 shows the total annual operational carbon emissions of each of these homes.

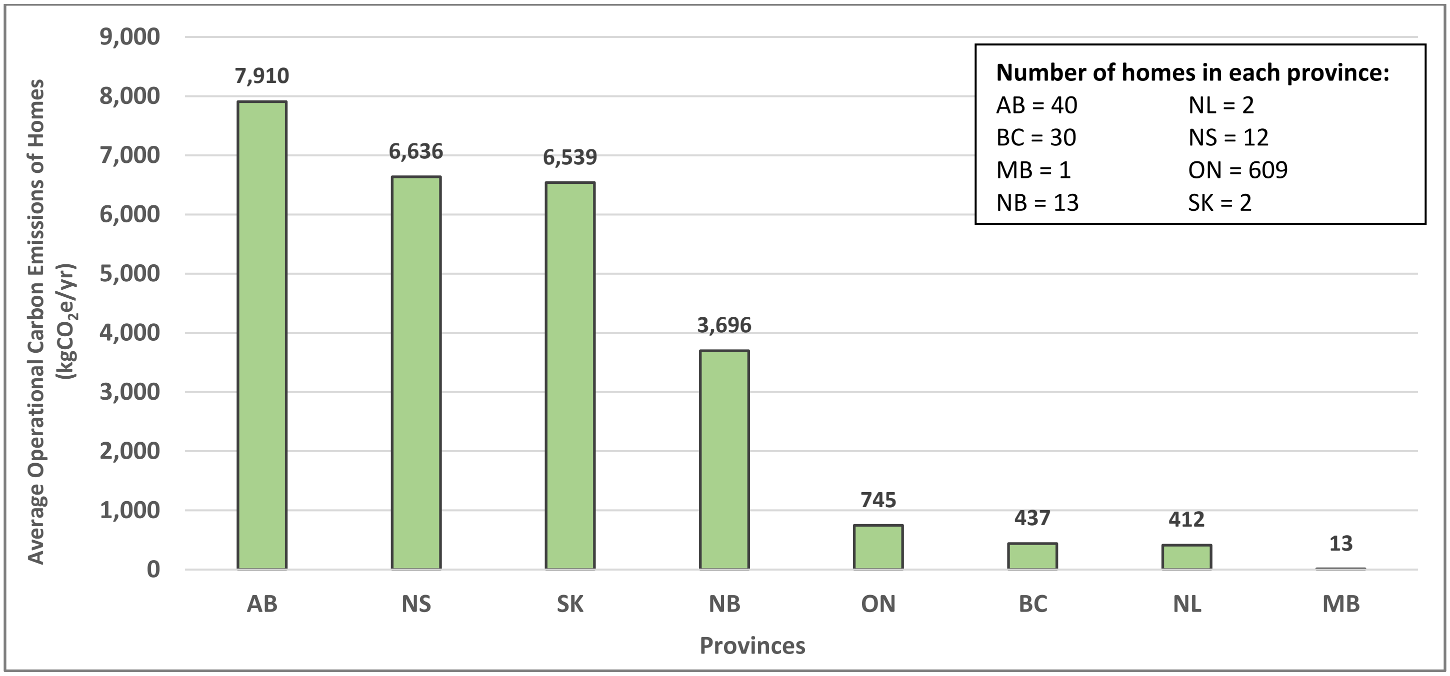

Figure 20: Average Annual Operational Carbon Emissions of Homes by Province

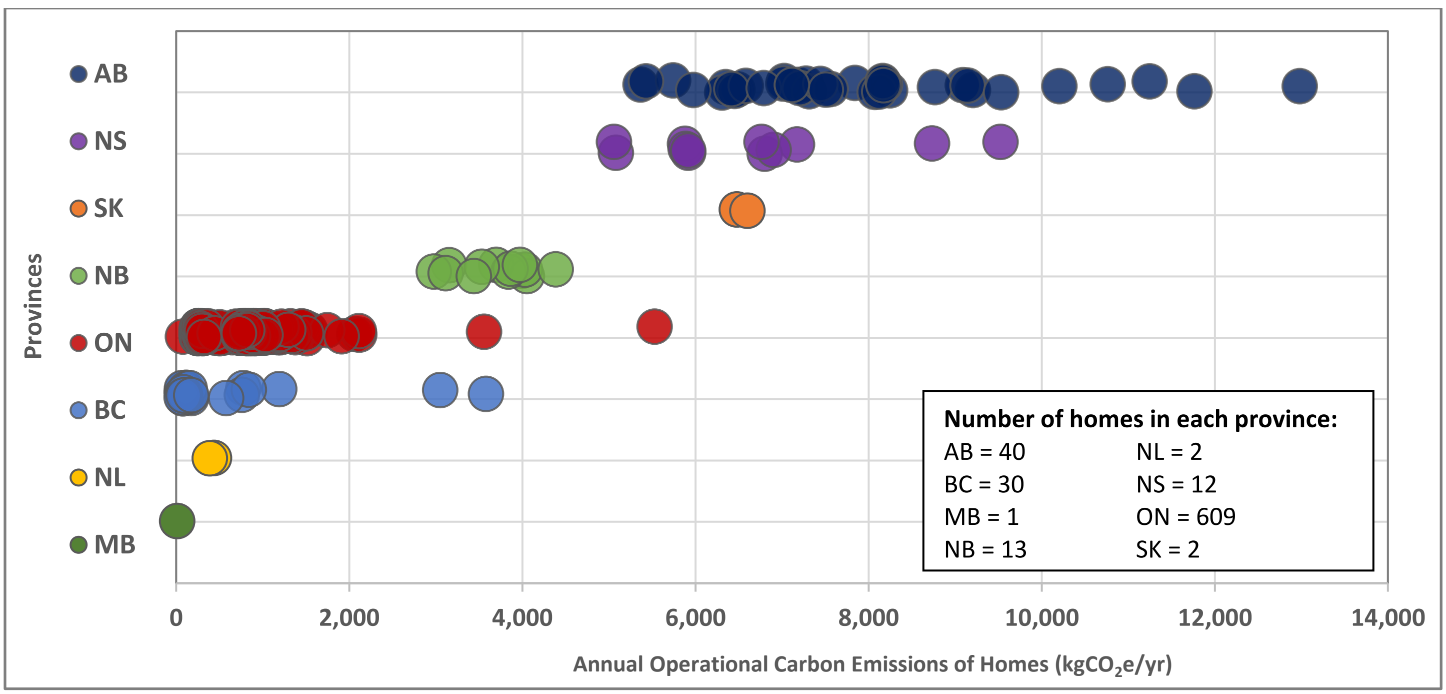

Figure 21: Annual Operational Carbon Emissions of Homes by Province

8.2 Annual Operational Carbon Emissions Intensity

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

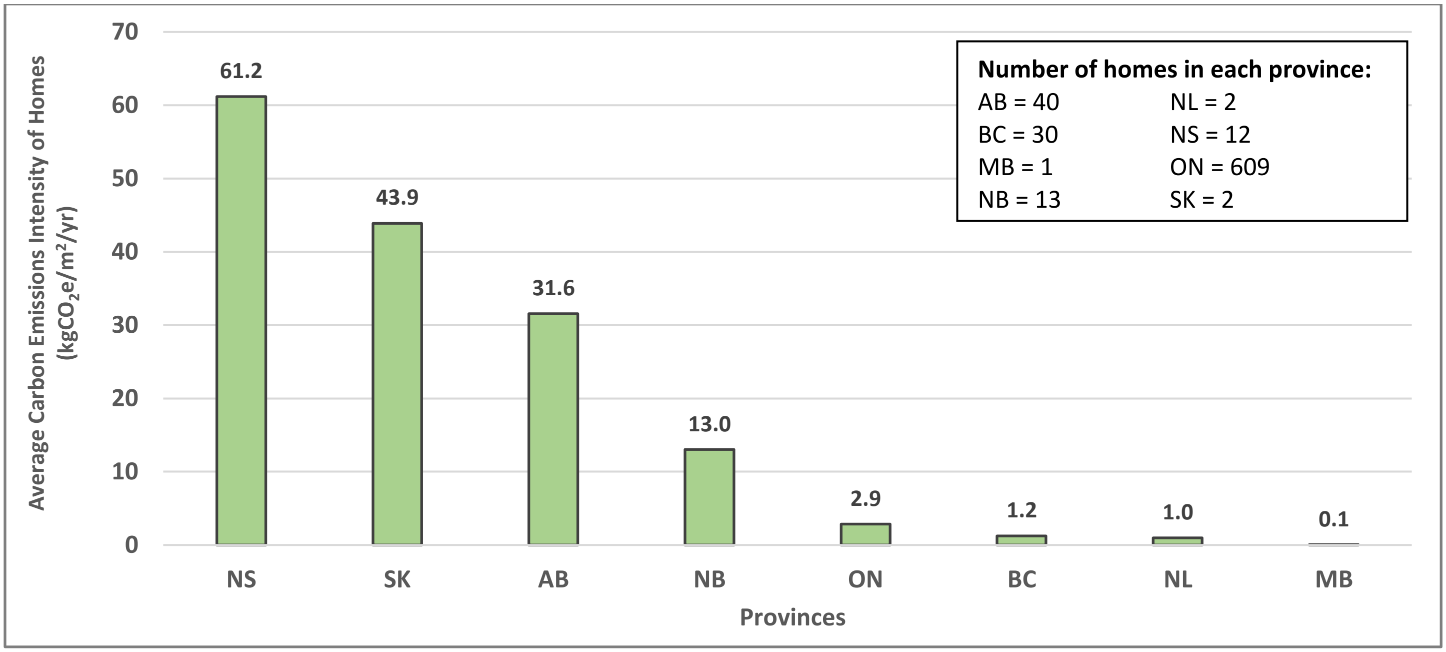

Figure 22: Average Annual Operational Carbon Emissions Intensity of Homes by Province

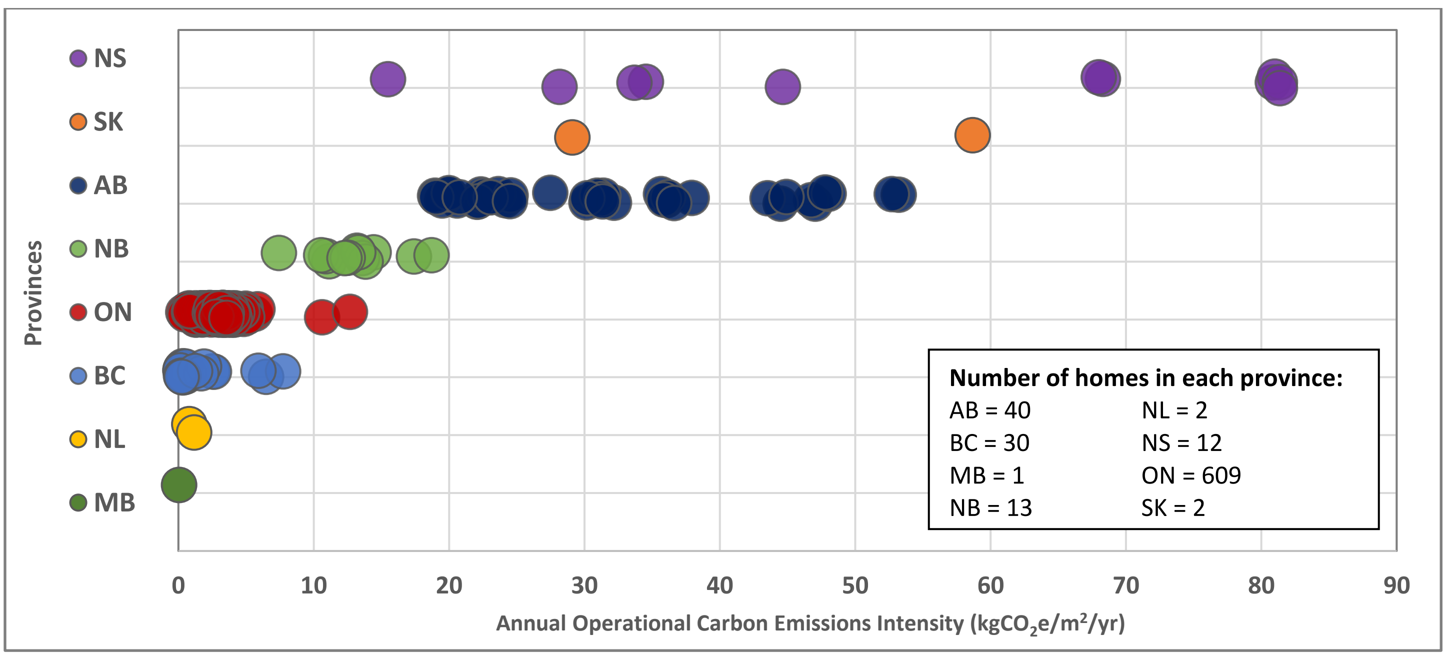

Figure 23: Annual Operational Carbon Emissions Intensity of Homes by Province

Note: *1 outlier was removed from Figure 23. This home had a carbon intensity of 116.9* $kgCO_2e/m^2$/year, *and a very small floor area.*

8.3 Operational Carbon Emissions Offset by Renewables

In this section the operational carbon emissions of homes are compared with the offset carbon emissions provided by solar photovoltaic systems, which are non-emitting, "clean" energy sources. Most Net Zero Homes use solar photovoltaic systems to offset 100% of their annual energy consumption and therefore reach net zero energy consumption annually. Figure 24 shows the total net annual operational carbon emissions of all the Net Zero and Net Zero Ready Homes labelled within each province.

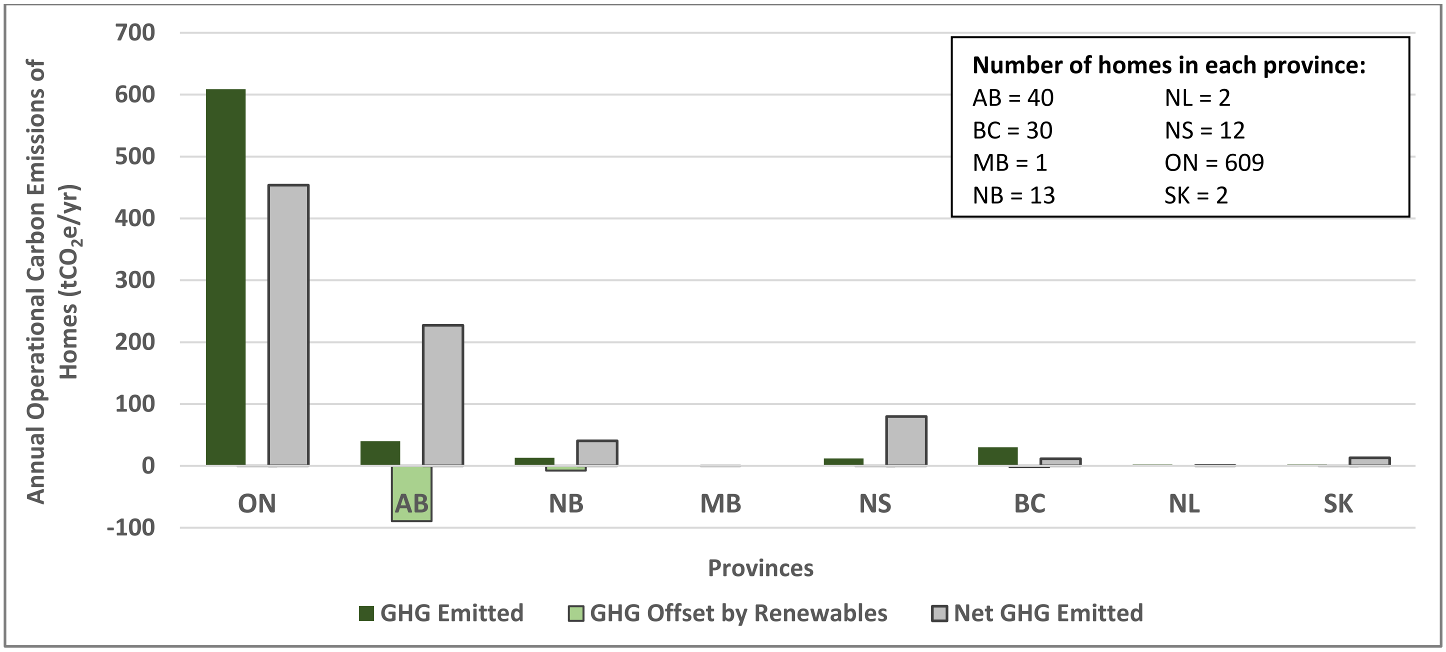

Figure 24: Total Net Carbon Emissions with Renewables by Province

ANALYSIS

The carbon intensity of Net Zero Homes varies considerably based on both the provincial emission factors as well as the fuel selection of the build. Ontario and British Columbia have electrical utilities with lower carbon intensities since they have hydro-based electricity, compared to natural gas or coal-fired electricity such as in Alberta.

Considering the carbon emissions offset of on-site solar electric panels, they can greatly reduce the home's operational carbon emissions. The homes with the largest carbon emission difference when going from NZr to NZ are the electrically heated homes in provinces with high electrical emission factors (AB, SK), while homes with lower emission factors and the cleanest electricity show the smaller reductions in carbon emissions when adding on-site solar panels because the electrical source is already very clean.

This analysis only considers the operational carbon emitted from the modelled energy use of the homes and does not consider the embodied carbon of the materials used to build the homes or whether the homes were built on-site or off-site. It is understood that material selection and method of construction can impact the total carbon footprint of homes.

9.0 Renovations

This section looks at the homes labelled under the Net Zero Renovations Pilot which concluded in March 2021. Six homes were labelled under the Net Zero Renovations Pilot; three Net Zero and three Net Zero Ready. Homes labelled under the Net Zero Renovations Pilot meet the same performance level and same Technical Requirements as homes labelled under new Homes Program, with 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)
  - Load distribution of annual energy consumption, measured by percentage
  - 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
  - Assembly distribution of whole home heat loss, measured by percentage
- Airtightness Comparison, measured in air changes per hour at 50 pascals (ACH@50)
- Annual Operational Carbon 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.

9.1 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 Net Zero Homes Program for new homes 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.

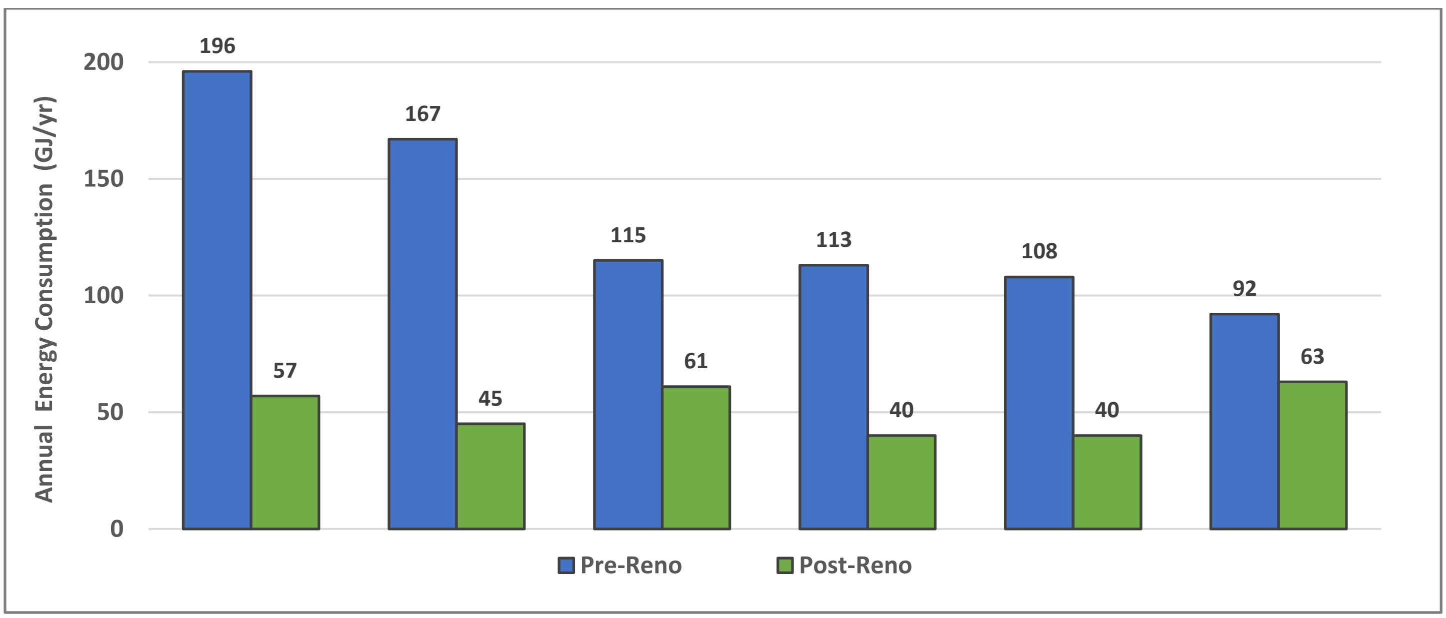

Figure 25: Net Zero Renos – Annual Energy Consumption Comparison

Note: *In Figure 25 above, the GJ values reflect the energy consumption of the homes—without the renewable energy generation.*

TOTAL ENERGY USE INTENSITY

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. In this report, 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). 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.

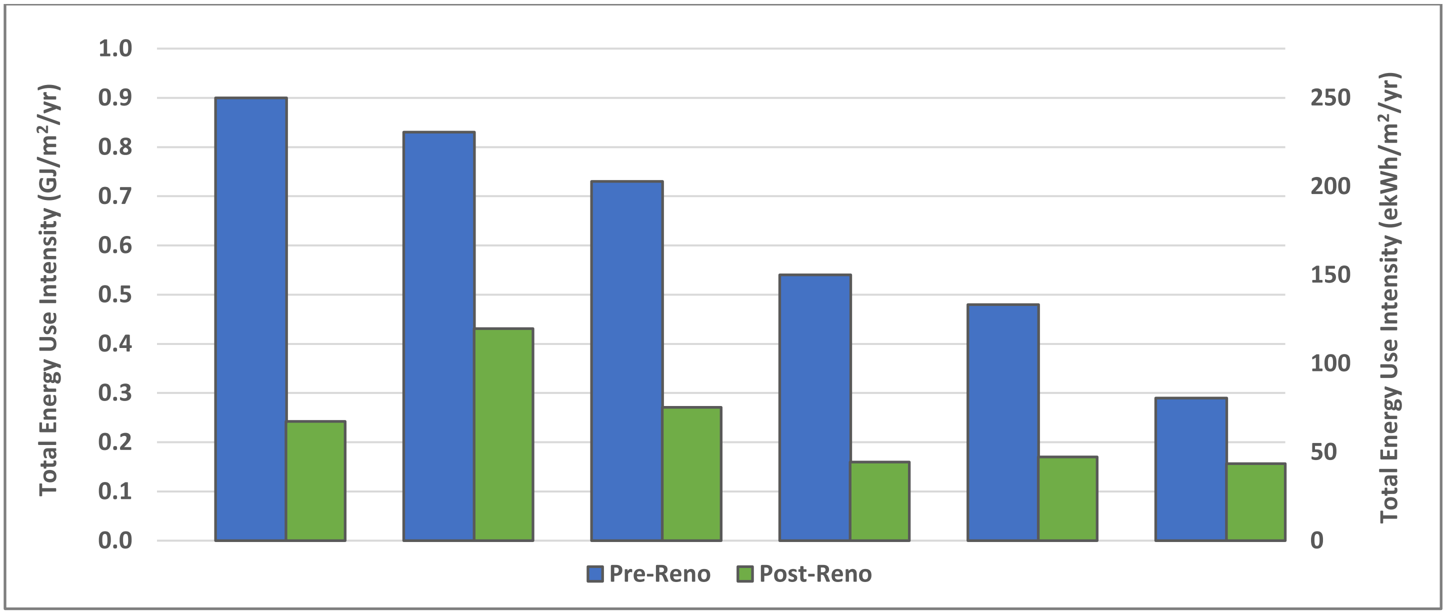

Figure 26: Net Zero Renos – Total Energy Use Intensity Comparison

LOAD DISTRIBUTION OF ANNUAL ENERGY CONSUMPTION

In this section the total annual energy consumption is considered by separating the amounts of energy required for individual load types. The energy required for space heating, space cooling, water heating, ventilation and occupant loads (lighting, appliances, and plug loads). The energy for each load type is represented as a percentage of the total annual energy consumption for the home, both pre-renovation and post-renovation. It's important to note that in all six renovations the modelled total annual energy consumption post-renovation was substantially less than the home pre-renovation (as shown in Figure 25).

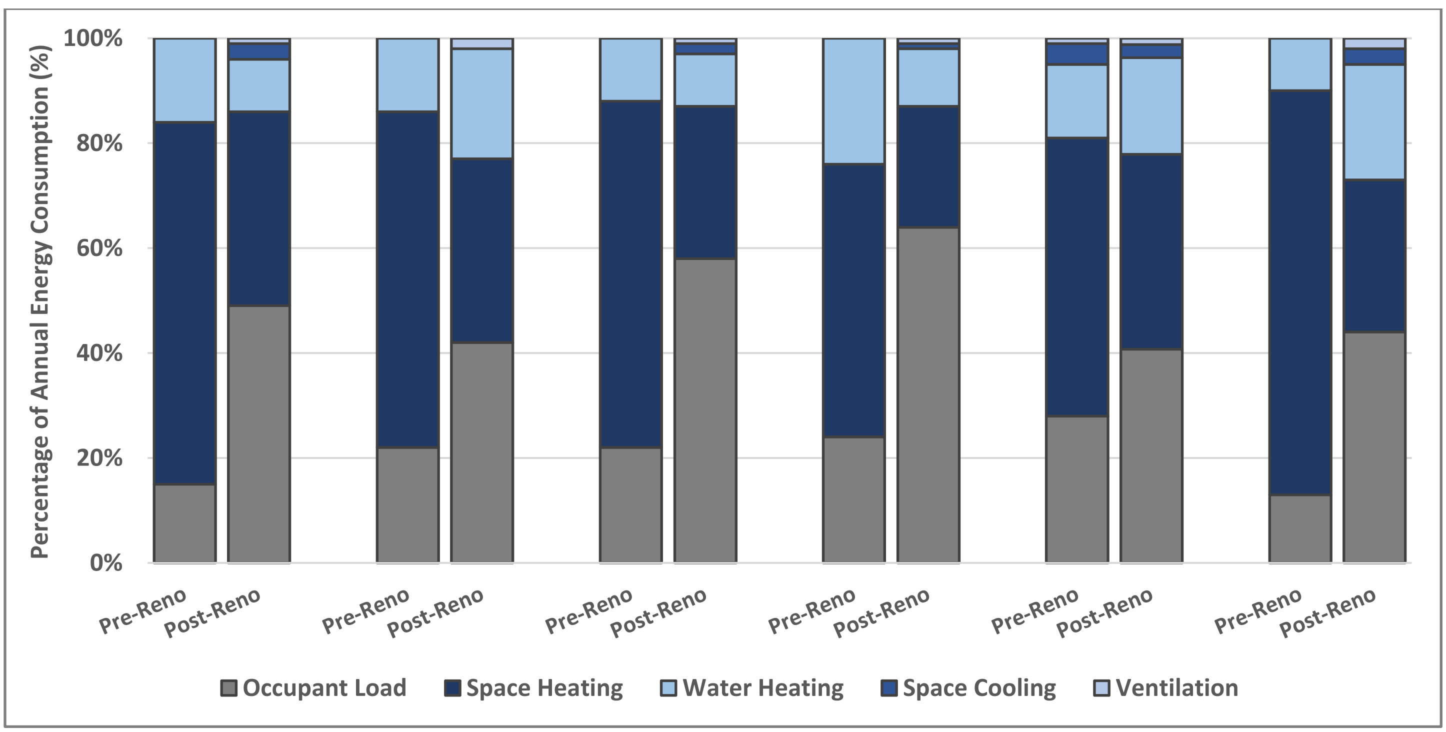

Figure 27: Net Zero Renos – Load Distribution of Annual Energy Consumption Comparison

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.

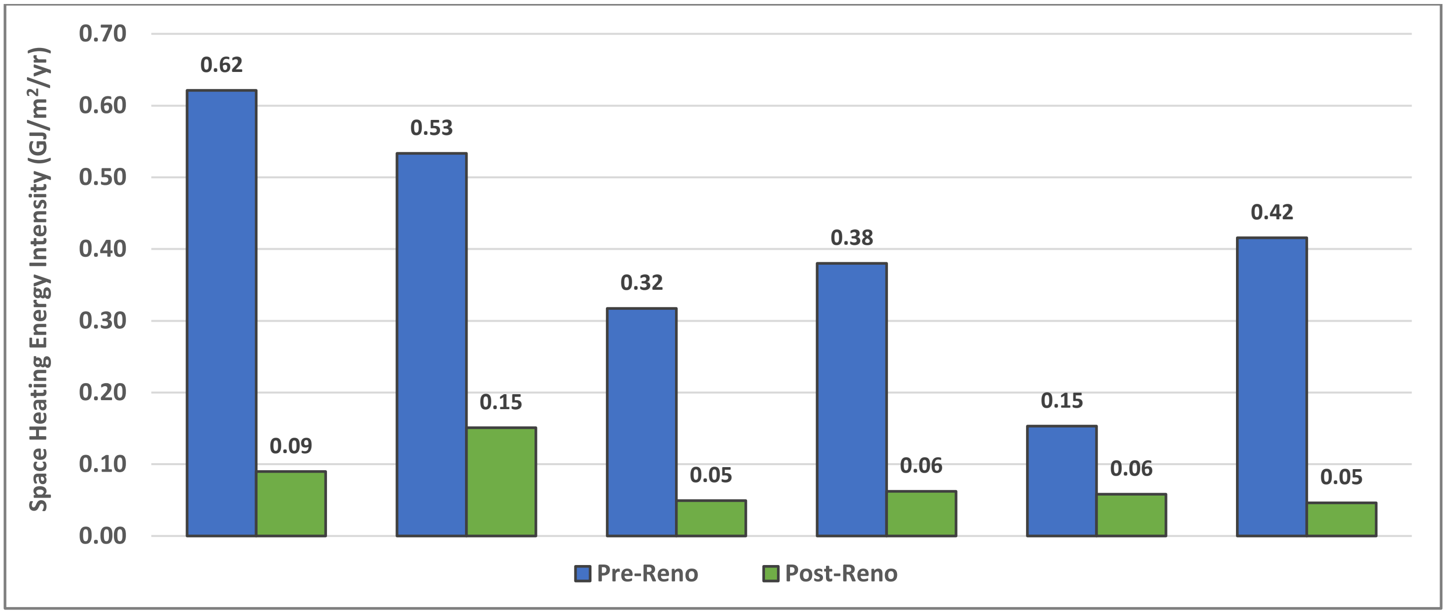

Figure 28: Net Zero Renos – Space Heating Energy Intensity Comparison

ANALYSIS

- The average modelled annual energy consumption of a Net Zero Renovation is 51 GJ/year.
- The average decrease in annual energy consumption was 81 GJ/year, an average percent decrease of 58%.
- The average decrease in total energy use intensity was 0.39 GJ/m^2/year, an average percent decrease of 61%.
- The average decrease in space heating energy intensity was 0.33 GJ/m^2/year, an average percent decrease of 79%.

Net Zero Renovations greatly reduce the amount of energy required to power the homes annually. All six Net Zero Renovations achieved comparable energy performance to that of the Net Zero new homes. In some Net Zero Renovations that participated in the Pilot, the renovators not only increased the efficiency of the home, 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-renovations, rather than just the total modelled annual energy consumption alone.

9.2 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.

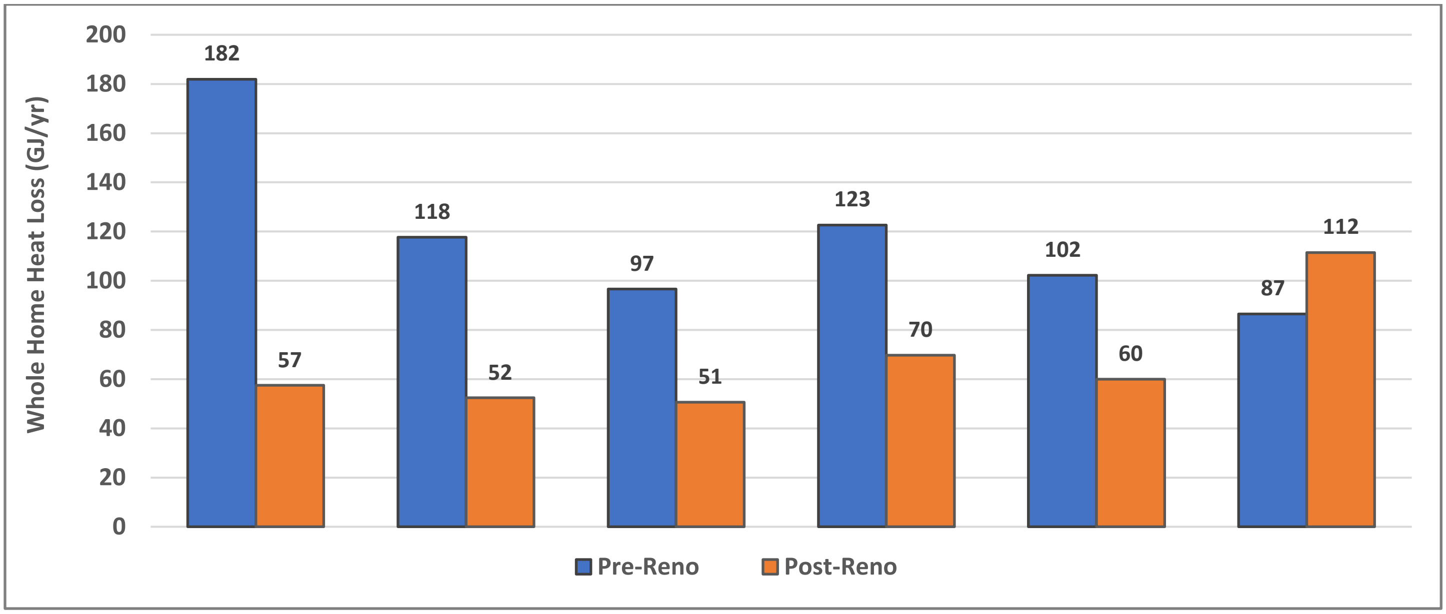

Figure 29: Net Zero Renos – Whole Home Heat Loss Comparison

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/m^2/year.

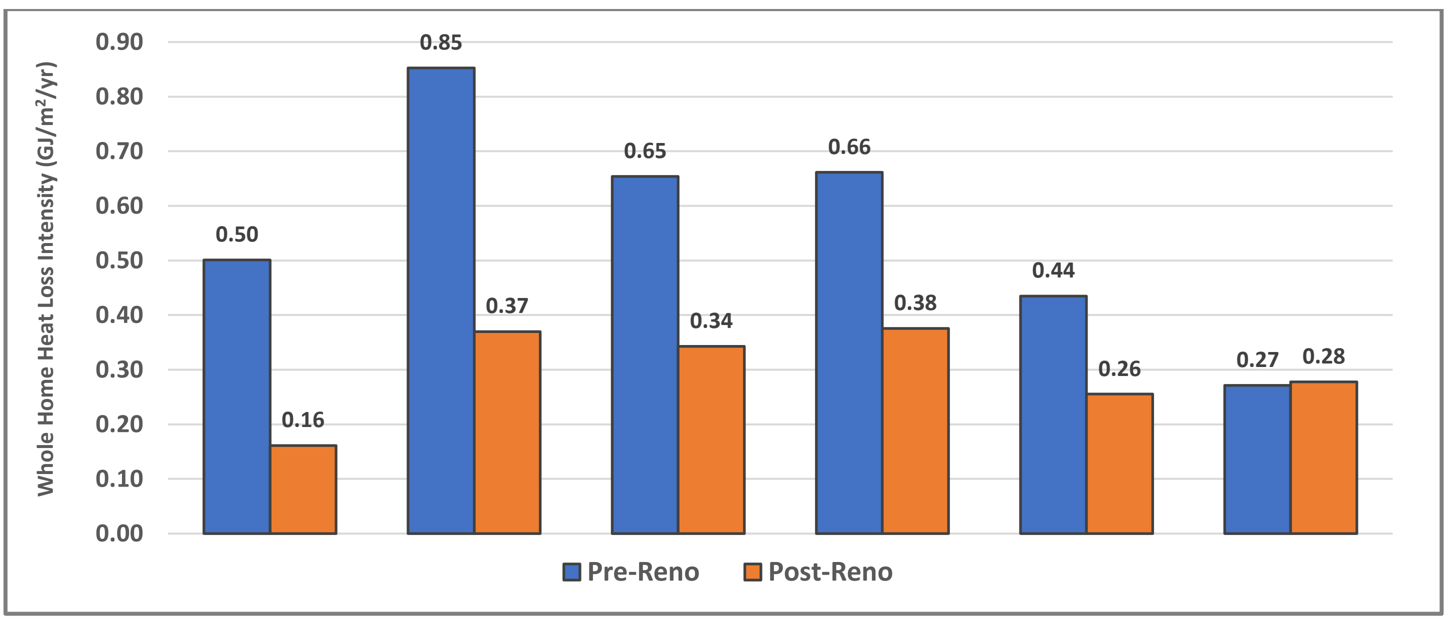

Figure 30: Net Zero Renos – Whole Home Heat Loss Intensity Comparison

ASSEMBLY DISTRIBUTION OF WHOLE HOME HEAT LOSS

This section considers amount of heat energy lost annually through the different assemblies of the home. The home "assemblies" considered are the foundation, ceilings, walls, exposed floors, windows and doors, and through air leakage. They are each represented as a percentage of the total heat lost through all assemblies annually, both pre-renovation and post-renovation. As shown in Figure 31 below, it's important to note that in all six renovations the modelled whole home heat loss post-renovation was substantially less than pre-renovation.

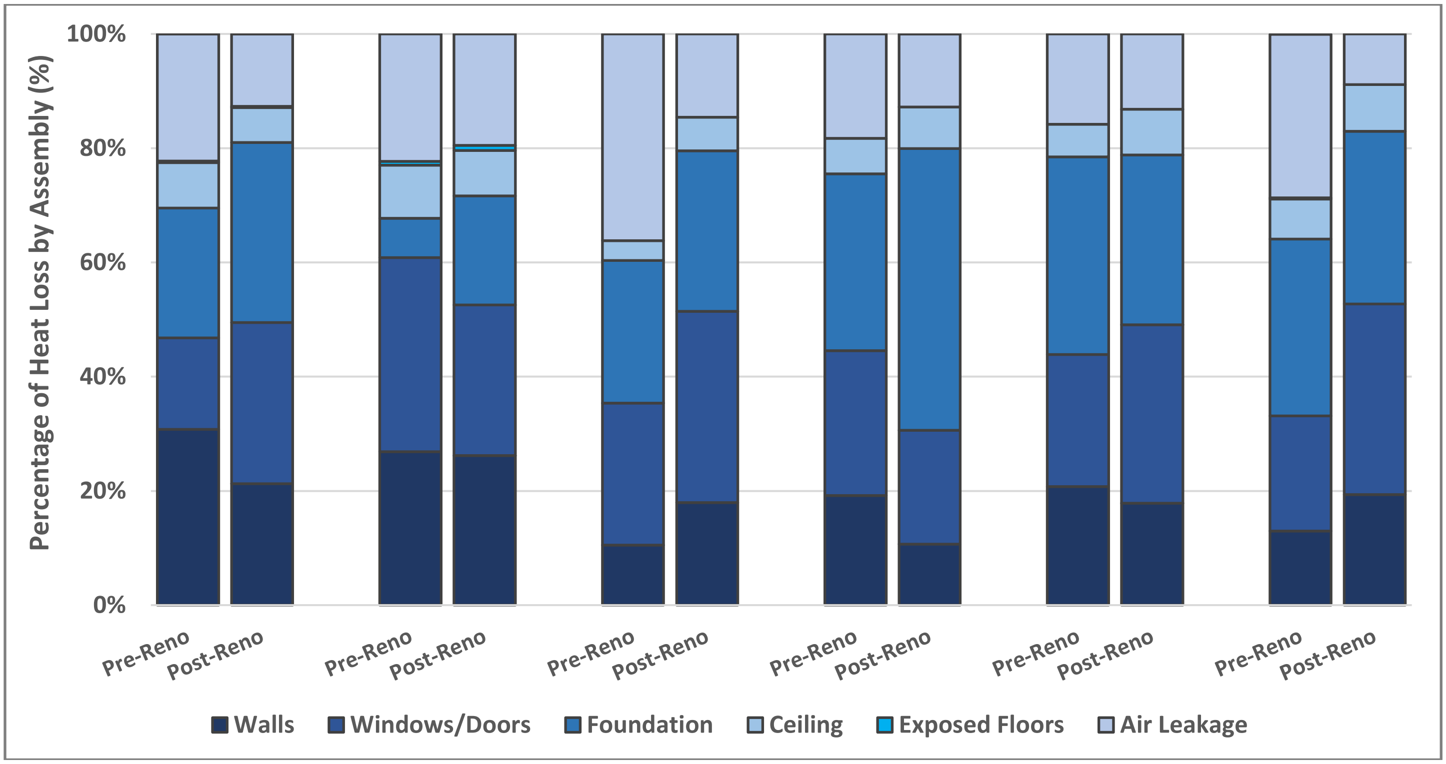

Figure 31: Net Zero Renos – Assembly Distribution of Whole Home Heat Loss Comparison

ANALYSIS

- The average decrease in whole home heat loss was 51 GJ/year, an average percent decrease of 38%.
- The average decrease in whole home heat loss intensity was 0.26 GJ/m^2/year, an average percent decrease of 42%.

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 building's 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.

9.3 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, or 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.

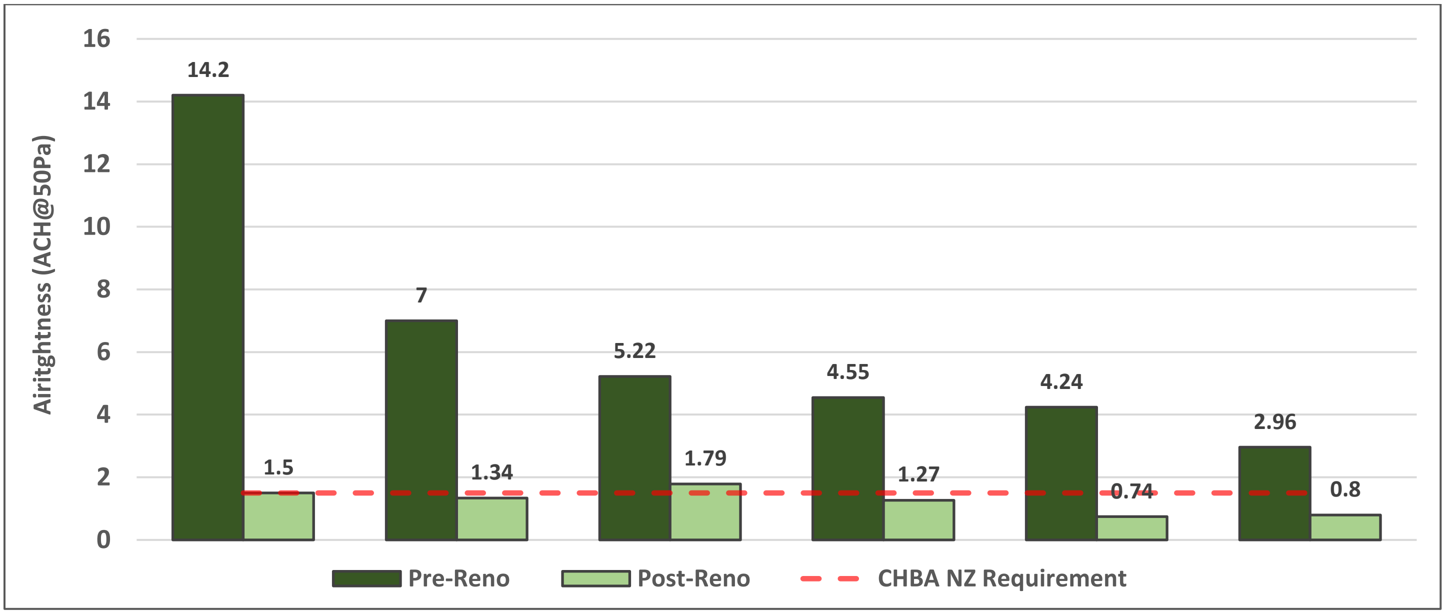

Figure 32: Net Zero Renos – Airtightness Comparison

Note: *The home that exceeded the 1.5 ACH@50Pa target in Figure 32 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-renovation airtightness achieved was 1.24 ACH@50Pa.
- The average decrease in airtightness was 5.12 ACH@50Pa, an average percent decrease of 77%.

The CHBA Net Zero Renovations Program uses the same performance target for airtightness as the new Net Zero Homes Program - maximum 1.5 ACH@50 for detached homes and maximum 2.0 ACH@50 for attached homes. 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 1.09 ACH@50Pa whereas the average of the six homes labelled under the Net Zero Renovations Pilot was 1.24 ACH@50Pa. The percent decrease in airtightness achieved in renovations depends greatly on the pre-renovation airtightness level of the home.

9.4 Annual Operational Carbon Emissions Comparison

ANNUAL OPERATIONAL CARBON EMISSIONS

This section considers the modeled reduction in annual operational carbon emissions from the six homes labelled in the Net Zero Renovations Pilot. Operational carbon emissions reductions are measured by comparing the estimated operational carbon emissions resulting from the home before the renovation to the resulting operational carbon emission of the home after the renovation. In a Net Zero or Net Zero Ready Renovation it is expected that the home's annual operational carbon emissions will be reduced when comparing the pre-renovated home to the post-renovated home. This section of the report uses the same methodology as was used in Section 8 to calculate operational carbon emissions. More details of the methodology can be found in Appendix A. This section includes the operational carbon emissions offset provided by solar photovoltaic systems. Therefore, the first three Net Zero Renovations presented below have a "Post-Reno" operational carbon emissions of 0 tCo_2e/year.

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 2020 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 carbon emissions using averages over several years of reported emission factors, from the same Environment Canada reports.*

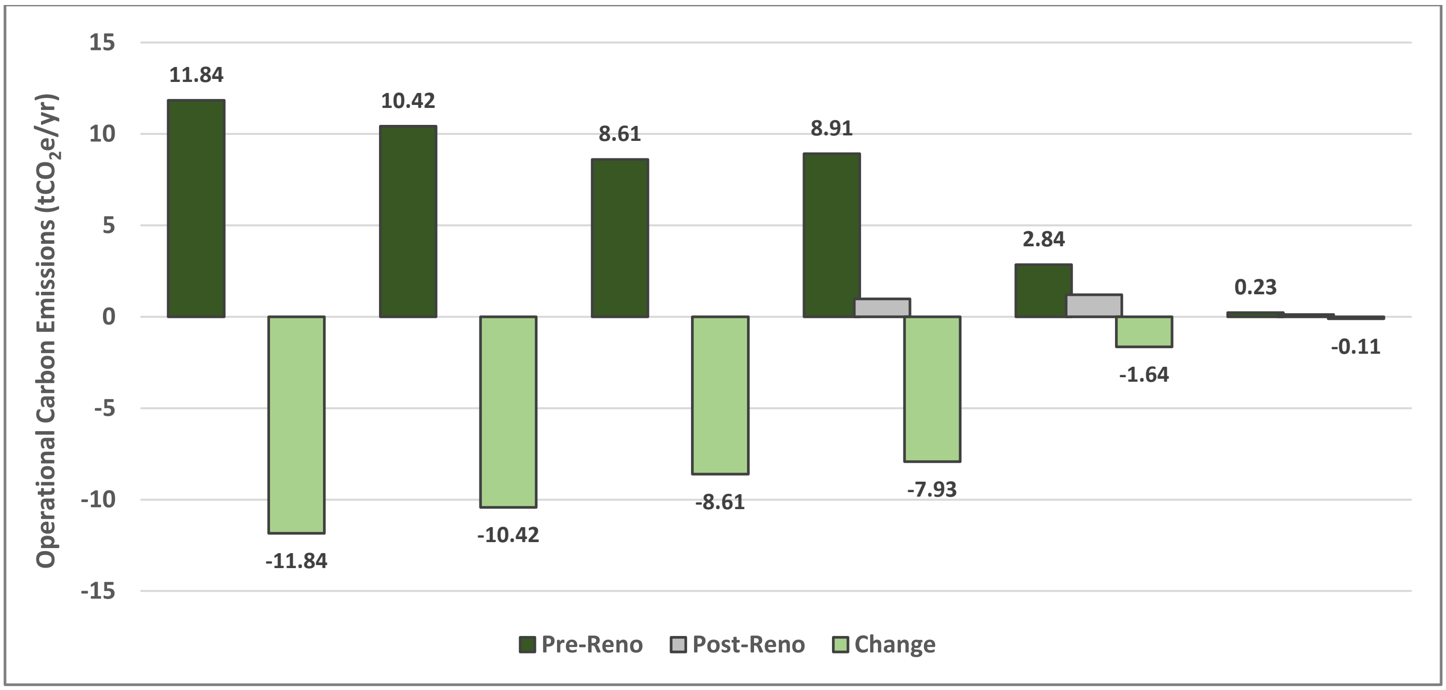

Figure 33: Net Zero Renos – Annual Operational Carbon Emissions Comparison

ANALYSIS

- The lowest annual operational carbon emission reduction was 0.11 tonnes CO_2e/year. This represented an all-electric home in a province with "clean" electricity.
- The highest annual operational carbon emission reduction was 11.84 tonnes CO_2e/year. This represented a home that converted from natural gas heating to all-electric and included on-site renewable energy.

The annual operational carbon emissions reduction can be significantly impactful from the Net Zero Renovations. The range of carbon emissions reductions varies significantly with the emission factor and fuel choices before and after renovations.

Appendix A

OPERATIONAL CARBON EMISSIONS CALCULATION METHODOLOGY

For the purposes 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 associated estimated operational carbon emission for each home. The emission factors used are from *Environment Canada's National Inventory Report – 2022 Edition*. The most recent reporting values are from the year 2020.

Global Warming Potentials applied to Natural Gas and Propane emission factors 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, 2022)*

Electricity		$t/CO_2e/kWh$
Newfoundland and Labrador	NL	0.0000240
Prince Edward Island	PE	0.0000000
Nova Scotia	NS	0.0006700
New Brunswick	NB	0.0002900
Quebec	QC	0.0000015
Ontario	ON	0.0000250
Manitoba	MB	0.0000011
Saskatchewan	SK	0.0005800
Alberta	AB	0.0005900
British Columbia	BC	0.0000073
Yukon	YT	0.0001000
Northwest Territories	NT	0.0001800
Nunavut	NU	0.0007700

Electricity emission factors for each province are from: *National Inventory Report (1990-2020): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC) Part 3, Table(s) A13-2 to A13-14. Electricity Emission Details for Canada, pg. 62-74*

Natural Gas		$t/CO_2e/m^3$
Newfoundland and Labrador	NL	0.001932355
Prince Edward Island	PE	0.001932355
Nova Scotia	NS	0.001932355
New Brunswick	NB	0.001932355
Quebec	QC	0.001937355
Ontario	ON	0.001932355
Manitoba	MB	0.001926355
Saskatchewan	SK	0.001931355
Alberta	AB	0.001973355
British Columbia	BC	0.001977355
Yukon	YT	0.001977355
Northwest Territories	NT	0.001977355
Nunavut	NU	0.001977355

Natural gas emission factors for each province are from: *National Inventory Report (1990-2020): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC) Part 2,*
Table A6.1-1 CO_2 Emission Factors for Marketable Natural Gas Liquids, pg. 254
Table A6.1-3 CH_4 and N_20 Emission Factors for Natural Gas, pg. 255

Propane	$t/ CO_2e/L$
same for all provinces	0.001547859

Propane emission factors for each province are from: *National Inventory Report (1990-2020): Greenhouse Gas Sources and Sinks in Canada (submission to UNFCCC) Part 2,*
Table A6.1-4 CO_2 Emission Factors for Natural Gas Liquids, pg. 256

Appendix B

CHBA NET ZERO RENOVATIONS PILOT – TECHNICAL REQUIREMENTS

The chart below describes the sections in the Net Zero Technical Requirements Version 1.3 (for new Homes) that were revised for the Net Zero Renovations Pilot. 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.