CHBA NET ZERO HOME LABELLING PROGRAM
Summary Report – 2019

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, 2019, 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 1.2 million jobs
- Paying more than $73.6 billion in wages
- Generating $150.9 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 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. More information can be found at www.chba.ca/nzc 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 combat 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 considers the program uptake of Net Zero and Net Zero Ready Homes labelled under the Program from September 29, 2015 until December 31, 2019, 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: envelope efficiency, mechanical systems installed, and fuel source configurations.

In addition, six performance metrics are also analyzed for the detached and attached homes: annual energy consumption, whole home heat loss, airtightness, mechanical energy use intensity, percent better than reference house – envelope, and percent better than reference house – annual energy consumption. These performance metrics are based on the modelled values determined by the Qualified Net Zero Energy Advisor using the modeling software HOT2000. The performance metrics for the homes are reviewed against a variety of variables including: the province in which the home is located, the climate zone in which the home is located, the program year that the home was completed in, the heated floor area of detached homes, and the unit type for attached homes.

Here are some highlights of the report content:

- 123 Net Zero Homes and 132 Net Zero Ready Homes for a total of 255 homes were labelled under the Program as of December 31, 2019.
- They were labelled in 8 provinces with the majority (83.5%) in Ontario.
- The majority (82%) of detached and attached homes used above-grade walls with an RSI efficiency of between 3.5 and 5.3 (R20-R30).
- The most common ceiling RSI efficiency for detached and attached homes was between 8.9 and 11.4 (R50-560).
- The most common space heating and cooling configuration (53%) was an air source heat pump with a natural gas furnace as backup for heating.
- The water heating system most often installed was a natural gas instantaneous condensing water heater (50%).
- Drain water heat recovery was installed in 86% of homes.
- For ventilation, most homes (78%) installed an energy recovery ventilator (ERV).
- Most Net Zero Homes (80%) used an all-electric configuration and most Net Zero Ready Homes (99%) used a dual source configuration.
- Most of the detached homes (61%) achieved a modelled annual energy consumption of between 40 and 55 GJ/yr.
- For the average detached home, the occupant load made up 47% of the annual energy consumption and the operational load made up the remaining 53%. For the average attached home the occupant load made up 59% of the annual energy consumption and the operational load made up the remaining 41%.
- Most detached homes (64%) were modelled to have a whole home heat loss of less than 70 GJ annually.
- The average airtightness for detached homes was 0.95 ACH@50 and the average airtightness for attached homes is 1.53 ACH@50.
- The calculated mechanical energy use intensity was less than 25 kWh/(m2·year) for 74% of the detached homes and 53% of attached homes.
- The average percent better than reference – annual energy consumption was 69.9% for detached homes and 66.8% for attached homes.
- The average percent better than reference –envelope was 53.9% for detached homes and 64.6% for attached homes.

We will release a detailed report of this nature annually. In addition, a program summary update will be presented each year at the CHBA Spring Meetings in order to communicate the advancements in the program

2.0 DEFINITIONS

The Program terminology is provided below.

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.

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.

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 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.

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.

3.0 PROGRAM TO-DATE

This section provides an overall evaluation of Program activity and uptake as of December 31, 2019, which includes participants and homes in the Pilot through to the end of Year 3 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

The differences in Program Requirements for qualifying a home in the Pilot vs. Version 1 can be found in **Appendix A and B**. Home labelled in 2017, 2018, and 2019, were qualifying 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 four 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"), and
4. CHBA Qualified Net Zero Builder/Renovator ("Builder/Renovator").

The requirements for participants to become qualified under the Program can be found on the CHBA website at www.chba.ca/nze. As of December 31, 2019, there were 10 SOs, 23 EAs, 4 Trainers, and 44 Builders that have been qualified under the Program. The Lists of these Qualified SOs, EAs and Trainers can be found on the CHBA website at www.chba.ca/nze and Qualified Builders can be found at www.netzerohome.com.

TRAINING
Builders/Renovators, EAs, and Trainers are required to successfully complete the CHBA Net Zero Builder Training offered through a Qualified Net Zero SO and delivered by a Qualified Net Zero Trainer. Additionally, EAs and Trainers are required to successfully complete CHBA Net Zero Energy Advisor (EA) Training offered through a Qualified Net Zero SO and delivered by a Qualified Net Zero Trainer.

Table 1: Number of Newly Trained Participants by Year

Program Year	Pilot	2017	2018	2019	Total
Participants	253	190	73	72	588

NZC Sponsor Members Owens Corning, JELD-WEN and Dettson provided support to run a "blitz" of training sessions across Canada during the Pilot, which resulted in excellent attendance by early adopters in the training during that timeframe.

3.2 Number of Homes

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

Label	Pilot	2017	2018	2019	Total
Net Zero Home	26	9	8	80	123
Net Zero Ready Home	2	10	10	110	132
Total	**28**	**19**	**18**	**190**	**255**

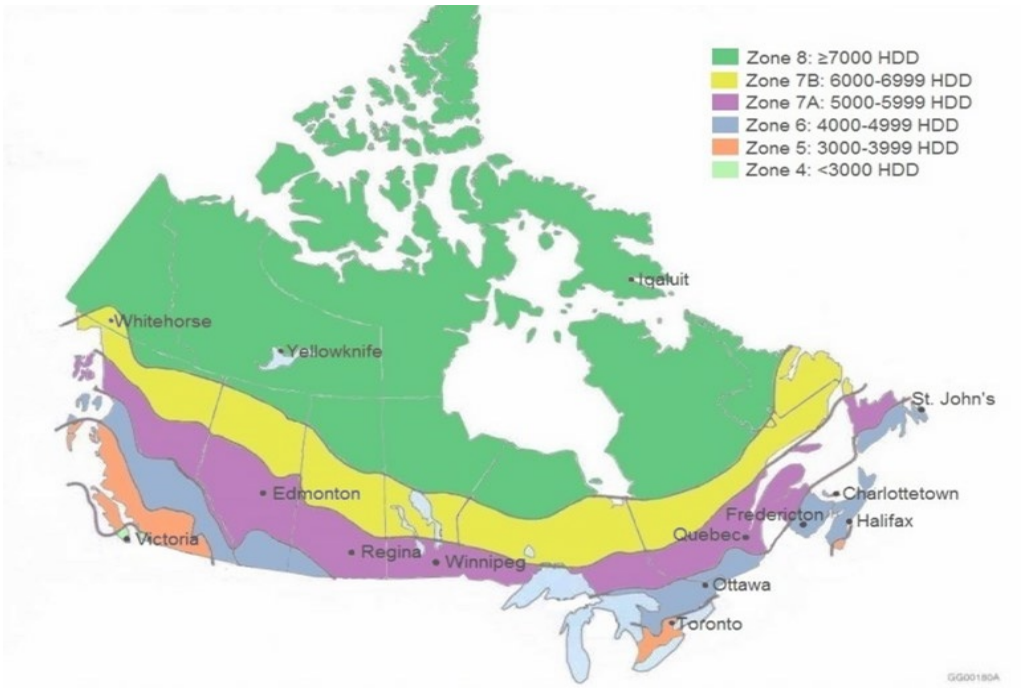

Figure 1: Climate Zone Map of Canada (source: Natural Resource Council of Canada, colour coding by NAIMA Canada).

Table 3: Number of Homes by Province

Province	Labels
Alberta	16
British Columbia	8
New Brunswick	6
Newfoundland & Labrador	1
Nova Scotia	4
Ontario	213
Quebec	6
Saskatchewan	1

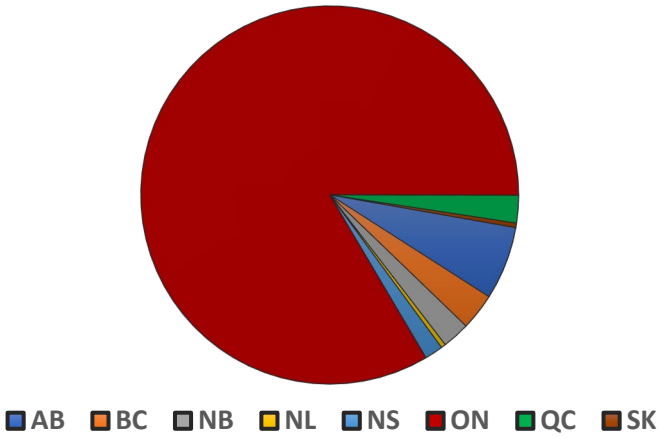

Figure 2: Number of Homes by Province

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

Type of House	Qty. per Climate Zone			
	4	5	6	7a
Detached Homes	2	52	81	17
Attached Homes	1	72	21	0
Unit by Unit - MURB	0	0	6	0
Whole Building - MURB	0	3	0	0
Subtotal	3	127	108	17
Total	255			

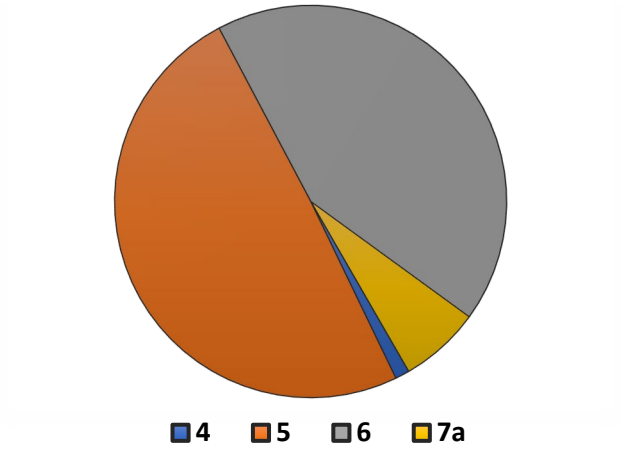

Figure 3: Distribution of Homes by Climate Zone

CONCLUSION

There has been a significant amount of program uptake in the years 2018 and 2019. Since the Program's first report, "The Pilot and Year 1 Summary Report", the number of Qualified Net Zero Builder's has increase by more than 130% and the number of Qualified Net Zero and Net Zero Ready Homes has increased by more than 440%. As a result of this program expansion, our data set of homes has become more diverse allowing us to extrapolate trends in the data with a higher degree of certainty. These trends can be seen throughout this report.

4.0 ENVELOPE

This section explores the envelope assemblies used by the 255 homes labelled under the Program prior to December 31, 2019.

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,
- Unit by unit – multi-unit residential buildings (MURB), and
- Whole building – multi-unit residential buildings (MURB)

Note: This report contains data from three projects under the home type Whole Building – MURB. It should be noted that each MURB was very different: one project had 3 units, one project had 10 units, and one project had 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	36	208	2,241	**5.35 [30.4]** 4.21 [23.9] 7.33 [41.6]	**10.58 [60.1]** 8.11 [46.1] 14.05 [79.8]	**4.85 [27.5]** 2.00 [11.4] 6.88 [39.1]
Detached ≥2,600 ft^2 <4,000 ft^2	5,6,7a	77	299	3,221	**5.06 [28.7]** 4.23 [24.0] 9.22 [52.4]	**10.55 [59.9]** 8.39 [47.6] 16.19 [91.9]	**4.32 [24.5]** 0.00 [0.0] 9.16 [52.0]
Detached ≥4,000 ft^2	4,5,6,7a	39	545	5,872	**5.23 [29.7]** 3.86 [21.9] 7.54 [42.8]	**10.49 [59.6]** 7.15 [40.6] 13.43 [76.3]	**4.51 [25.6]** 0.00 [0.0] 7.45 [42.3]
Attached	4,5,6	94	178	1,913	**5.08 [28.8]** 4.05 [23.0] 8.74 [49.6]	**9.32 [52.9]** 6.39 [36.3] 13.66 [77.6]	**3.3 [18.7]** 0.00 [0.0] 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	3	776	8,354	**5.24 [29.8]** 5.18 [29.4] 5.33 [30.3]	**8.90 [50.6]** 8.58 [48.7] 9.08 [51.6]	**3.85 [21.8]** 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 [2]	5 [28.4]	8.33 [47.3]	4.32 [24.5]
5 [52]	4.59 [26.1]	10.26 [58.2]	4.3 [24.4]
6 [81]	5.27 [29.9]	10.50 [59.6]	4.29 [24.3]
7a [17]	6.51 [37.0]	11.87 [67.4]	6.08 [34.5]

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 [1]	8.74 [49.6]	8.70 [49.4]	6.15 [34.9]
5 [72]	5.01 [28.5]	9.22 [52.4]	2.95 [16.8]
6 [21]	5.03 [28.6]	9.71 [55.1]	4.39 [24.9]

4.1 Above-Grade Wall Assemblies

This section considers the effective thermal resistance of above-grade wall assemblies. The 152 detached homes as well as the 94 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.

DETACHED HOMES

Frequently used effective thermal resistance of above-grade wall assemblies:

- **4.5 – 5.3 [R25 – R30]:** 45% (69/152 homes)
- **3.5 – 4.4 [R20 – R25]:** 29% (44/152 homes)

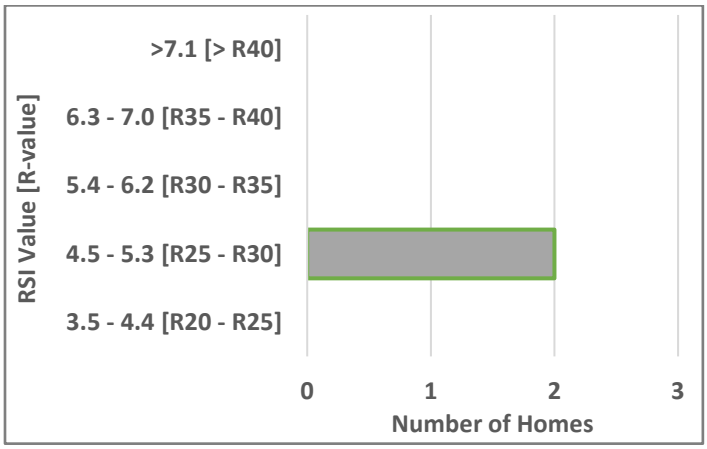

Figure 4: Detached Homes - Distribution of Above-Grade Wall RSI^{eff} in Climate Zone 4

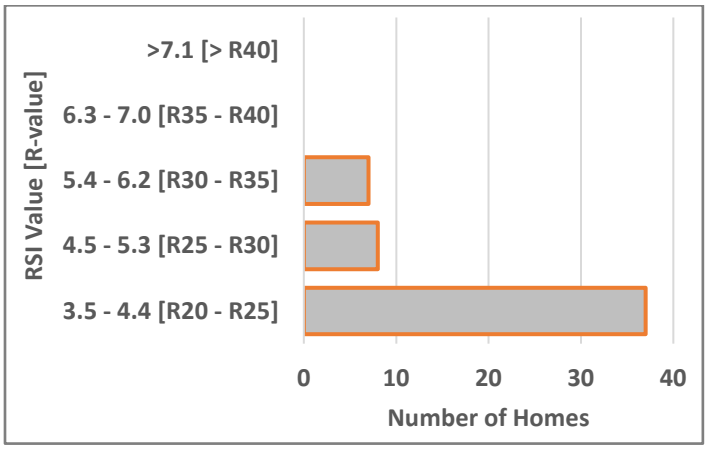

Figure 5: Detached Homes - Distribution of Above-Grade Wall RSI^{eff} in Climate Zone 5

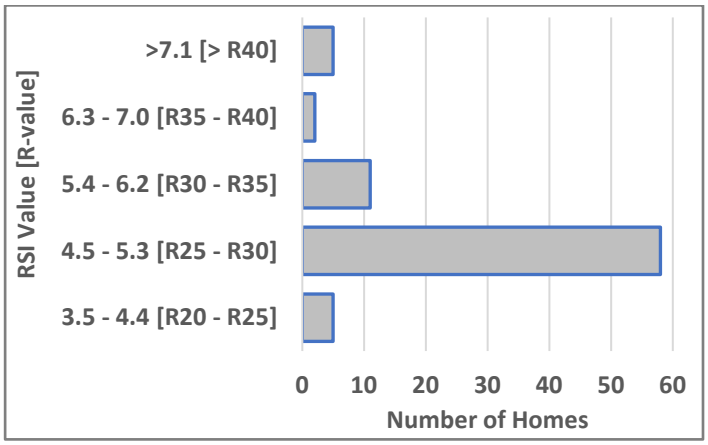

Figure 6: Detached Homes - Distribution of Above-Grade Wall RSI^{eff} in Climate Zone 6

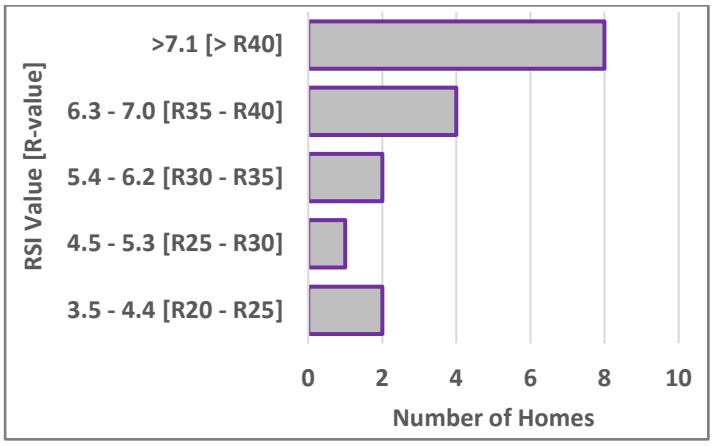

Figure 7: Detached Homes - Distribution of Above-Grade Wall RSI^{eff} in Climate Zone 7a

ATTACHED HOMES

Frequently used effective thermal resistance of above-grade wall assemblies:

- 4.5 – 5.3 [R25 – R30]: 76% (71/94 homes)
- 3.5 – 4.4 [R20 – R25]: 19% (18/94 homes)

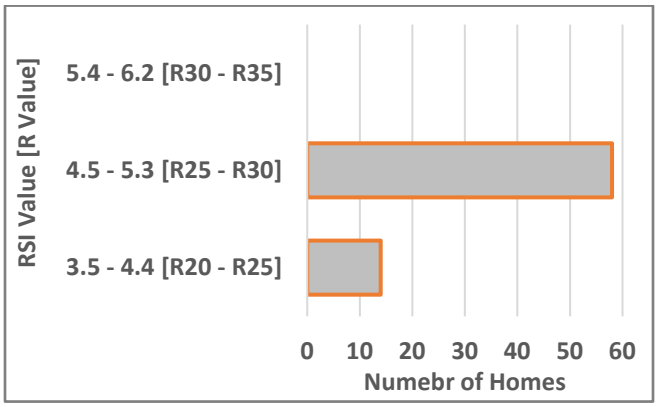

Figure 8: Attached Homes - Distribution of Above-Grade Wall RSI^{eff} in Climate Zone 5

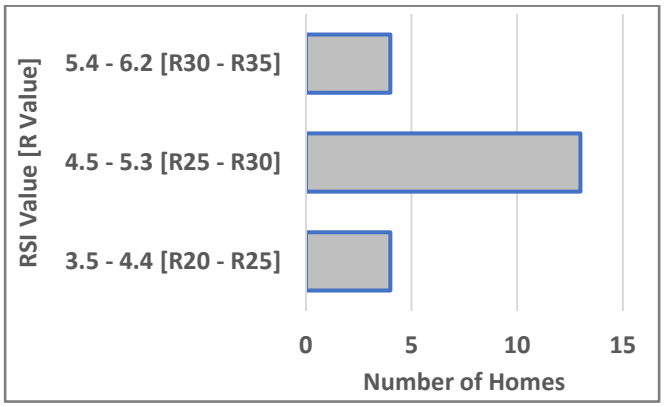

Figure 9: Attached Homes - Distribution of Above-Grade Wall RSI^{eff} in Climate Zone 6

Note: There was only one attached home in climate zone 4. This home used an effective thermal resistance of RSI 8.7 [R50] for above-grade wall assemblies.

4.2 Ceiling Assemblies

This section considers the effective thermal resistance of ceiling assemblies. The 152 detached homes as well as the 94 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.

DETACHED HOMES

Frequently used effective thermal resistance of ceiling assemblies

- 9.8 – 10.6 [R55 – R60]: 58% (88/152 homes)
- 8.9 – 9.7 [R50 – R55]: 13% (19/152 homes)

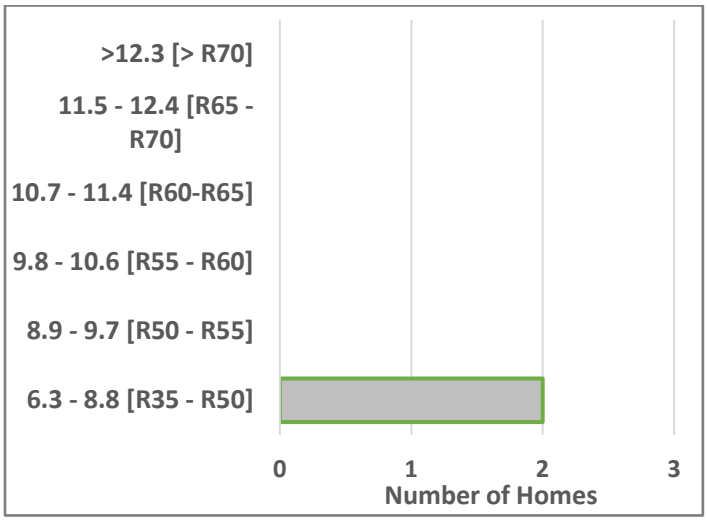

Figure 10: Detached Homes - Distribution of Ceiling RSI^{eff} in Climate Zone 4

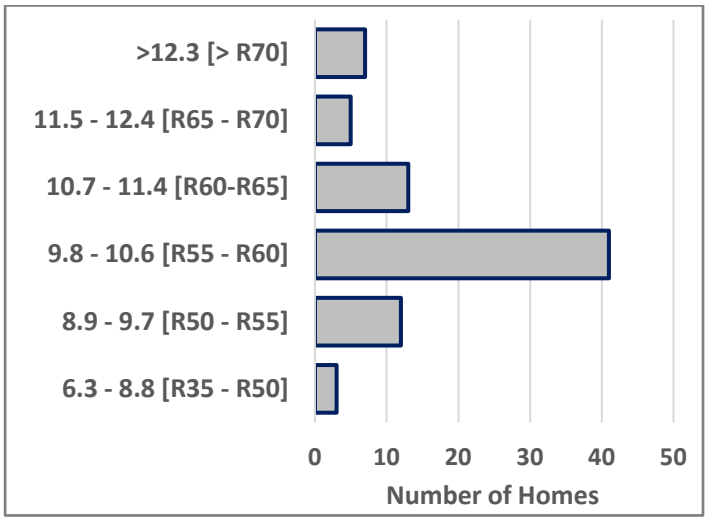

Figure 12: Detached Homes - Distribution of Ceiling RSI^{eff} in Climate Zone 6

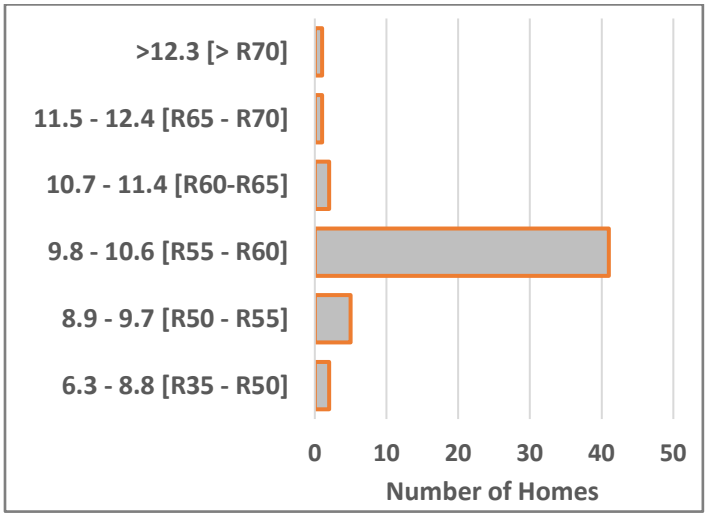

Figure 11: Detached Homes - Distribution of Ceiling RSI^{eff} in Climate Zone 5

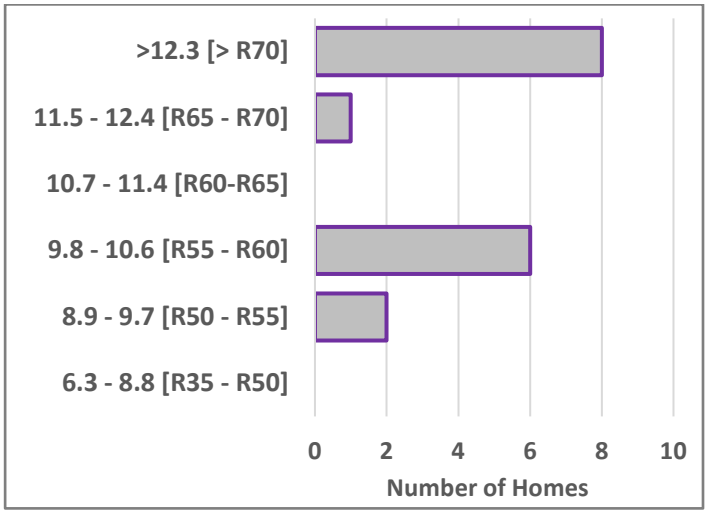

Figure 13: Detached Homes - Distribution of Ceiling RSI^{eff} in Climate Zone 7a

ATTACHED HOMES

Frequently used effective thermal resistance of ceiling assemblies:

- 8.9 – 9.7 [R50 – R55]: 43% (41/94 homes)
- 6.3 – 8.8 [R35 – R50]: 29% (27/94 homes)

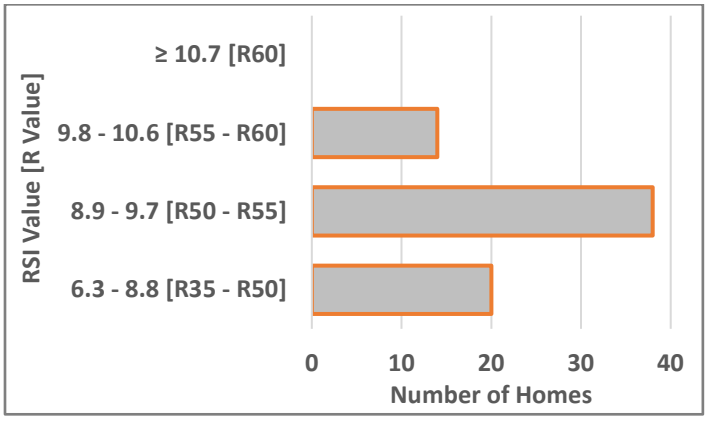

Figure 14: Attached Homes - Distribution of Ceiling RSI^{eff} in Climate Zone 5

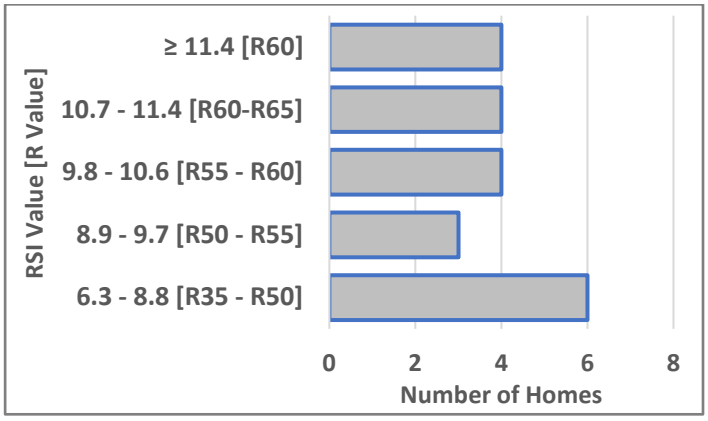

Figure 15: Attached Homes - Distribution of Ceiling RSI^{eff} of in Climate Zone 6

Note: There is only one attached home in climate zone 4. This home used an effective thermal resistance of RSI 8.7 [R50] for the ceiling assemblies.

4.3 Basement Assemblies

This section considers the basement assemblies used by homes in the Program. The basement assemblies are described by four different basement configurations as modelled. These basement configurations as well as the effective thermal resistance of foundation walls are evaluated by climate zone below. The CHBA Program has minimum requirements for the effective thermal resistance of foundation wall assemblies outlined in the Technical Requirements.

- **Basement:** 95% (242/255 homes)
- **No basement:** 5% (13/255 homes)
  - **BCCB_4:** 86% (207/242 homes)
  - **BCIB_4:** 13% (31/242 homes)
  - **BCIB_1:** 1% (3/242 homes)
  - **BCIA_1:** <1% (1/242 homes)

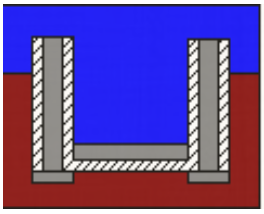

Figure 16: BCCB_4

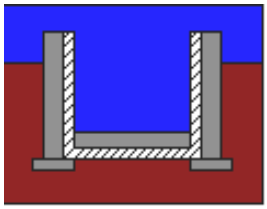

Figure 17: BCIB_4

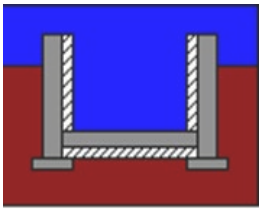

Figure 18: BCIB_1

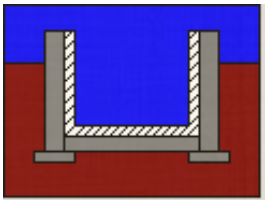

Figure 19: BCIA_1

Table 8: Frequently Used Basement Assemblies by Climate Zone

Climate Zone	Basement Assembly	# of labels using Basement Assembly	Avg. RSI^{eff} [R] of Foundation Wall
4	BCCB_4	3	4.93 [28.0]
5	BCCB_4	121	4.22 [24.0]
	BCIB_4	3	4.53 [25.7]
6	BCCB_4	70	4.15 [23.6]
	BCIA_1	1	9.16 [52.0]
	BCIB_1	1	4.16 [23.6]
	BCIB_4	26	5.05 [28.7]
7a	BCCB_4	13	6.47 [36.7]
	BCIB_1	2	4.13 [23.5]
	BCIB_4	2	5.55 [31.5]

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 homes labelled under the Program.

- **All electric source:** 42% (108/255 homes)
- **All natural gas source:** 2% (6/255 homes)
- **Dual source:** 55% (141/255 homes)

Only six 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.

Table 9: Space Heating Configuration of all Net Zero and Net Zero Ready Homes[1]

Secondary Heating System	Primary Heating Fuel Source	Primary Heating System	Pilot	Qty. 2017	Qty. 2018	Qty. 2019	Qty. Total
Air Source Heat Pump (ASHP)	Electricity	Baseboard/Hydronic/Plenum(duct) heaters	9	1	4	9	23
		Furnace	11	5	3	65	84
	Natural Gas	Condensing Furnace	8	9	9	110	136
		Condensing Boiler	0	0	1	2	3
	Propane	Condensing Furnace	0	1	0	0	1
Ground Source Heat Pump	Electricity	Furnace	0	1	0	0	1
	Propane	Condensing Boiler	0	0	0	1	1
	Natural Gas	Condensing Furnace	0	2	0	1	3
		Condensing Boiler	0	0	1	1	2
	Propane	Condensing furnace	0	0	0	1	1
		Total	**28**	**19**	**18**	**190**	**255**

[1] *The modelling software used, HOT2000, is designed to heat the home with the heat pump prior to the alternate source. As a result, heat pumps are shown as the primary heating system even though it will be the secondary system likely heating the home on the coldest day of the year.*

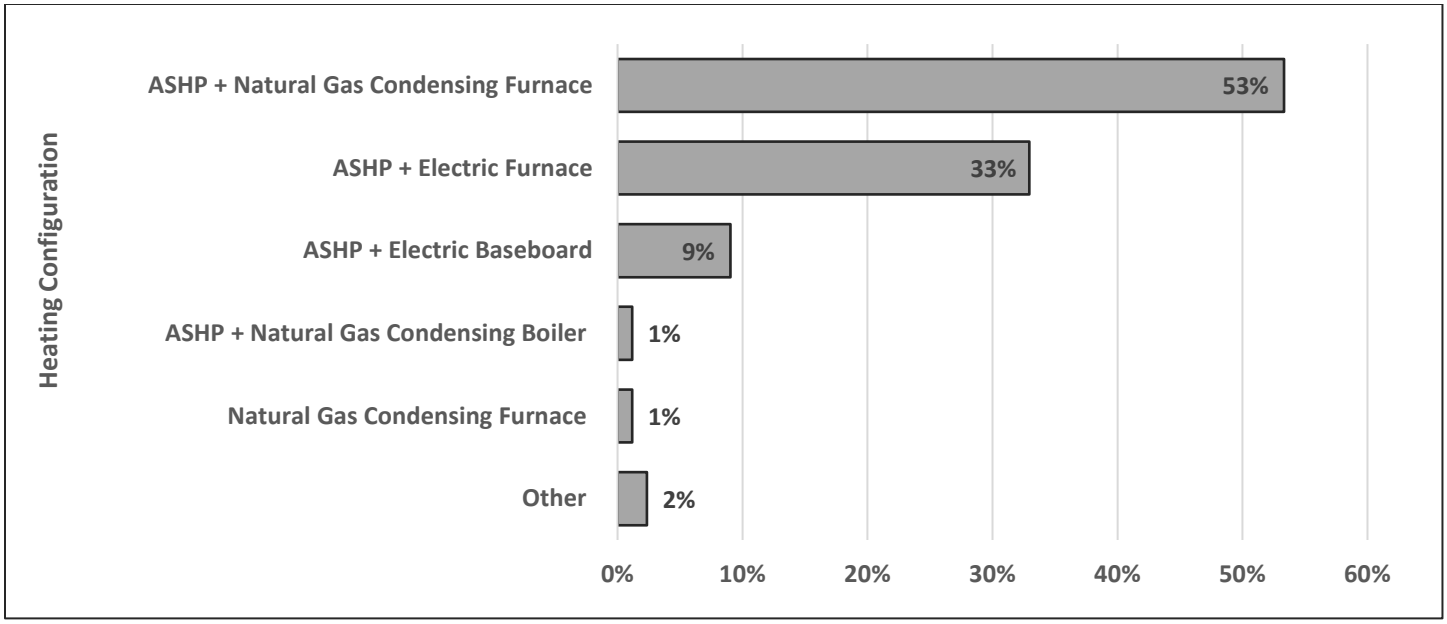

Figure 20: Frequently Used Space Heating Configurations used in Homes by Percentage

5.2 Ventilation

This section evaluates the ventilation systems used in the homes. The CHBA Program has a requirement that the principle ventilation capacity for homes shall be achieved through a heat recovery ventilator (HRV), an energy recovery ventilator (ERV), or an integrated mechanical system (IMS) which is outlined in the Technical Requirements. Integrated mechanical systems have not yet been used in the Program.

- **Heat Recovery Ventilator (HRV):** 22% (56/255 homes)
- **Energy Recovery Ventilator (ERV):** 78% (199/255 homes)

Table 10: Ventilation Systems of all Net Zero and Net Zero Ready Homes

Type	Qty. Pilot	Qty. 2017	Qty. 2018	Qty. 2019	Qty. Total
Heat Recovery Ventilator (HRV)	19	10	7	20	56
Energy Recovery Ventilator (ERV)	9	9	11	170	199

Table 11: Frequently Used Ventilation Systems by Climate Zone

Climate Zone	Favoured Ventilation Systems	# of Labels using Configuration	% of Homes Using System Indicated	Average Efficiency of Unit at 0°C
4	HRV	2	66%	75.0%
5	ERV	122	96%	71.2%
6	ERV	76	71%	73.5%
7a	HRV	17	100%	79.%

5.3 Water Heating

This section looks at the water heating systems used in homes labelled under the Program.

- **Electric water heating:** 48% (122/255 homes)
- **Natural gas water heating:** 50% (129/255 homes)
- **Solar water heating:** 1% (2/255 homes)
- **Propane water heating:** 1% (2/255 homes)

Note: *Drain water heat recovery (DWHR) was installed in 86% (220/255) of the homes.*

Table 12: Water Heating Configuration of all Net Zero and Net Zero Ready Homes

Fuel Type	Equipment Type	Drain Water Heat Recovery	Qty. Pilot	Qty. 2017	Qty. 2018	Qty. 2019	Qty. Total
Electricity	Conventional tank	Yes	19	1	2	62	84
		No	6	1	1	0	8
	Integrated heat pump	Yes	0	2	6	10	18
		No	0	5	1	6	12
Natural gas	Instantaneous (Condensing)	Yes	2	7	5	103	117
		No	1	2	2	5	10
	Induced Draft Fan	No	0	0	0	1	1
	Direct Vent (sealed)	Yes	0	0	0	1	1
Propane	Instantaneous (Condensing)	No	0	0	0	1	1
	Direct Vent (sealed)	No	0	0	0	1	1
Solar	Solar collector system	No	0	1	1	0	2

6.0 FUEL SOURCE

This section looks at the fuel source configuration used in the 255 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, propane, or solar thermal as energy sources. The CHBA Program has no requirement for heating fuel sources. The only related requirement is that the total energy consumption is modelled to 0 GJ/year using onsite renewables.

- Net Zero all-electric: 39% (99/255 homes)
- Net Zero dual source: 9% (24/255 homes)
- Net Zero Ready all-electric: <1% (1/255 homes)
- Net Zero Ready dual source: 51% (131/255 homes)

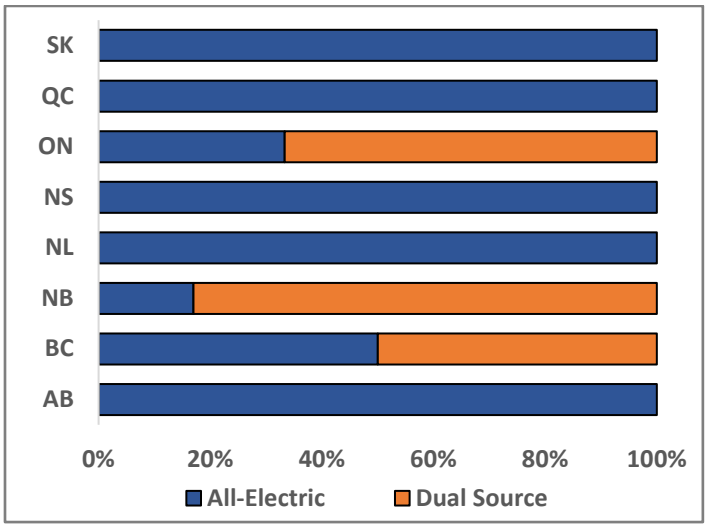

Figure 21: Fuel Source Configuration of Homes by Province

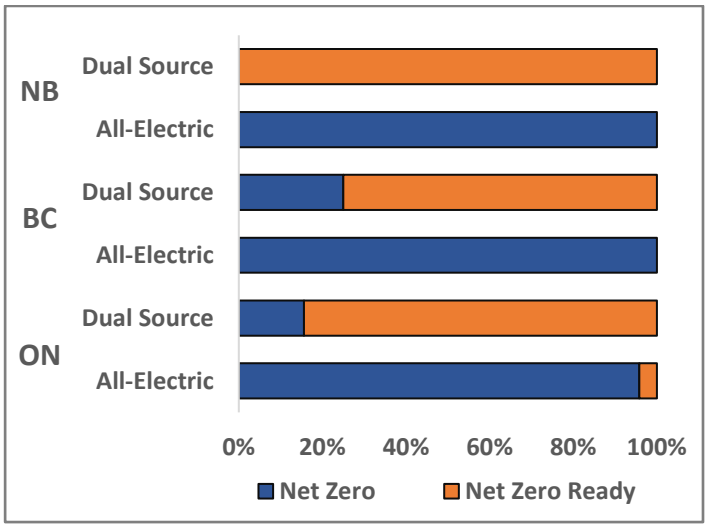

Figure 23: Fuel Source Configuration of Homes in Ontario, British Columbia and New Brunswick

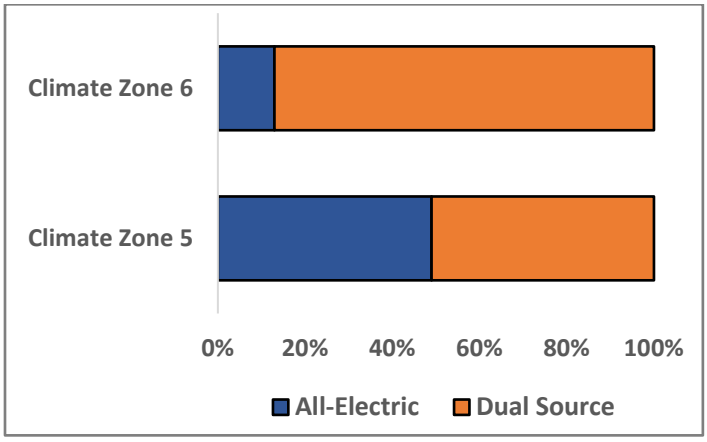

Figure 22: Fuel Source Configuration of Homes in Ontario by Climate Zone

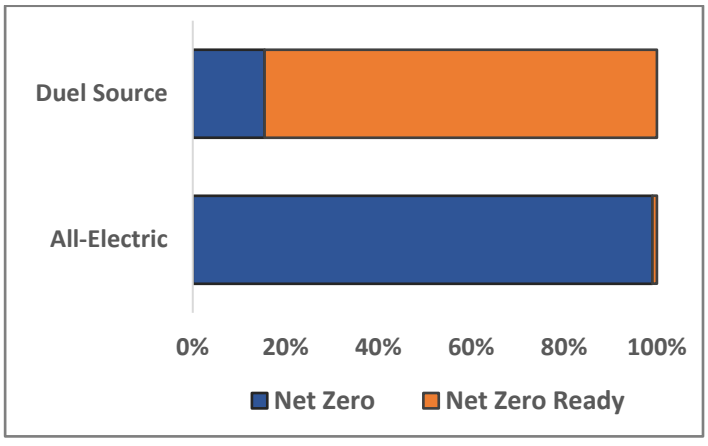

Figure 24: Fuel Source of Net Zero and Net Zero Ready Homes in Canada

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

Table 13: 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.	MEUI Avg. Min. Max.	Ref AEC[2] Avg. Min. Max.	Ref Env Avg. Min. Max.
Detached <2,600 ft^2	5,6,7a	36	208	2,241	**42.9** 32.3 53.7	**45.3** 27.5 63.3	**0.88** 0.40 1.71	**26.5** 12.3 69.7	**68.7** 61.2 83.0	**58.2** 45.9 72.0
Detached ≥2,600 ft^2 <4,000 ft^2	5,6,7a	77	299	3,221	**48.6** 35.4 82.7	**60.2** **38.8** 99.0	**0.95** 0.41 1.67	**22.4**[3] 10.4 56.6	**69.2** 36.1 85.9	**53.5** 35.3 88.7
Detached ≥4,000 ft^2	4,5,6,7a	39	545	5,872	**63.9** 31.9 130.8	**107.3** 64.3 227.6	**1.00** 0.49 1.50	**20.9**[4] 9.9 56.1	**72.0** 47.3 85.0	**50.6** 35.0 63.1
Attached	4,5,6	94	178	1,913	**37.8** 27.2 51.7	**34.1** **19.6** 65.8	**1.53** 0.46 2.49	**24.5**[5] 8.4 34.1	**66.8** 57.2 86.7	**64.6** 38.2 82.9
Single Unit MURB	6	6	101	1,084	**20.9** 19.8 21.5	**24.4** 19.0 26.6	**1.47** 1.36 1.63	**20.7** 13.5 31.0	N/A	**85.3** 77.6 93.3
Whole Building MURB	5	3	776	8,354	**229.5** 69.7 353.2	**257.0** 76.5 378.5	**2.52** 2.49 2.58	**66.3** 24.5 146.4	**63.6** 63.0 64.0	**52.3** 41.0 67.3

The following sub-sections explore the performance metrics for the 152 detached homes and the 94 attached homes. The performance metric of the detached homes are considered against 1) climate zone and 2) floor area and the performance metrics of the attached homes are considered against 1) climate zone and 2) unit type.

[2] *19 Detached homes, 6 attached homes, and all 6 Single Unit - MURBs did not have this calculation ("Ref AEC").*

[3] *1 Detached home greater than 2,600ft^2 and less than 4,000ft^2 in floor area did not have this calculation ("MEUI").*

[4] *1 Detached home greater than 4,000ft^2 in floor area did not have this calculation ("MEUI").*

[5] *1 Detached home greater than 4,000ft^2 in floor area did not have this calculation ("MEUI").*

7.1 Annual Energy Consumption

DEFINITION

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: *The GJ values below reflect the energy consumption of the homes—without the renewable energy generation.*

DETACHED HOMES

- 36% (55/152) of the homes were modelled to consume less than 45 GJ/year.
- 47% (30/64) of the homes that were modelled to consume greater than 50 GJ/year are greater than 4,000 ft^2 in floor area.
- 91% (58/64) of the homes that were modelled to consume greater than 50 GJ/year are located in climate zones 6 or 7a.

Table 14: Detached Homes - Statistics and Distribution of Annual Energy Consumption by GJ/year

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 40	≥ 40 to < 45	≥ 45 to < 50	≥ 50 to < 55	≥ 55 to < 60	≥ 60
Climate Zone										
7a [17 of 152]	46.1	42.5	52.8	49.1	2	6	4	1	2	2
6 [81 of 152]	37.9	57.5	48.1	57.5	11	5	12	21	12	20
5 [52 of 152]	37.8	51.9	58.9	45.8	5	25	16	1	2	3
4 [2 of 152]	N/A	41.8	N/A	48.9	0	1	1	0	0	0
Area										
< 240 (2,600 ft^2) [36 of 152]	38.7	44.2	49.9	44.1	6	2	17	7	4	0
≥ 240 (2,600 ft^2) to < 370 (4,000 ft^2) [77 of 152]	44.1	50.6	45.5	49.3	0	8	18	21	17	13
≥ 370 (4,000 ft^2) [39 of 152]	N/A	57.4	67.5	65.1	1	1	2	5	2	28

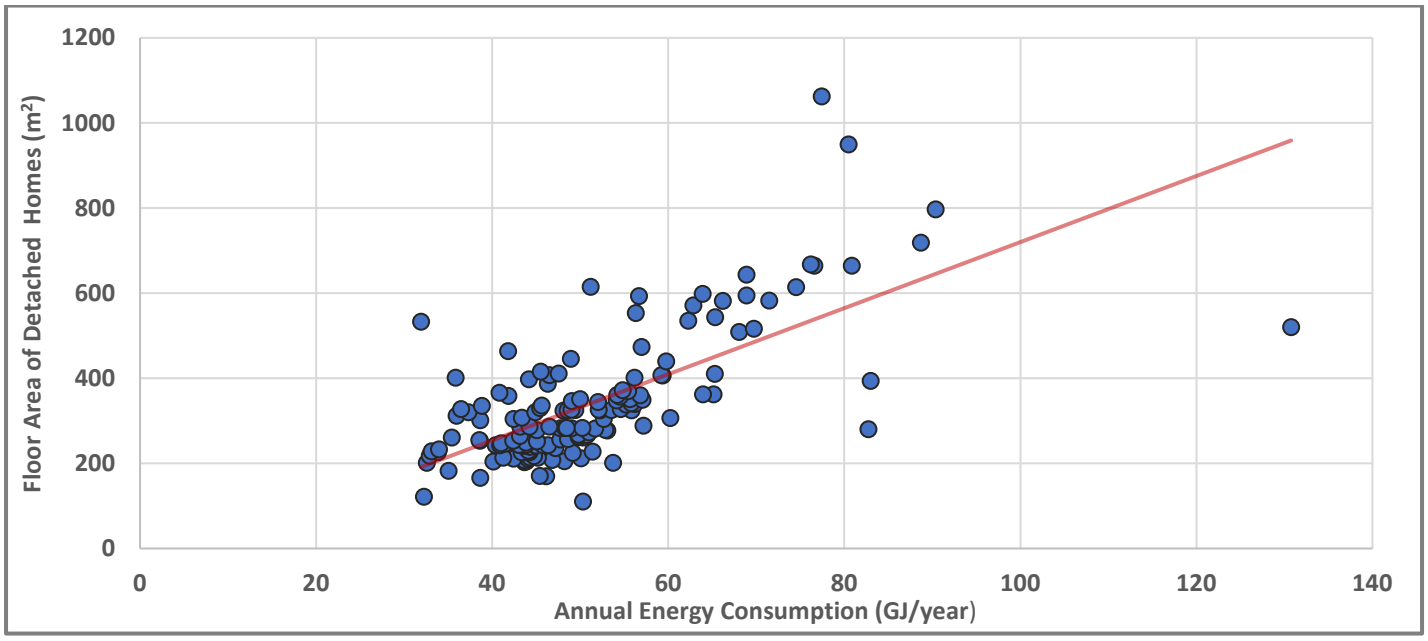

Figure 25: Detached Homes - Annual Energy Consumption of Homes by Floor Area

ATTACHED HOMES

- 83% (76/92) of the homes were modelled to consume less than 40 GJ/year.
- 68% (63/92) of the homes were modelled to consume between 35 GJ/year and 40 GJ/year.

Note: *Table 15 includes 92 of 94 attached homes because 2 attached homes did not have this calculation.*

Table 15: Attached Homes - Statistics and Distribution of Annual Energy Consumption by GJ/year

Characteristic [# of Labels]	Pilot	2017	2018	2019	DISTRIBUTION				
	Avg.	Avg.	Avg.	Avg.	< 30	≥ 30 to < 35	≥ 35 to < 40	≥ 40 to < 45	≥ 45
Climate Zone									
6 [19 of 92]	34.4	45.9	43.5	38.4	2	2	6	4	5
5 [72 of 92]	N/A	N/A	39.4	37.1	0	9	56	7	0
4 [1 of 92]	N/A	N/A	N/A	38.3	0	0	1	0	0
Unit Type									
End Unit [45 of 92]	36.7	45.9	42.3	38.4	2	0	30	8	5
Middle Unit [47 of 92]	32.2	N/A	N/A	36.4	0	11	33	3	0

7.1.1 Occupant and Operational Load Breakdown

DEFINITION

In this section the 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 and ventilation are considered the operational load. The operational load represents the amount of energy the home consumes annually to operate only essential equipment, regardless of occupancy. These energy requirements are modelled based on the energy performance of actual equipment used in the home. The occupant load (or baseload) is modelled using estimated energy consumption averages for lighting, appliances and plug loads. The occupant load estimates the average energy consumption of the occupants within the home. HOT2000 estimated the occupant load based on the assumed consumption of three occupants for detached homes and two occupants per unit for MURBs. The CHBA Program has a modelled performance target of 0 GJ for the total annual energy consumption and does not consider the individual load types.

AVERAGE DETACHED HOME

- **Occupant Load:** 47% (24.0 GJ/yr)
- **Operational Load:** 53% (27.2 GJ/yr)
  - -Space Heating: 15.7 GJ/yr
  - -Space Cooling: 2.0 GJ/yr
  - -Water Heating: 8.6 GJ/yr
  - -Ventilation: 0.9 GJ/yr

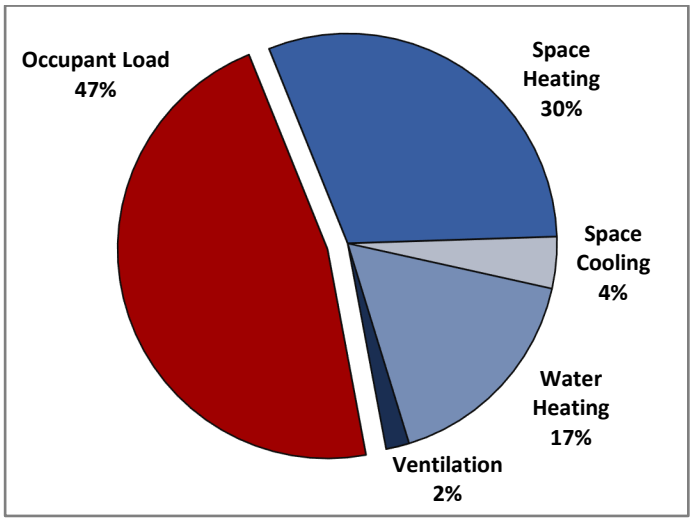

Figure 26: Annual Energy Consumption Breakdown of Detached Homes

AVERAGE ATTACHED HOMES

- **Occupant Load:** 59% (22.5 GJ/yr)
- **Operational Load:** 41% (15.3 GJ/yr)
  - -Space Heating: 4.6 GJ/yr
  - -Space Cooling: 1.4 GJ/yr
  - -Water Heating: 8.6 GJ/yr
  - -Ventilation: 0.8 GJ/yr

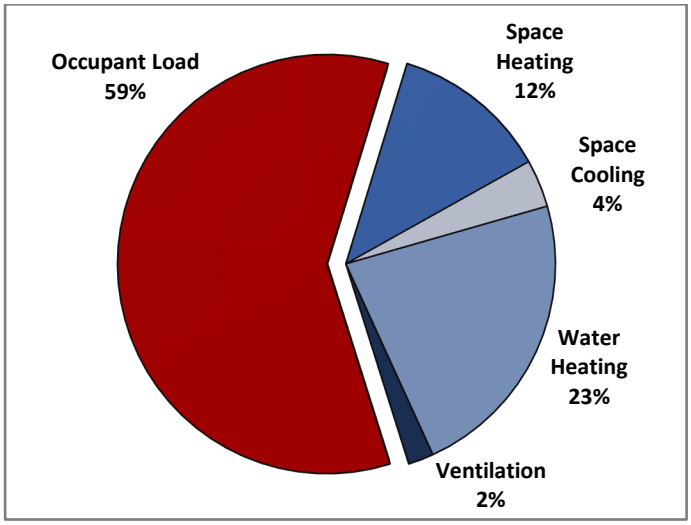

Figure 27: Annual Energy Consumption Breakdown of Attached Homes

7.2 Whole Home Heat Loss

DEFINITION

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, 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.

DETACHED HOMES

- 64% (98/152) of the homes were modelled to have a whole home heat loss of less than 70 GJ annually.
- 75% (27/36) of the homes that are less than 2,600 ft^2 in floor area were modelled to have a whole home heat lose of less than 50 GJ annually.
- 95% (37/39) of the homes that are greater than 4,000 ft^2 in floor area are modelled to have a whole home heat loss of greater than 70 GJ annually.

Table 16: Detached Homes - Statistics and Distribution of Whole Home Heat Loss by GJ/year

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 50	≥ 50 to < 70	≥ 70 to < 90	≥ 90 to < 110	≥ 110
Climate Zone									
7a [17 of 152]	48.5	96.5	68.0	82.3	6	6	1	3	1
6 [81 of 152]	48.3	76.7	68.3	78.3	9	31	22	8	11
5 [52 of 152]	55.5	83.1	88.6	54.5	29	17	0	3	3
4 [2 of 152]	N/A	75.3	N/A	70.3	0	0	2	0	0
Area									
< 240 (2,600 ft^2) [36 of 152]	40.1	52.1	52.8	45.9	27	9	0	0	0
≥ 240 (2,600 ft^2) to < 370 (4,000 ft^2) [77 of 152]	61.5	53.7	59.9	60.7	17	43	15	2	0
≥ 370 (4,000 ft^2) [39 of 152]	N/A	122.9	115.4	102.6	0	2	10	12	15

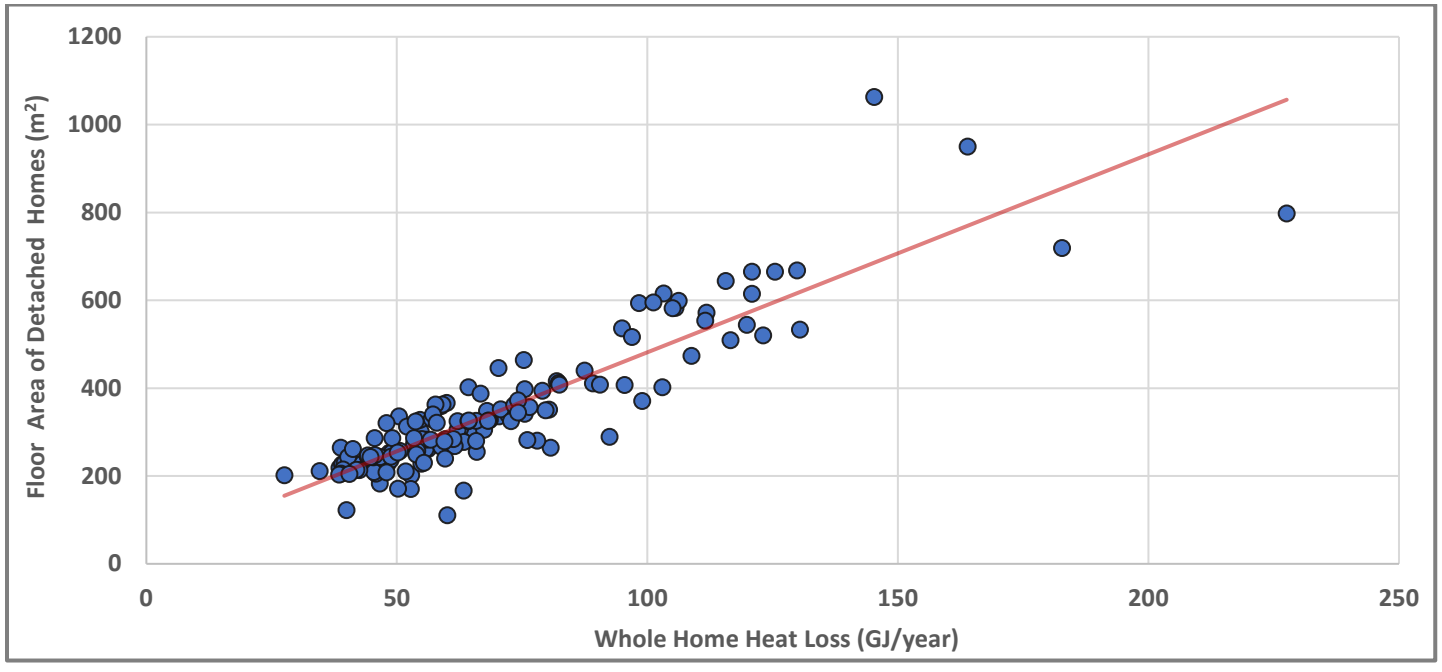

Figure 28: Detached Homes - Whole Home Heat Loss of Homes by Floor Area

ATTACHED HOMES

- 85% (80/94) of the homes were modelled to have a whole home heat loss of less than 40 GJ annually.
- 83% (30/36) of the homes that were modelled to have a whole home heat loss of less than 30 GJ annually are middle units.
- 90% (38/42) of the homes that were modelled to have a whole home heat loss of greater than 35 GJ annually are end units.

Table 17: Attached Homes - Statistics and Distribution of Whole Home Heat Loss by GJ/year

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 30	≥ 30 to < 35	≥ 35 to < 40	≥ 40 to < 45	≥ 45
Climate Zone									
6 [21 of 94]	39.3	49.4	50.6	36.1	2	2	5	3	9
5 [72 of 94]	N/A	N/A	37.7	31.5	34	14	23	1	0
4 [1 of 94]	N/A	N/A	N/A	39.8	0	0	0	1	0
Unit Type									
End Unit [47 of 94]	47.3	49.4	46.9	35.7	6	3	26	3	9
Middle Unit [47 of 94]	31.3	N/A	N/A	29.2	30	13	3	1	0

7.3 Airtightness

DEFINITION

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

DETACHED HOMES

- The average achieved airtightness of all 152 detached homes is 0.95 ACH@50.
- 57% (87/152) of the homes achieved airtightness of 1.0 ACH@50 or less.
- 74% (113/152) of the homes achieved airtightness of between 0.50 and 1.25 ACH@50.

Table 18: Detached Homes - Statistics and Distribution of Airtightness by ACH@50pa

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 50	≥ 0.50 to < 0.75	≥ 0.75 to < 1.00	≥ 1.00 to < 1.25	≥1.25
Climate Zone									
7a [17 of 152]	0.54	0.96	0.81	0.83	5	6	4	0	2
6 [81 of 152]	0.98	0.89	0.75	1.11	5	14	13	25	24
5 [52 of 152]	0.73	0.78	0.88	0.90	0	16	22	11	3
4 [2 of 152]	N/A	0.75	N/A	0.67	0	2	0	0	0
Area									
< 240 (2,600 ft²) [36 of 152]	0.79	0.64	0.81	0.98	4	9	12	7	4
≥ 240 (2,600 ft²) to < 370 (4,000 ft²) [77 of 152]	0.73	0.94	0.78	0.99	5	17	24	18	13
≥ 370 (4,000 ft²) [39 of 152]	N/A	0.93	0.84	1.07	1	12	3	11	12

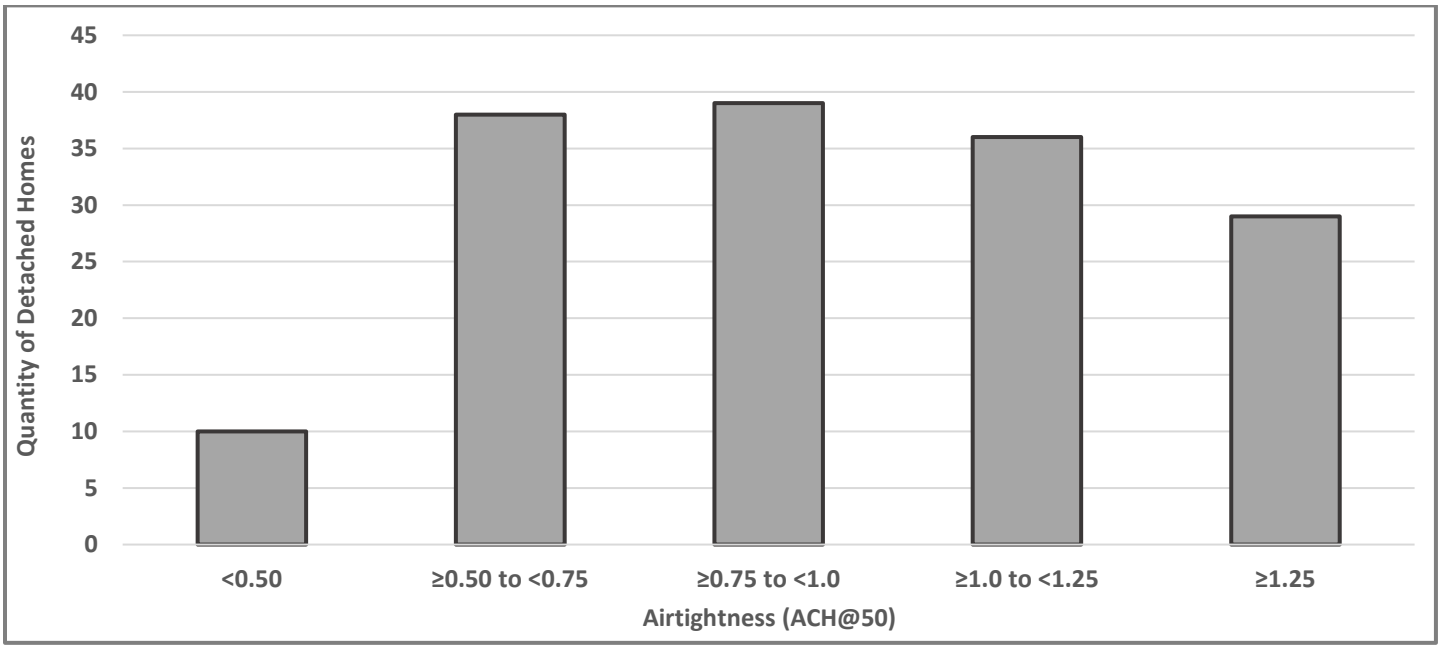

Figure 29: Detached Homes - Distribution of Airtightness by ACH@50

ATTACHED HOMES

- The average achieved airtightness of all 94 attached homes is 1.53 ACH@50.
- 60% (56/94) of the homes achieved airtightness of between 1.0 and 1.8 ACH@50.
- 94% (43/47) of the middle units achieved airtightness of 1.4 ACH@50 or greater.

Table 19: Attached Homes - Statistics and Distribution of Airtightness by ACH@50

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 0.6	≥ 0.6 to < 1.0	≥ 1.0 to < 1.4	≥ 1.4 to < 1.8	≥ 1.8
Climate Zone									
6 [21 of 94]	1.47	0.6	1.26	1.47	2	2	6	9	2
5 [72 of 94]	N/A	N/A	1.53	1.60	0	11	11	29	21
4 [1 of 94]	N/A	N/A	N/A	1.41	0	0	0	1	0
Unit Type									
End Unit [47 of 94]	1.47	0.60	1.34	1.28	2	13	14	14	4
Middle Unit [47 of 94]	1.47	N/A	N/A	1.83	0	0	3	25	19

7.4 Mechanical Energy Use Intensity (MEUI)

DEFINITION

Mechanical Energy Use Intensity is the energy consumption of the home's mechanical systems compared to the size of the home. MEUI is measured in kWh/(m^2 per year) with a lower value indicating better performance. The MEUI calculation in this report follows the MEUI calculation as described in the BC Energy Step Code. MEUI includes the energy required for space heating, space cooling, domestic water heating, and ventilation and divides the total by the heated floor area. Occupant baseloads are excluded from this calculation. The CHBA Program does not have a performance target for MEUI; however, the highest step in the BC Energy Step Code includes a MEUI target of 25 kWh/(m^2 per year) as a compliance path.

DETACHED HOMES

- 74% (111/150) of the homes achieved a MEUI of less than 25 kWh/(m²·year).
- 27% (40/150) of the homes achieved a MEUI of less than 20 kWh/(m²·year).
- *Cold climate affects the ability to achieve a low MEUI:* Of the 26% (39/150) homes that were greater than 25 kWh/(m²·year), 80% (32/39) were in Climate Zones 6 or 7a.

Note: *Table 20 includes 150 of 152 Detached homes because 2 homes did not have this calculation.*

Table 20: Detached Homes - Statistics and Distribution of MEUI by kWh/m²·year

Characteristic [# of Labels]	Pilot	2017	2018	2019	DISTRIBUTION					
	Avg.	Avg.	Avg.	Avg.	< 15	≥ 15 to < 20	≥ 20 to < 25	≥ 25 to < 30	≥ 30 to < 35	≥ 35
Climate Zone										
7a [15 of 150]	25.5	53.9	29.5	24.1	0	1	4	7	0	3
6 [81 of 150]	15.3	21.9	22.4	24.2	16	7	36	13	5	4
5 [52 of 150]	12.2	18.3	21.4	22.5	5	9	31	6	1	0
4 [2 of 150]	N/A	12.7	N/A	14.5	2	0	0	0	0	0
Area										
< 240 (2,600 ft²) [36 of 150]	19.9	40.2	38.6	25.8	5	0	10	13	4	4
≥ 240 (2,600 ft²) to < 370 (4,000 ft²) [76 of 150]	16.0	21.8	21.4	23.4	8	11	42	12	2	1
≥ 370 (4,000 ft²) [38 of 150]	N/A	15.9	19.6	22.0	10	6	19	1	0	2

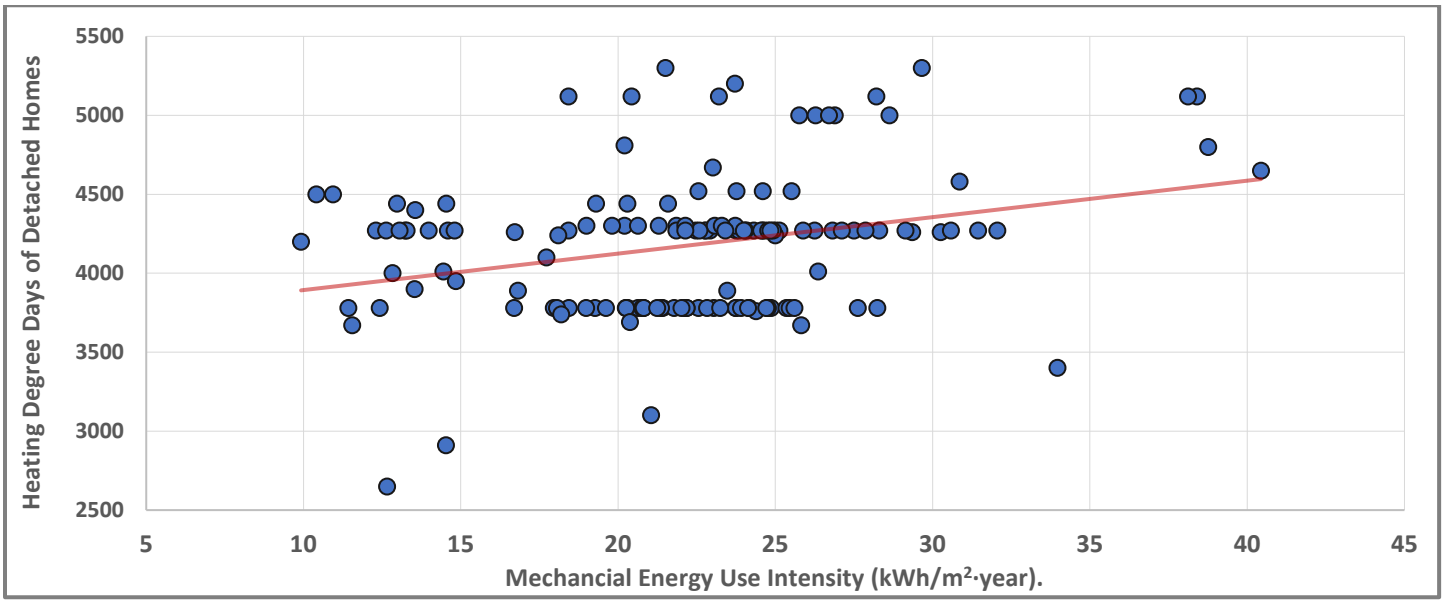

Figure 30: Detached Homes - MEUI by Heating Degree Days

Note: *3 homes were removed from the Figure 30 dataset as outliers.*

Analysis

The data points have developed two noticeable trends which create two horizontal lines across the chart. These lines represent many homes constructed within locations with the same number of heating degree days. The modelling software used in the Program identifies the heating degree days based on the city that the homes are located in. The horizontal lines represent the popularity of the Program in two cities: Guelph, Ontario and St. Thomas, Ontario, with 4,270 and 3,780 heating degree days respectively.

ATTACHED HOMES

- 53% (49/92) of the homes achieved a MEUI of less than 25 kWh/(m^2·year).
- 92% (40/92) of the homes achieved a MEUI of less than 20 kWh/(m^2·year).

Note: *Table 21 includes 92 of 94 attached homes because 2 homes did not have this calculation.*

Table 21: Attached Homes - Statistics and Distribution of MEUI by kWh/m^2·year

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 15	≥ 15 to < 20	≥ 20 to < 25	≥ 25 to < 30	≥ 30
Climate Zone									
6 [19 of 92]	18.0	20.0	19.2	22.2	2	5	10	2	0
5 [72 of 92]	N/A	N/A	31.5	25.8	0	0	31	34	7
4 [1 of 92]	N/A	N/A	N/A	8.4	1	0	0	0	0
Unit Type									
End Unit [45 of 92]	20.5	20.0	22.7	25.3	3	2	21	14	5
Middle Unit [47 of 92]	15.4	N/A	N/A	25.0	0	3	20	22	2

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

DEFINITION

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 133 Detached homes have this calculation because it was included in the updated version of HOT2000. The 18 Detached homes in the Pilot and 1 home in Year 1 do not have this calculation.*

DETACHED HOMES

- The average for all 133 Detached homes is 69.9% better than reference house for annual energy consumption.
- 96% (128/133) of the homes achieved greater than 60% better than the reference house for annual energy consumption.
- 56% (75/133) of the homes achieved between 60% and 70% better than the reference house for annual energy consumption.

Table 22: Detached Homes - Statistics and Distribution of Percent Better Than Reference House - Annual Energy Consumption by %

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 50	≥ 50 to < 60	≥ 60 to < 70	≥ 70 to < 80	≥ 80
Climate Zone									
7a [9 of 133]	N/A	72.7	71.0	77.4	0	0	3	5	1
6 [73 of 133]	N/A	70.4	74.7	69.1	3	2	39	21	8
5 [49 of 133]	N/A	74.7	69.4	68.4	0	0	33	15	1
4 [2 of 133]	N/A	80.1	N/A	73.9	0	0	0	1	1
Area									
< 240 (2,600 ft^2) [26 of 133]	N/A	74.4	64.6	68.1	0	0	19	5	2
≥ 240 (2,600 ft^2) to < 370 (4,000 ft^2) [69 of 133]	N/A	65.8	74.1	68.9	2	1	43	18	5
≥ 370 (4,000 ft^2) [38 of 133]	N/A	77.7	73.7	70.6	1	1	13	19	4

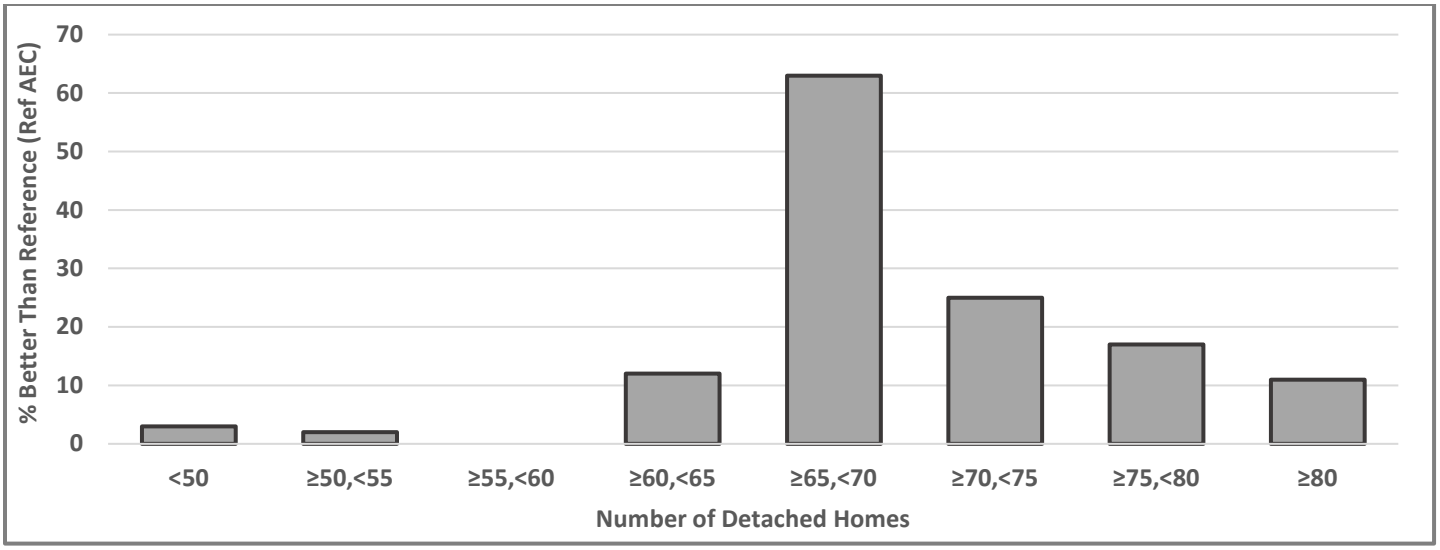

Figure 31: Detached Homes - Distribution of Percent Better Than Reference house - Annual Energy Consumption by %

ATTACHED HOMES

- The average for all 88 attached homes is 66.8% better than reference house for annual energy consumption.
- 64% (56/88) of the homes achieved greater than 65% better than the reference house for annual energy consumption.
- 84% (74/88) of the homes achieved between 60% and 70% better than the reference house for annual energy consumption.

Note: *Table 23 includes 88 of 94 attached homes because 6 homes did not have this calculation.*

Table 23: Attached Homes - Statistics and Distribution of Percent Better Than Reference House - Annual Energy Consumption by %

Characteristic [# of Labels]	Pilot	2017	2018	2019	DISTRIBUTION				
	Avg.	Avg.	Avg.	Avg.	< 55	≥ 55 to < 60	≥ 60 to < 65	≥ 65 to < 70	≥ 70
Climate Zone									
6 [15 of 88]	N/A	72.9	74.3	71.6	0	0	1	6	8
5 [72 of 88]	N/A	N/A	64.1	65.3	0	2	29	38	3
4 [1 of 88]	N/A	N/A	N/A	86.7	0	0	0	0	1
Unit Type									
End Unit [43 of 88]	N/A	72.9	71.4	67.1	0	1	13	19	10
Middle Unit [45 of 88]	N/A	N/A	N/A	65.6	0	1	17	25	2

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 proposed house is in the area of 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 reference house for building envelope.

DETACHED HOMES

- The average for all 152 detached homes is 53.9% better than reference house envelope.
- 65% (99/152) of the homes achieved greater than 50% better than reference house envelope.
- 20% (30/152) of the homes achieved greater than 60% better than reference house envelope.

Table 24: Detached Homes - Statistics and Distribution of Percent Better Than Reference House - Building Envelope in %

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 50	≥ 50 to < 60	≥ 60 to < 70	≥ 70 to < 80	≥ 80
Climate Zone									
7a [17 of 152]	67.4	57.7	59.9	52.9	3	4	7	3	0
6 [81 of 152]	64.9	53.0	60.6	51.2	31	35	11	3	1
5 [52 of 152]	65.3	55.6	57.3	50.7	19	28	5	0	0
4 [2 of 152]	N/A	53.7	N/A	56.9	0	2	0	0	0
Area									
< 240 (2,600 ft²) [36 of 152]	65.6	62.0	54.8	54.1	5	17	12	2	0
≥ 240 (2,600 ft²) to < 370 (4,000 ft²) [77 of 152]	66.4	52.8	62.6	50.8	26	40	6	4	1
≥ 370 (4,000 ft²) [39 of 152]	N/A	52.0	56.5	49.6	22	12	5	0	0

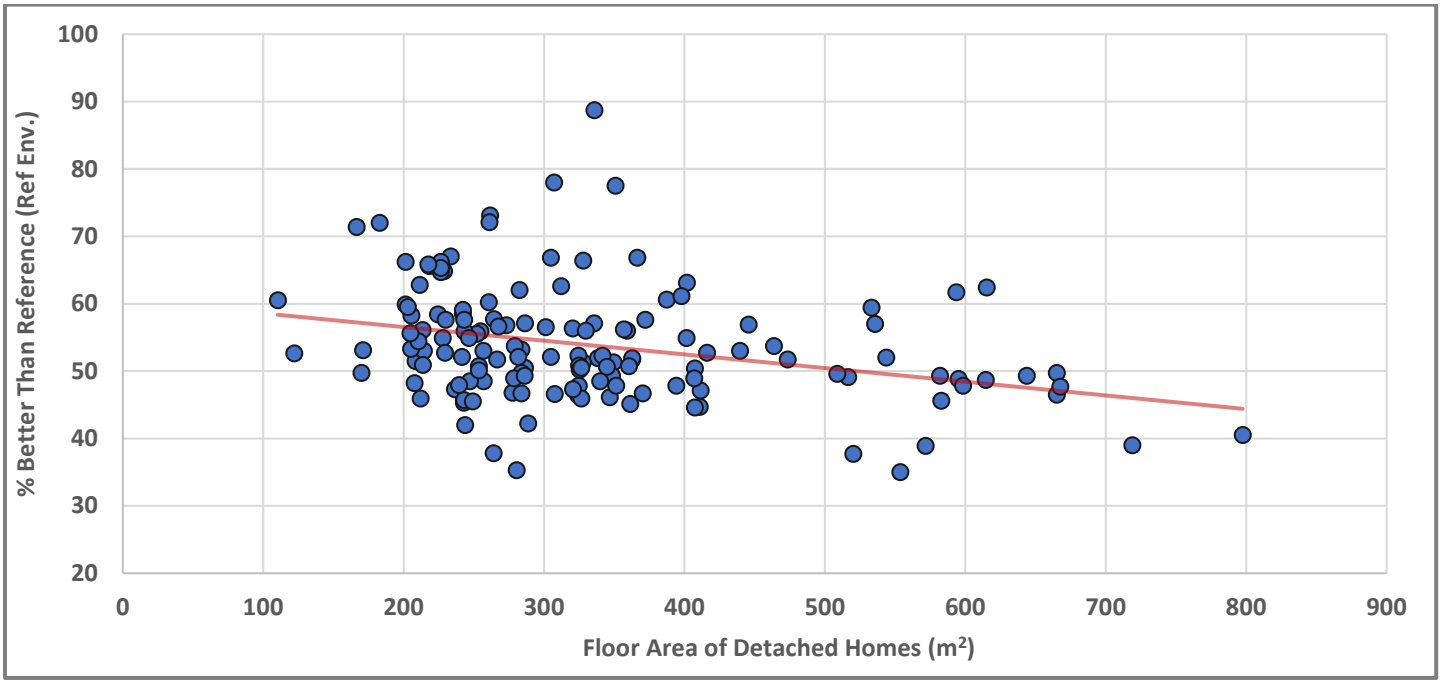

Figure 32: Detached Homes - Percent Better Than Reference House - Building Envelope in % by Floor Area

Note: *2 homes were removed from the Figure 32 dataset as outliers.*

ATTACHED HOMES

- The average for all 94 attached homes is 64.6% better than reference house envelope.
- 85% (80/94) of the homes achieved greater than 55% better than reference house envelope.
- 59% (55/94) of the homes achieved greater than 65% better than reference house envelope.

Table 25: Attached Homes - Statistics and Distribution of Percent Better Than Reference House - Building Envelope in %

Characteristic [# of Labels]	Pilot Avg.	2017 Avg.	2018 Avg.	2019 Avg.	DISTRIBUTION < 55	≥ 55 to < 60	≥ 60 to < 65	≥ 65 to < 70	≥ 70
Climate Zone									
6 [21 of 94]	81.4	66.0	56.9	57.6	4	6	2	4	5
5 [72 of 94]	N/A	N/A	64.7	64.8	10	6	11	24	21
4 [1 of 94]	N/A	N/A	N/A	78.9	0	0	0	0	1
Unit Type									
End Unit [47 of 94]	79.9	66.0	59.1	58.2	14	8	12	9	4
Middle Unit [47 of 94]	82.8	N/A	N/A	68.9	0	4	1	19	23

8.0 EXPERIENCED BUILDER ANALYSIS

DEFINITION

This section looks at the trends in performance metrics from 9 builders who have each built 3 or more Net Zero or Net Zero Ready Homes. This section only looks at single-family detached and doubles/semi-detached homes. These homes span three provinces (AB, NB, ON) and three climate zones (5,6,7a). Each colour represents a different builder's dataset of Net Zero or Net Zero Ready homes and each chart evaluates a different performance metric.

ANNUAL ENERGY CONSUMPTION (AEC)

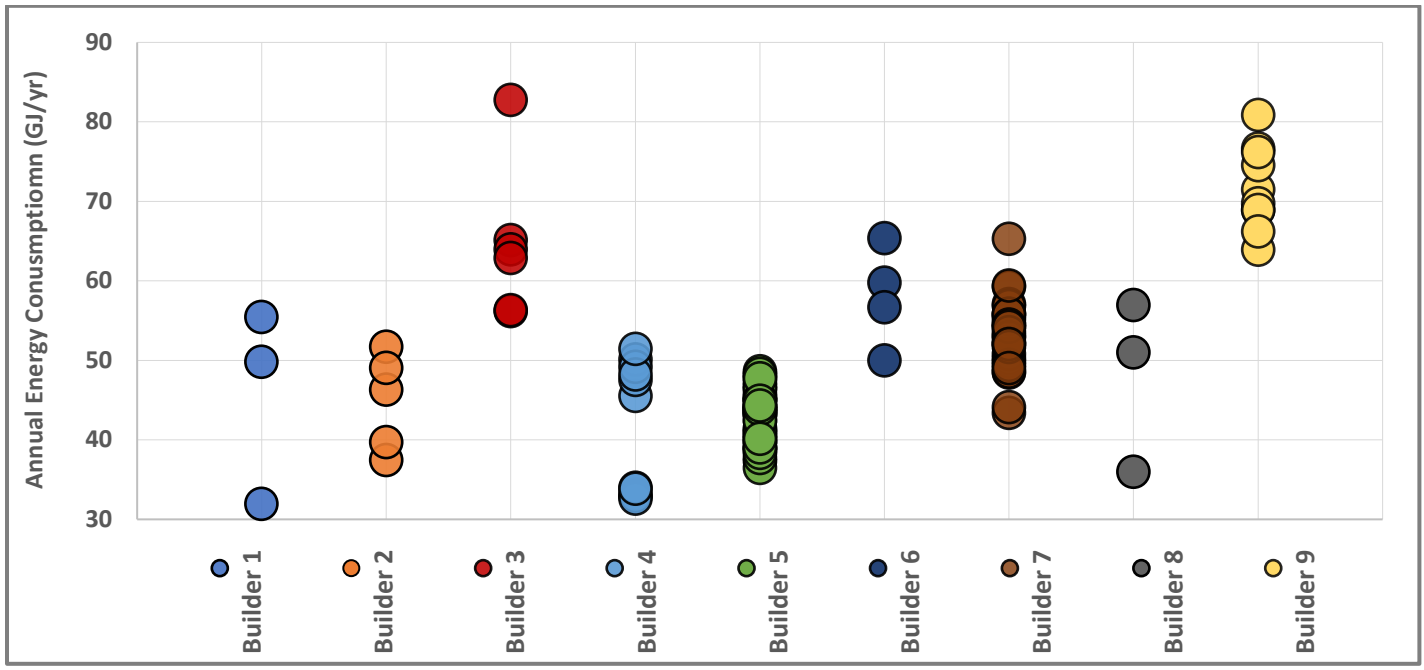

Figure 33: Annual Energy Consumption of Homes by Experienced Builders

WHOLE HOME HEAT LOSS (WHHL)

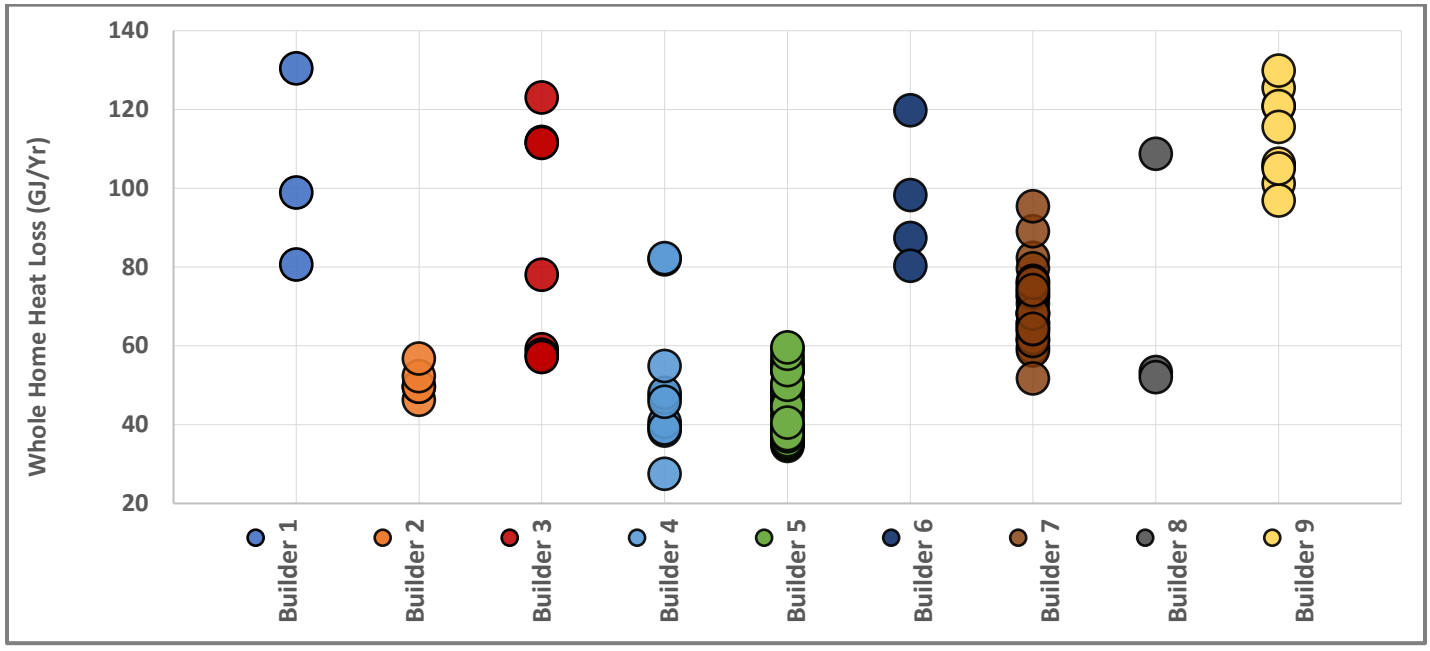

Figure 34: Whole Home Heat Loss of Homes by Experienced Builders

AIRTIGHNESS (ACH@50)

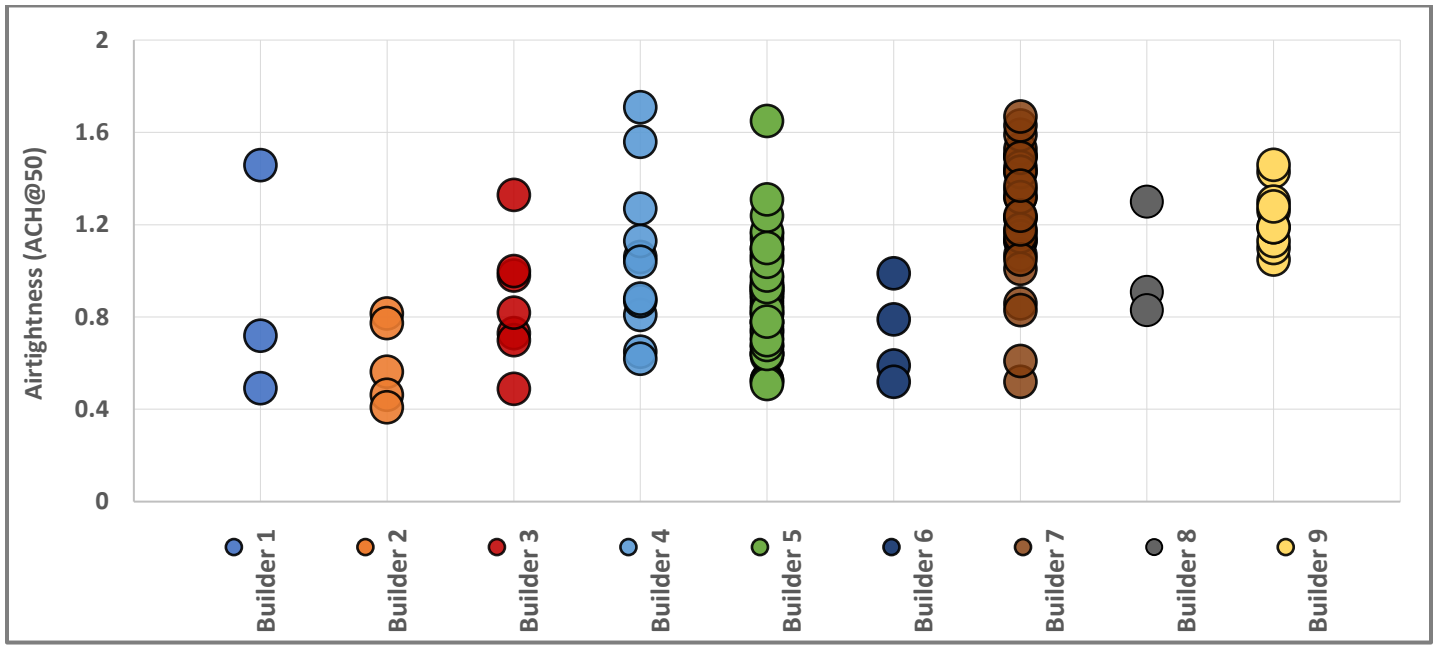

Figure 35: Airtightness of Homes by Experienced Builders

MECHANICAL USE INTENSITY (MEUI)

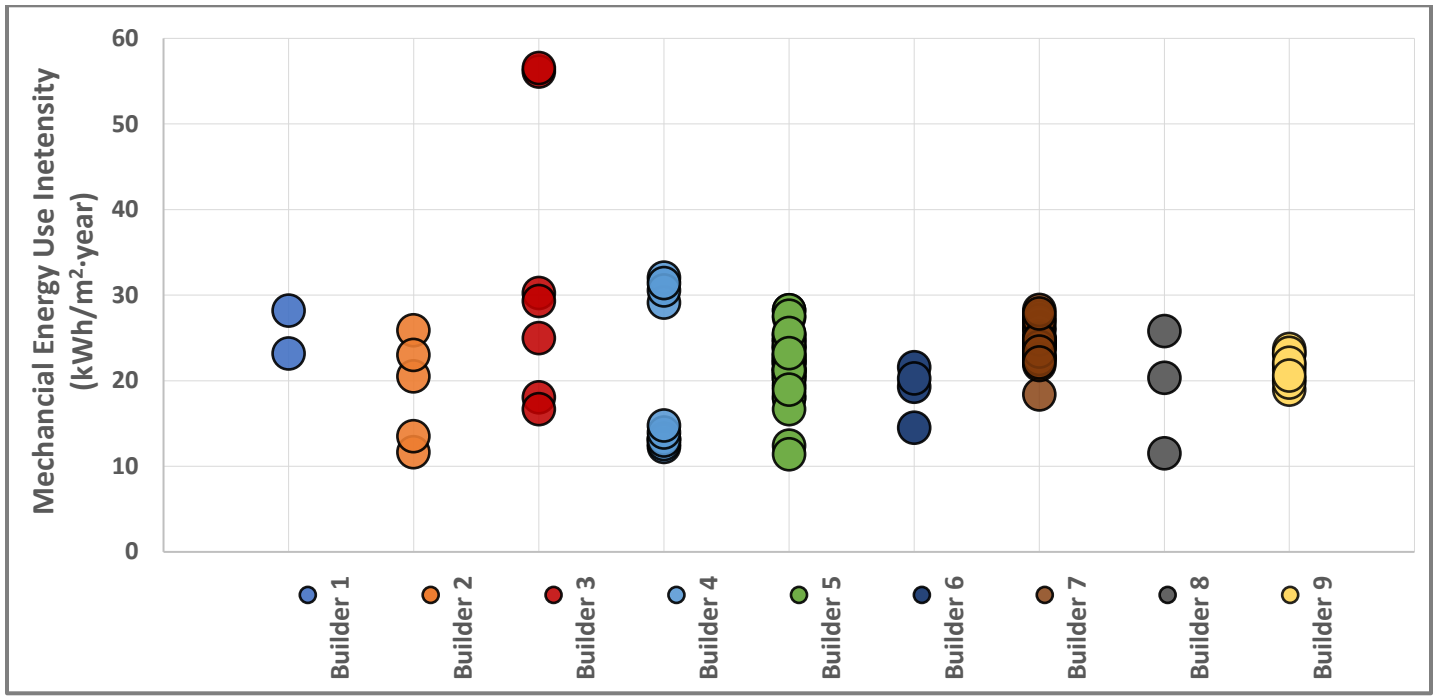

Figure 36: MEUI of Homes by Experienced Builders

PERCENT BETTER THAN REFERENCE HOUSE– ANNUAL ENERGY CONSUMPTION (REF AEC)

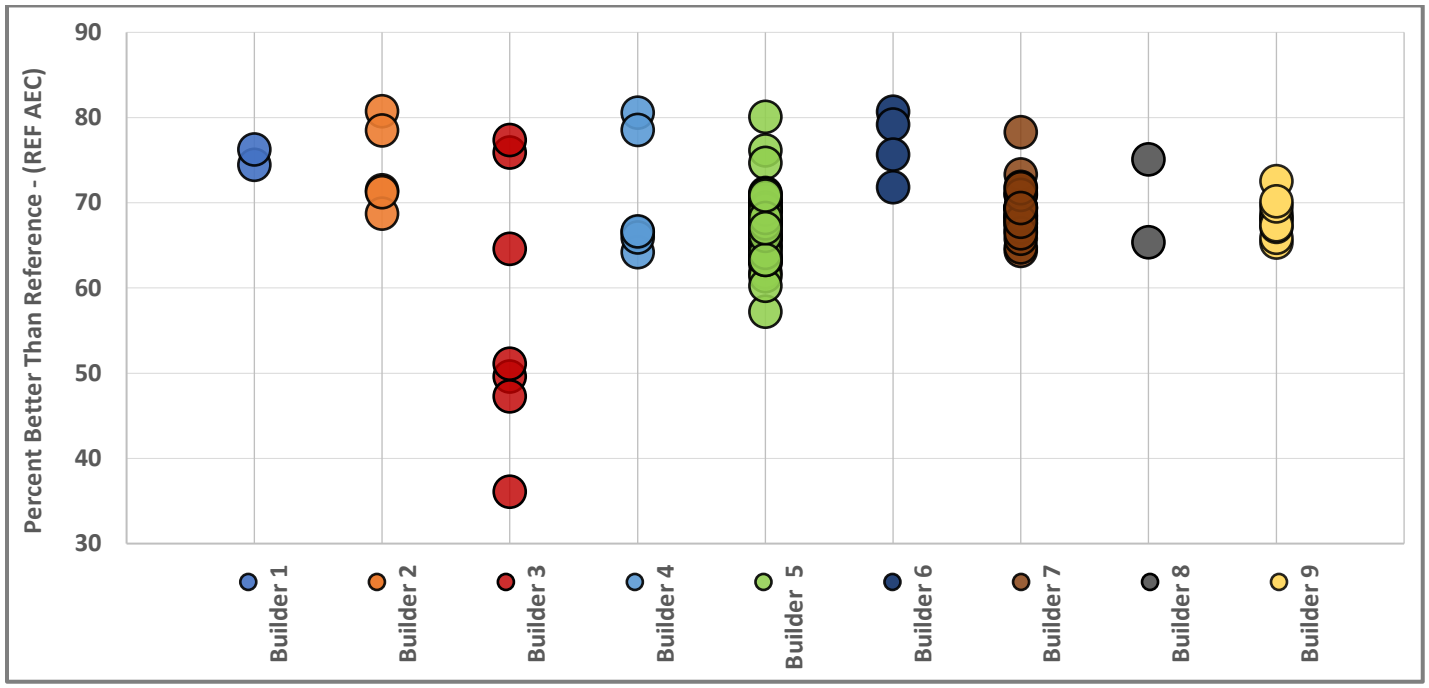

Figure 37: Percent Better Than Reference – Annual Energy Consumption (REF AEC) by Experienced Builder

PERCENT BETTER THAN REFERENCE HOUSE – ENVELOPE (REF ENV.)

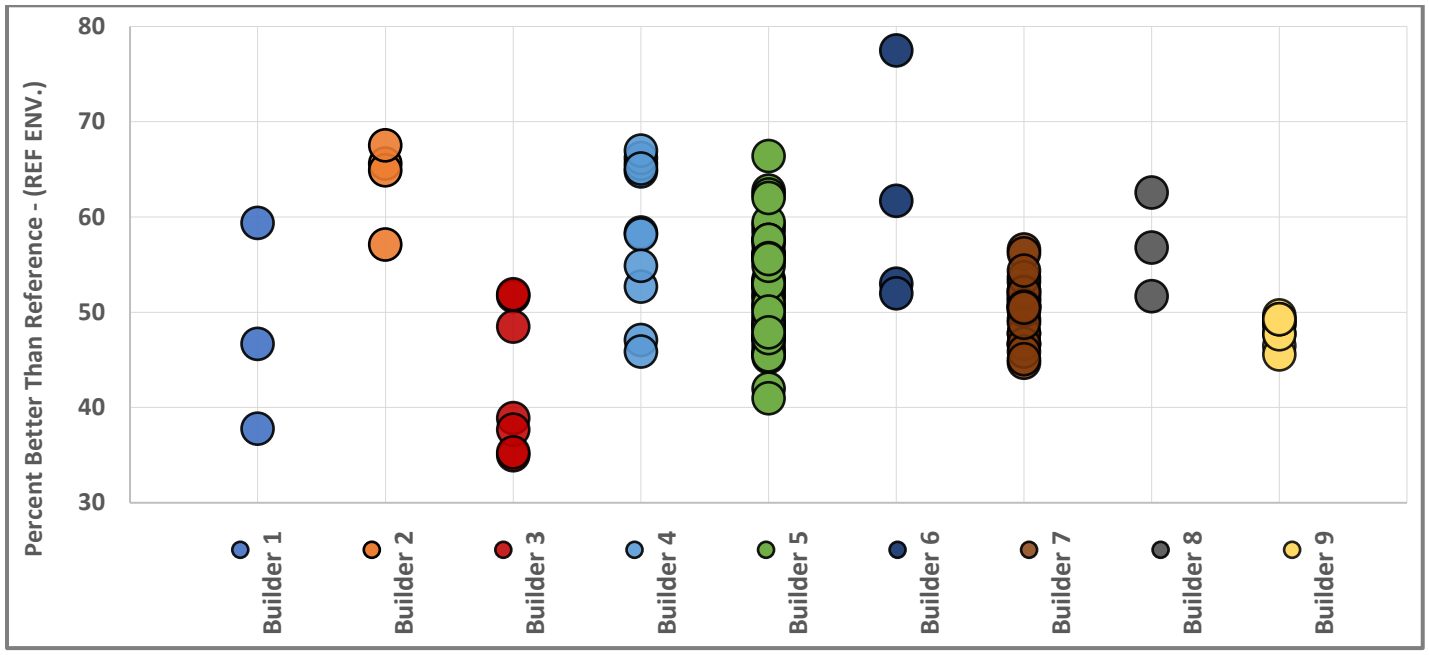

Figure 38: Percent Better Than Reference - Envelope (REF ENV.) by Experienced Builder

APPENDIX

A) Program Requirements for the Participants

- Pilot
  - Builder/Renovators:
    - Training: Must have successfully completed NRCan R-2000 Builder Training and CHBA NZ Builder Training delivered by NRCan R-2000 Service Organizations
    - License ERS: Must be licensed through NRCan to deliver EnerGuide Rating System (ERS).
    - License ESNH: Must be licensed through NRCan to deliver ENERGY STAR for New Homes (ESNH).
    - Labels NRCan: Obtain ERS, ESNH, and R-2000 label from NRCan.
    - Label CHBA: Obtain an NZ/r label from CHBA.

- Year 1-3
  - Service Organizations
    - Membership: Must be a member with the CHBA.
    - License ERS: Must be licensed through NRCan to deliver EnerGuide Rating System (ERS) v15.
    - License ESNH/R-2000: Must be licensed through NRCan to deliver ENERGY STAR for New Homes or R-2000.
    - Energy Advisors: Must employ/contract a minimum of one CHBA Qualified Net Zero Energy Advisor (EA) and ensure that they meet all the Program Requirements.
    - Training (Optional): Must employ/contract a CHBA Qualified Net Zero Trainer.
    - Insurance: Must provide proof of carrying and maintaining certain insurance policies.
  - Trainers
    - License ERS: Must be licensed through NRCan to deliver EnerGuide Rating System (ERS) v15 training.
    - License ESNH/R-2000: Must be licensed through NRCan to deliver ENERGY STAR for New Homes training for R-2000 training.
    - Qualified EA: Must be a CHBA Qualified Net Zero Energy Advisor (EA).
    - Training: Must have successfully completed an adult learning instructional skills/train-the-trainer course, and/or have experience in delivering technical training.
    - Mentoring: Must receive mentoring at their first session from a CHBA Qualified Net Zero Trainer.
  - Energy Advisors
    - License ERS: Must be licensed through NRCan to deliver EnerGuide Rating System (ERS) v15.
    - License ESNH/R-2000: Must be licensed through NRCan to deliver ENERGY STAR for New Homes or R-2000.
    - Training: Must successfully complete both CHBA Net Zero Energy Advisor Training and CHBA Net Zero Builder Training.
    - Consulting: Must successfully complete at least two (2) Net Zero Home files.
    - Insurance: Must provide proof of carrying certain insurance policies.
  - Builder/Renovators
    - License ERS: Must be registered through NRCan as an ERS builder
    - Membership: Must be a member with the CHBA.
    - Training: Must have successfully completed Net Zero Builder Training.
    - Label: Must successfully obtain their first Net Zero / Ready Label for a Home.
  - **All Qualified Participants must sign an Agreement with the CHBA whereas the CHBA has developed the Net Zero Home Labelling Program ("the Program") to recognize builders and service professionals who commit to its Administrative Requirements and recognizes houses that these builders and service professionals attest to meeting the Technical Requirements.**

B) Program Requirements for the Homes

- Pilot
  - ENERGY STAR for New Homes Certified
  - R-2000 Certified
  - Fenestration installed as per ESNH 4.2.3.1
  - Doors installed as per ESNH 4.2.3.2
  - Space cooling installed as per R-2000 NZE Pilot Space Cooling threshold manual calculation spreadsheet (.xslx)
  - NZE: Renewable energy system installed (Custom CHBA NZ Requirement)
    NZr: Renewable energy system designed (Custom CHBA NZ Requirement)
  - Energy monitoring system installed (Custom CHBA NZ Requirement)

- Year 1-3
  - **Net Zero Homes**
    - Comply with CHBA Net Zero Home Labelling Program Year 1 Technical Requirements
    - 3 HOT2000 files modelled with the renewable energy system to 0 GJ:
      - Building Envelope Design Model
      - Space Cooling Evaluation Model
      - Proposed Design Model
    - Building Envelope / Space Cooling (BE/SC) Evaluation Tool (.xls)
    - PV System Commissioning Report
  - **Net Zero Ready Homes**
    - Comply with CHBA Net Zero Home Labelling Program Year 1 Technical Requirements
    - 3 HOT2000 files modelled with the renewable energy system to 0 GJ:
      - Building Envelope Design Model
      - Space Cooling Evaluation Model
      - Proposed Design Model
    - 3 HOT2000 files modelled without the renewable energy system:
      - Building Envelope Design Model
      - Space Cooling Evaluation Model
      - Proposed Design Model
    - Building Envelope / Space Cooling (BE/SC) Evaluation Tool (.xls)
    - PV Ready Checklist