



Photo courtesy of the Government of Yukon

NET ZERO ENERGY READY IN THE YUKON - REPORT FOR PART 9 HOMES (NBC)

TECHNICAL REPORT ON ACHIEVING
NZER IN BUILDING CODES



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OVERVIEW

Net Zero Energy Ready (NZER) is, as further clarified in this report, defined as a building

- that achieves the highest energy tier of the national model codes; and
- that can offset its modeled annual energy use with renewable energy produced on-site or in the local community.

NZER can be achieved by a combination of measures such as more energy efficient building design, mandating air tightness testing, and installing heat pumps (cold-climate or hybrid).

Barriers to adoption should be addressed prior to implementing NZER across the Yukon.

INTRODUCTION AND BACKGROUND

To support the progressive improvement of energy efficiency in new buildings and the transition toward net-zero-energy-ready (NZER) construction through building codes, the Government of Yukon engaged Andrew Pride Consulting to identify opportunities and challenges associated with achieving this objective.

The project involved several components, including a cross-country jurisdictional scan, technical engagements with industry stakeholders and partners, and developing a path to NZER. A *Discussion Paper: Preparing for Net-Zero-Energy-Ready Codes in the Yukon* was developed to describe the findings from the project activities, including the tiered energy code plan for new construction in the Yukon. The discussion paper included both homes constructed under Part 9 of the National Building Code of Canada (NBC) and the larger buildings covered by the National Energy Code of Canada for Buildings (NECB).

This report recommends a definition of NZER for the Yukon and how NZER can be achieved for new homes in the territory. A separate report is provided for buildings that apply to the NECB, however, the definition of NZER will remain consistent between the two codes.



ENERGY TIERS

The 2020 edition of the National Building Code of Canada (NBC) included the introduction of progressive performance tiers to provide a framework to achieve higher levels of energy use performance. Authorities having jurisdiction can adopt and increase energy efficiency performance levels at their own pace and set a predictable roadmap for industry to move to higher performance. The five energy performance tiers for homes and small buildings (NBC 2025 Section 9.36.) are illustrated in Figure 1.

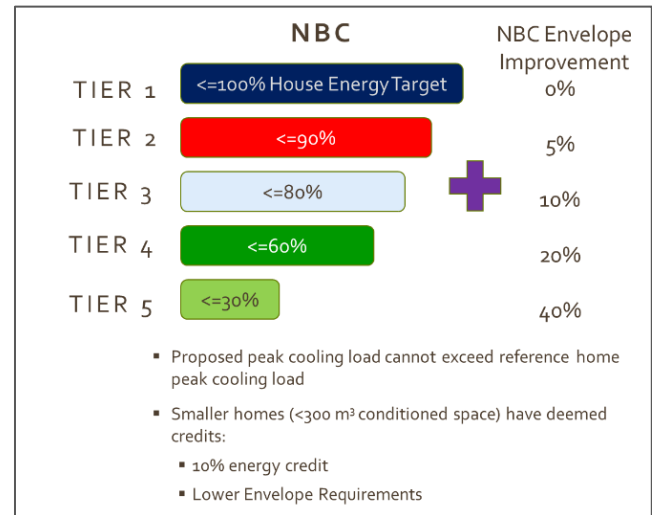


Figure 1: Energy Tiers in the NBC as a Percent of Energy Target

Tier 1 performance is equivalent to the requirements established in the 2012 edition of the 2010 NBC. Many jurisdictions, including the Yukon, have now exceeded the Tier 1 performance level either through the support of regulations or voluntary action by builders.

The NBC offers multiple methods of compliance to verify that a specified tier has been attained. At the discretion of the builder, any of the following paths may be pursued:

1. Energy modeling a reference and proposed house to demonstrate a percent improvement over base code. (NBC 2025 Sub-Section 9.36.7)
2. Select from a list of energy conservation measures provided in the code. Each measure has energy conservation points provided. The conservation points are added together until the total reaches the amount needed for each Tier. (NBC 2025 Sub-Section 9.36.9.)
3. Comply with the National Energy Code of Canada for Buildings. (NECB)
4. Compare the modeled energy use for the proposed house against a calculated energy use intensity metric. (NBC 2025 Sub-Section 9.36.8.)

CITY OF WHITEHORSE BUILDING AND PLUMBING BY-LAW

In June 2014, the City of Whitehorse introduced energy efficiency requirements in its building and plumbing by-law. This effort significantly improved the energy efficiency in the City and influenced improved energy performance across the territory. In addition, the by-law required all new homes to have an energy label. The labeling provides a wealth of data on energy performance which was used to guide the recommendations in this report.

YUKON CONSTRUCTION PERMITS

Construction activity in the Yukon is growing, with new residential construction permits doubling from 214 to 429 annually over the past ten years (excluding anomalous peaks in 2020/2021). Figure 2 shows the permit trends. Over the decade, approximately 70% of new homes were constructed in the City of Whitehorse. Figure 3 provides a sense of the distribution of permits across different regions in 2023.

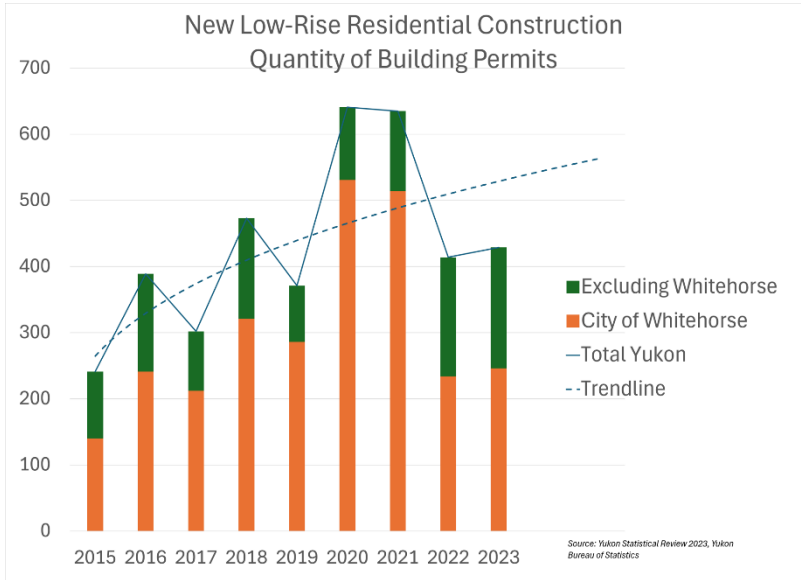


Figure 2: New Residential Building Permits by Year in the Yukon

2023 RESIDENTIAL PERMITS (New Construction)		
YUKON	QTY	\$000
WHITEHORSE	246	52,830
CARMACKS	7	590
DAWSON CITY	23	1,453
HAINES JUNCTION	21	1,971
WATSON LAKE	12	10,124
OTHER	120	14,955

Figure 3: New Residential Building Permits by Geography



NET ZERO ENERGY READY - DEFINITION

Stakeholder and partner discussions on accelerating to net-zero energy ready (NZER) set the context for an appropriate definition of NZER. Figure 4 provides an illustration of the prioritization of the NZER definition. Across Canada, net-zero energy is a relatively vague term used to describe a building whose annual energy consumption is offset by renewable energy production. Net-zero energy *ready* describes a building whose annual energy consumption *could* be offset by renewable energy production, if, or when, a renewable energy system supplies power to the building. The term “net” implies that the renewable energy does not need to be coincident with the minute-by-minute energy used. Most commonly, net refers to the average energy used in a year being offset by the average energy produced in a year. The challenge can be in the technical requirements to meet “net-zero energy”. The national code system effectively side-steps the definition by not having it as a defined term. The top tiers are anticipated to be equal to the performance of a net-zero energy ready building.

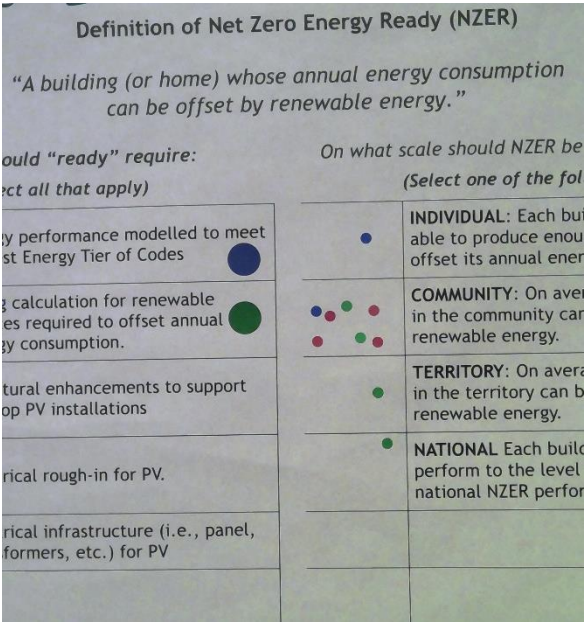


Figure 4: Sample of NZER Definition Poll from Technical Engagements

OVERALL DEFINITION

The recommended definition of NZER for all building types in the Yukon is:

- Net Zero Energy Ready (NZER) is defined as a building
- that achieves the highest energy tier of the national model codes and
 - that can offset its modeled annual energy use with renewable energy produced on-site or in the local community.

To further clarify the definition:

1. The highest Tier in the model codes is Tier 5 of the National Building Code of Canada (NBC) (applies to homes constructed under Part 9 of the NBC) and Tier 4 of the National Energy Code of Canada for Buildings (NECB) (applies to larger buildings).
2. The energy modeling will comply with the requirements outlined in the NBC or NECB and reflect as-built conditions.
3. The on-site or local renewable energy can be installed at a future date.

OTHER CONSIDERATIONS

The recommended definition provides a flexible option for the Yukon. For builders who wish to exceed the definition, they may consider the following options:

- A. Providing (on-site or community) photovoltaic generation systems (PV) to offset the annual energy use.
- B. Structurally reinforcing the roof for the future PV installation.
- C. Sizing the electrical service to accommodate future PV and heat pump technology (where applicable).
- D. Obtaining an engineering or utility opinion that the electrical infrastructure supplying the home or building is capable and sufficient for on-site renewable energy.

NZER TECHNICAL SPECIFICATIONS

Home builders in the Yukon are, on average, achieving NBC's Tier 4, with all but three of the homes tested achieving at least Tier 3. Figure 5 provides an illustration of new home performance¹ over the past decade. The recommended approach to achieve NZER in code is for the Yukon to incorporate progressive energy tiers across the territory. The most flexible approach is to provide multiple compliance paths from which builders can select.

There are several compliance options for Tier 5, or NZER performance. Builders can use an energy model comparing a reference and proposed house; they can use a prescriptive points path; or the new energy use intensity path. Further, in 2025 there will be a prescriptive solution that can be adopted (NBC 2025 Sub-Section 9.36.14.). However, that path has limited flexibility, is estimated to have an incremental cost² of up to \$40,000, and doesn't necessarily build from the current construction practices in the Yukon. Alternatively, it is recommended that a prescriptive path starting with the City of Whitehorse's prescriptive list³ is augmented with builder-selectable energy conservation measures found in NBC 2025 Sub-Section 9.36.9.

In any of the prescriptive paths, it is highly recommended, as is required in Whitehorse, to mandate air leakage testing, as this is a critical and needed element to achieving NZER. Guidelines on air leakage testing would also be helpful (e.g., use of Registered Energy Advisors, testing prior to drywall and then again at completion).

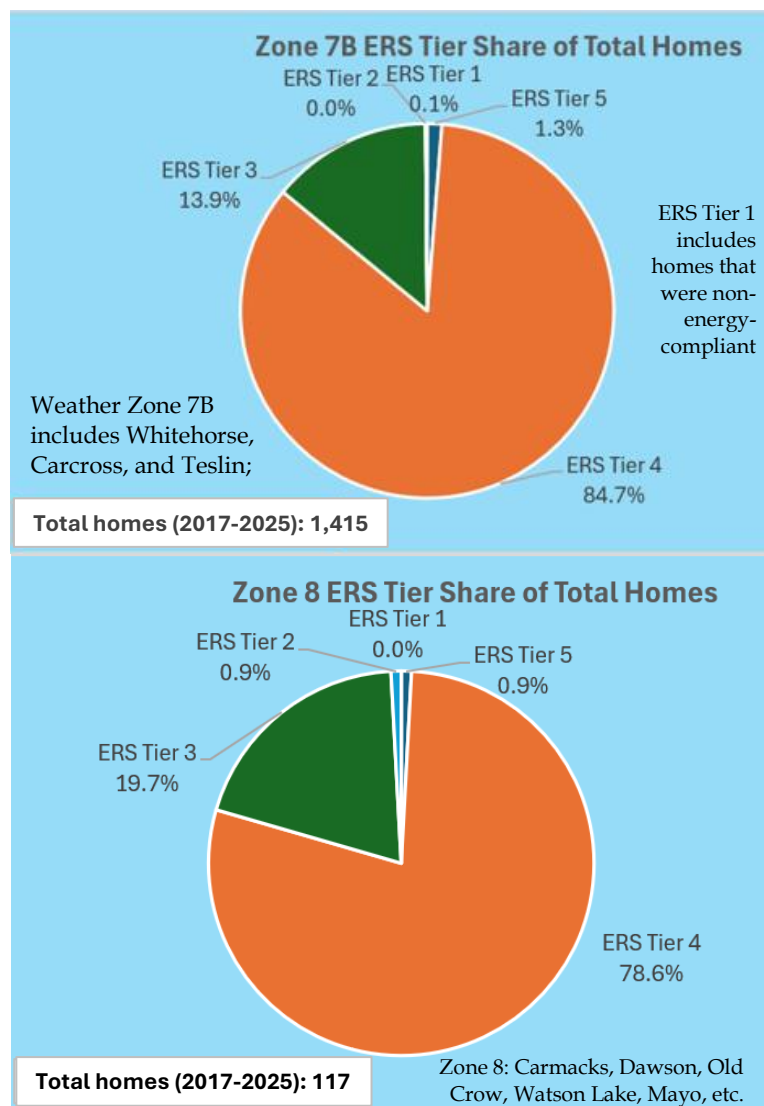


Figure 5: Energy Performance of New Homes Constructed, and tested, from 2017-2025.

¹ Based on an analysis of NRCan dataset of EnerGuide Rated new homes in the Yukon.

² Per NBC Proposed Change Form (PCF) 1830 compared to a Tier 1 home.

³ Thermal insulation values to be clarified as effective values, not nominal

MODELING PATH - ERS

The modeling path in the NBC 2025 Sub-Section 9.36.7., allows a builder to model the energy used by their proposed house to a house energy target. The code provides a rule set for the models that calculate energy consumption from space-conditioning, service water, and ventilation systems. The house energy target is the hypothetical energy used by the proposed house had it been built to the minimum prescriptive requirements. The proposed house energy use is then compared to the energy target to establish which tier has been achieved. This is the most flexible approach for builders as it allows full customization of the energy efficiency measures selected to achieve higher performance. The EnerGuide rating system (ERS) is an acceptable compliance tool.

PRESCRIPTIVE PATH

The prescriptive requirements to meet the City of Whitehorse by-law have helped transform the new home building industry into leaders in energy efficiency. By using the Tiered Energy Compliance: Points-based Prescriptive Trade-off Path (NBC 2025 Sub-Section 9.36.9.), the by-law requirements can be translated into “energy conservation points”. Figure 6 outlines the measures⁴ that exceed minimum NBC requirements and the associated points for each measure (other measures required in the by-law are minimum code). Tier 3 requires⁵ 20 points and Tier 4 require 40 points. As shown, the by-law achieves Tier 3 performance requirements. Further, if a home has an internal volume less than 300m³ (e.g., 1,300 ft² home with 8-foot ceilings), it qualifies for an additional 10 points, moving those homes to approximately 34 points – very close to Tier 4.

City of Whitehorse By-Law	Points ⁶ for Climate Zone 7B	Points for Climate Zone 8
Walls above grade – RSI 4.9 (R28)	4.97	4.87
Foundation Walls including below grade – RSI 4.9 (R28)	0.90	0.00
Ceilings throughout – RSI 10.57 (R60)	0.25	0.25
Windows and glazing installed shall have a minimum thermal resistance U value of 1.4W/m ² •K (R4)	0.58	0.62
The building envelope of new dwelling units shall be constructed with a maximum 1.5 air changes per hour at 50 Pa	8.5	9.7
Adder for unguarded air leakage testing	4.3	4.8
Heat recovery ventilators with a sensible recovery efficiency of 64% or more at an outside winter design temperature of -25°C.	4.1	3.86
Total prescriptive points:	23.6	24.1

Figure 6: City of Whitehorse Building and Plumbing By-Law, Energy Points for Elements Exceeding Minimum Code

Progressing from Tier 4 (40 points) to Tier 5 (70 points⁷) using prescriptive solutions involves adding one or more additional energy conservation measures to the highly insulated wall systems currently being constructed in the Yukon.

⁴ The Energy Points assume the by-law uses effective RSI values, the by-law does not specifically state effective or nominal (nominal would provide slightly fewer points than effective).

⁵ Each Tier also has minimum building envelope requirements.

⁶ Points based on 2025 Edition of the NBC (Proposed Change Forms 1834, 1838, 1888, and 1890).

⁷ Tier 5 is 75 points except for Zone 7B and 8 which requires 70 points

Examples of prescriptive energy conservation measures to augment the current construction practice:

1. Install a cold climate⁸ air source heat pump; this can add approximately 20-34 points to the home's energy savings.
2. Upgrade the windows to a thermal transmittance of 0.82 W/(m²×K) (R6.9); this can add approximately 10 points to the home's energy savings.
3. Improving air tightness from 1.5 air change per hour (ACH) to 0.6 ACH@50pa; This can add approximately 8 points to the home's energy savings.

These energy conservation measures are a sample of many that are provided in the NBC's Tiered Energy Compliance: Points-based Prescriptive Trade-off Path (NBC 2025 Sub-Section 9.36.9.).

ENERGY USE INTENSITY PATH

The NBC's 2025 Edition includes a new compliance path referred to as "energy use intensity" or EUI (NBC 2025 Sub-Section 9.36.8.). The EUI allows a more refined approach to energy compliance, scaling to home size and heating-degree-days⁹ (HDD).

The NRCan dataset of EnerGuide Rated homes used previously (to determine compliance through traditional modeling over the past decade), was analyzed again, but this time using the EUI path. Using the EUI path revealed that more homes in the Yukon are achieving higher tiers than previously calculated, when using the traditional modeling or prescriptive compliance paths. Figures 7 and 8 illustrate the 2017-2025 performance of homes using the EUI approach.

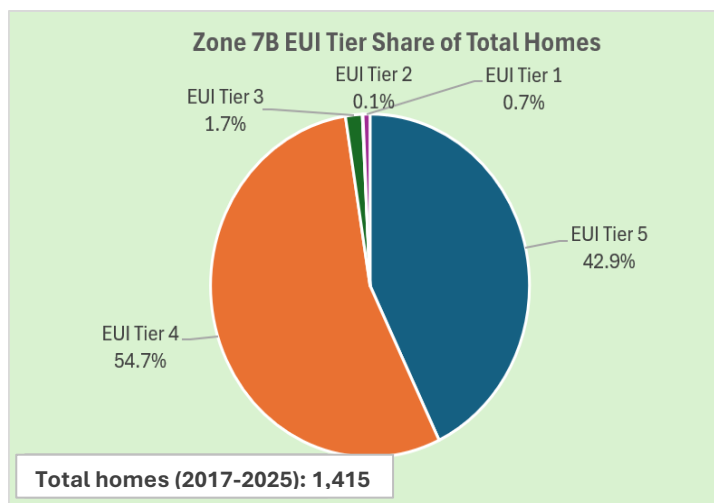


Figure 7: 2016-2025 Energy Tier Performance for Zone 7b Using Energy Use Intensity Compliance Path

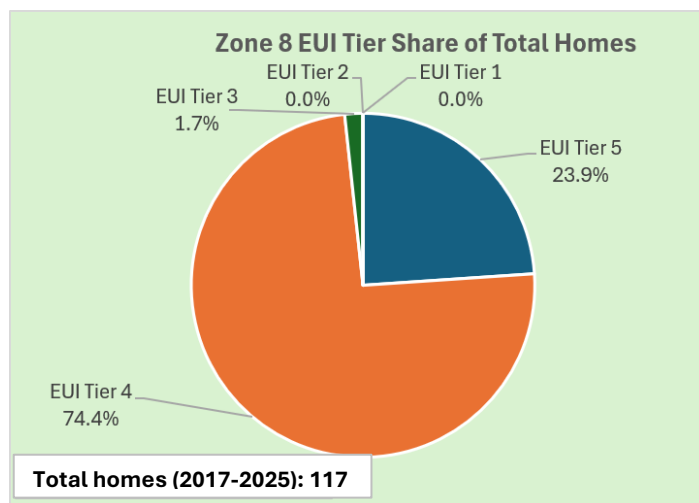


Figure 8: 2016-2025 Energy Tier Performance for Zone 8 Using Energy Use Intensity Compliance Path

The EUI path results in 42% of homes, in climate zone 7B, achieving Tier 5 compliance compared to only 1.3% using the traditional compliance calculation. Zone 8 also showed an increase from 1% to over 20% of homes that would be Tier 5 compliant. This highlights the additional performance flexibility for smaller homes and homes in Canada's colder climates.

⁸ A cold climate heat pump has a rated coefficient of performance greater than or equal to 1.8 at -15°C, and a rated capacity at -15°C that is greater than or equal to 70% of its rated capacity at 8.3°C.

⁹ HDD is a measure of how many degrees the average daily temperature is below a specific value (typically 18°C)

As builders can select the compliance option used to calculate the energy tier, Figure 9 shows that no tested homes fell below Tier 3, and more than 98% achieved Tier 4 or Tier 5.

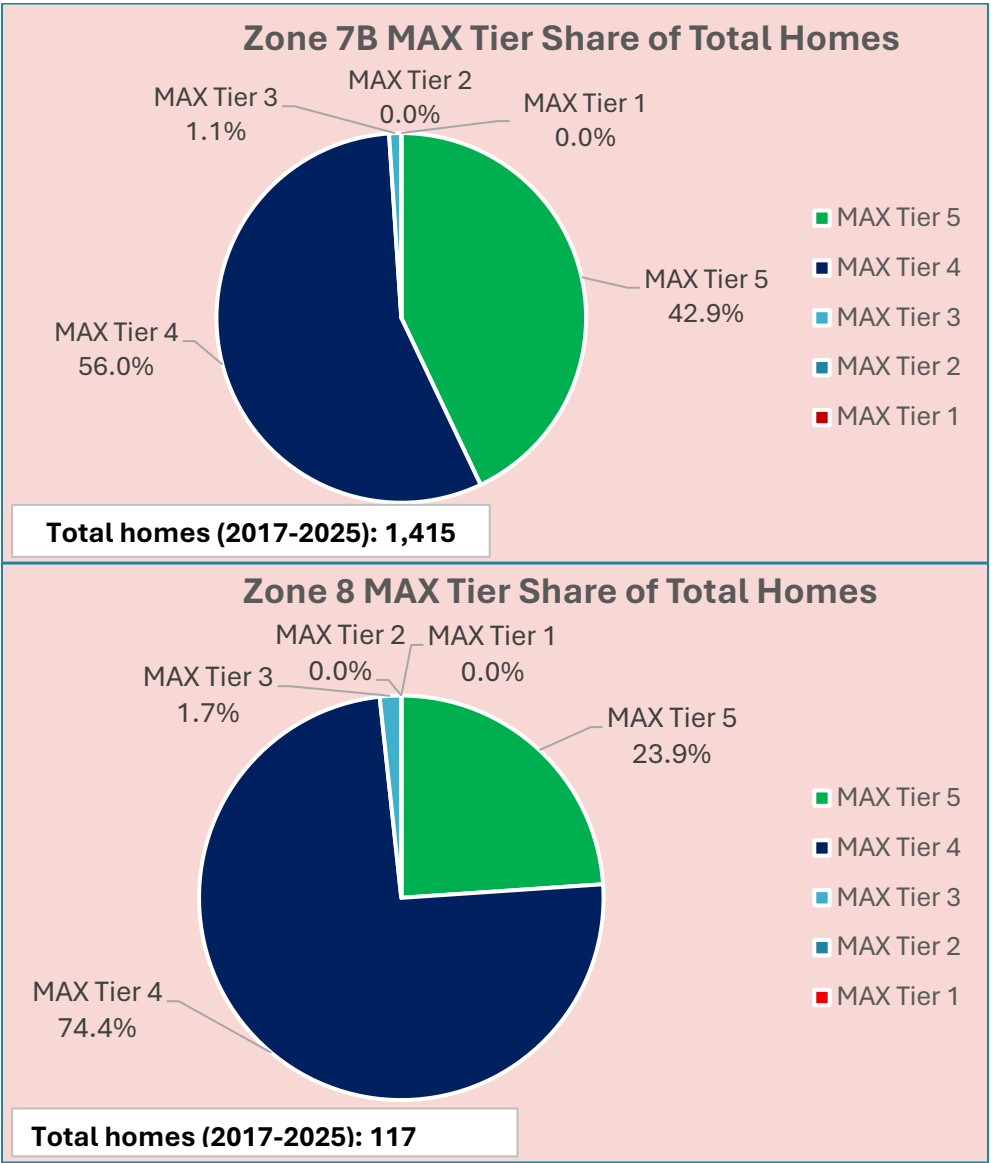


Figure 9: Historical energy performance of homes tested between 2016-2025 using the higher outcome of ERS and EUI methodology

CHALLENGES

The technical engagements with the Yukon industry revealed many strengths and challenges in advancing to NZER codes.

STRENGTHS	CHALLENGES
• Currently achieving strong results • Engaged builder community • Relatively small number of homes per year • Air tightness testing standard • Incentive programs • Government distribution of vacant land • Leverage high cost of energy to drive high energy efficiency in buildings	• Geographical separation of northern communities, and, generally, areas outside Whitehorse • Limited supplier and trade networks • Low understanding of non-energy benefits • Electricity supply shortage/ Connection challenges including diesel-fueled electricity • Misunderstanding of “Ready” aspect of NZER

The primary areas of concern can be articulated in topic areas: electricity supply, technical capacity, cost, and clearer understanding of the requirements.

ELECTRICITY SUPPLY

Conditioning a space with a heat pump provides substantial energy savings compared to baseboard or propane heat. However, switching from propane (or wood) to heat pumps typically requires a larger electrical panel and service for the home. This means that there needs to be sufficient capacity on the electricity system to supply the heat pump. Areas serviced by diesel generators tend to have limited capacity. As such those areas will require a more detailed investigation to achieve NZER. As shown in this report, there are solutions that can be implemented without heat pumps. Alternatively, a common solution is to use a hybrid heat pump, which optimizes the use of heat pump compressors when they run more efficiently and switch to propane for the much colder days (e.g., below -10°C). This balance provides excellent energy savings and reduces the capacity needs for the electricity system.

The Discussion Paper identified actions regarding electricity supply, which should help enable heat pumps once capacity in the constrained areas is resolved.

TECHNICAL CAPACITY

There are several solutions that will unlock NZER performance for new homes. Builders will need access to those solutions and assistance in establishing their individual recipes for NZER. Most progressive builders use Registered¹⁰ Energy Advisors (REA) to help evaluate options that suit the builder’s needs. REAs can also evaluate the most suitable option (i.e., prescriptive, performance, or EUI) compliance option. Having access to REAs across the Yukon was identified as a challenge. The Discussion Paper outlines several steps to help build capacity and provide builders with needed information to achieve NZER performance.

COST

Building from current construction practices in the Yukon, there are many ways to create a new NZER home. Costs can vary between jurisdictions and over time and can also change based on supply-demand balance. To provide a rough estimate on achieving NZER today, the incremental costs¹¹ for the energy conservation measures discussed earlier¹² are:

<i>Energy Conservation Measure</i>	<i>Estimated Incremental Cost Per Home</i>
<i>Windows (u-value 0.82; ER 44)¹³</i>	<i>\$2,000-\$2,500 for 20m² of window area</i>
<i>Cold Climate Air-Source Heat Pump¹⁴</i>	<i>\$7,000-\$24,000</i>
<i>Air Leakage¹⁵ 0.6 ACH₅₀</i>	<i>\$3,700-4,023</i>
<i>Approximate total</i>	<i>\$12,700-30,523</i>

These rough estimates are a sample of one scenario. A builder may develop their own cost-optimized list of solutions or model their home using the performance or EUI methodology. Having an incentive program, aligned with the energy tiers, to overcome the incremental cost of NZER would greatly improve early adoption of NZER.

UNDERSTANDING

Developing a clear understanding of NZER requirements is important. Again, the Discussion Paper identifies several options to help build a common understanding and tools to help the industry build higher performing homes.

¹⁰ Registered with NRCan
¹¹ Costs were extracted from Codes Canada 2023 public review of proposed changes to the NBC (PCF). Actual incremental costs will vary.
¹² Assumes City of Whitehorse by-law, using effective RSI values, is the starting point (i.e., \$0 incremental cost)
¹³ PCF 1889 - \$102-111/m²
¹⁴ PCF 2001
¹⁵ PCF 1888

NEXT STEPS AND CONCLUSION

NEXT STEPS

The key and urgent activities are:

- Develop training material specific to the design and construction of energy efficient buildings in the Yukon.
- Develop a program to encourage and retain more skilled trades available across the territory.
- Continue collaboration with the electricity supply chain, identifying and resolving capacity constraints.
- Review incentive structure to realign it with the energy efficiency tiers in advance of the tier's enforcement date to encourage early adoption of higher tiers. Refresh incentives when new tiers are enforced (i.e., lower incentive for mandated tiers and increase incentive for higher tiers).



FUTURE SENSING

The 2025 edition of the NBC also includes operation greenhouse gas (GHG) emissions; and the 2030 edition is expected to include on-site renewable energy. These items should be monitored for potential impact on building code for the Yukon.

Operational GHG is a separate measurement tool that allows jurisdictions to, in addition to energy tiers, define a trajectory for emissions generated by the building's equipment and from the electricity system. Level A represents an emission savings of 90% or more, while Level F represents less than 10% improvement. The baseline approximates a gas-fueled heating and domestic hot water system. It is not expected that the operational GHG requirements will impact the NZER recommendations outlined in this report, however, it may influence the types of systems selected to achieve NZER. For instance, heat pump technology in lieu of propane furnaces will deliver an improved operation GHG performance.

While the requirements are currently in progress with the national code committees, on-site renewable energy is expected to enable a scaled credit for higher energy tiers. This may ease the requirement for achieving Tier 5 in time for its enforcement date. It is expected that builders will have the flexibility to consider small PV systems on their homes as one of the prescriptive measures contemplated to achieve NZER. More details should be available by 2029 when proposed changes are out for public review. Overall, the on-site renewables do not negatively impact on the recommendations outlined in this report.

CONCLUSION

Achieving NZER in the Yukon for new Part 9 homes is feasible today. Many new homes constructed over the past decade have already met NZER requirements. Supporting the remainder of new homes in meeting higher energy tiers may involve some adjustments to traditional home construction practices; however, the overall changes are not extensive. Appropriate information and training, as well as a focused incentive program to assist with the initial costs should enable a successful transition as outlined in the NZER discussion paper. It will be critical to keep the industry informed with sufficient notice to allow for the transition.

Stakeholders and Partners stressed the need for transparent, reasonable timelines that provide the industry with sufficient time to adapt to higher energy performance, and that they are prepared to adapt.