

BUILDING SCIENCE LIVE

NOVEMBER 16, 2022

Net-Zero Energy and Carbon Building Design: Feasibility in Northern Canada and Alaska

Robin Urquhart MBS, MNRES, CEA





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- Some FAQs:
 - You will get a follow-up email regarding how to access the recording and a pdf of slides.
 - **If you need a completion certificate for self-reporting or Phius CPHC, EPP, and/or AIA or AIBC credits, please follow the link in the chat box to let us know.**
- Please use chat for housekeeping questions.
- Please use Q&A box for questions for the speaker.
 - We will break at the end for questions.
 - Use upvote feature to let us know what you're most curious about!

More questions? Please contact us at events@learnbuildingscience.com.



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Robin Urquhart

Robin is a building scientist, certified energy advisor and carpenter and has been with RDH since 2013. He is also the Building Science Specialist on staff at Yukon University. Born and raised in Whitehorse, YT he has specialized in northern construction practices, material testing, building diagnostics and guide development. With a background in construction, Robin is focused on practical solutions that work in the North. Robin is completing work on his own house that will be British Columbia's northernmost Energy Step Code - Step 5 (net-zero ready) building.



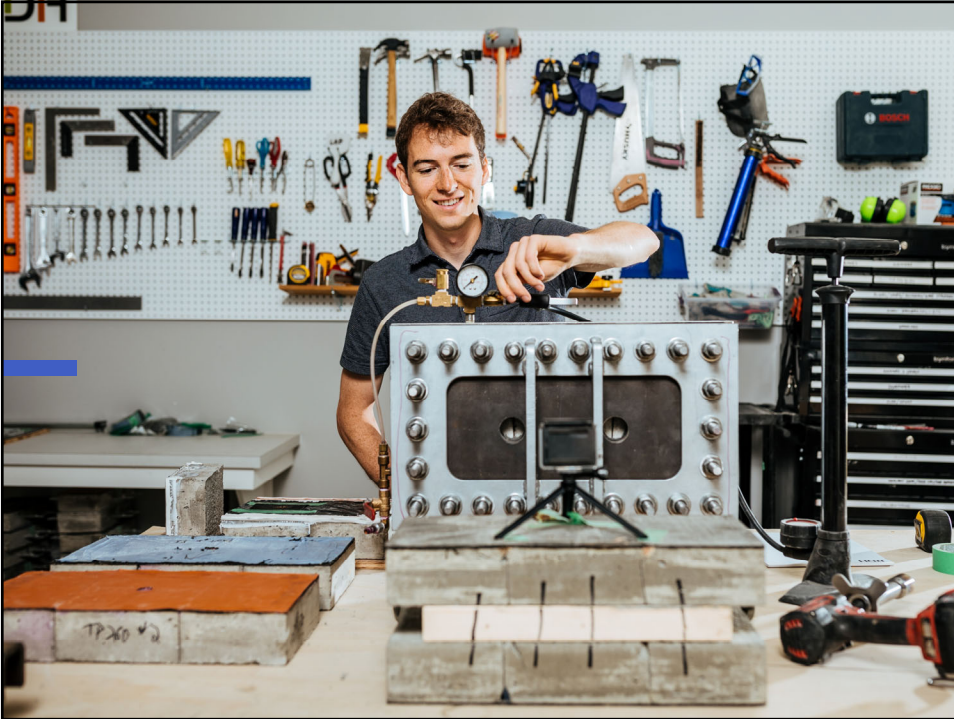
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A photograph of two men in a workshop or laboratory setting. They are both looking at a piece of equipment on a table. The man on the left is wearing a green shirt, and the man on the right is wearing a white shirt. The background shows wooden beams and other equipment.

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Education for Professionals

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Poll Question: Where do you primarily practice or operate?

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Agenda and Key Questions

1. Definition net-zero and 'the North'
2. Net-zero Energy design approach
3. Net-zero Energy case studies
4. Net-zero Carbon design approach
5. Net-zero Carbon case study
6. Key takeaways

- How feasible is net-zero in the North?
- What does it look like?
- Why are we doing this?



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What does Net-zero mean?

→ Inputs - outputs = zero

→ Net-Zero Energy

- *a building produces as much energy as it uses on an annual basis*
- Energy is measured in GJ
- Includes all fuel types

→ Net-zero Carbon

- *A building negates the amount of greenhouse gas emissions resulting from various phases of its existence*
- Carbon = carbon dioxide equivalent = GHG emissions
- Carbon is measured in t CO₂e
- *Net-zero Emissions*
- *Carbon Neutral*

Net-zero Carbon

Net-zero by 2050

Net-zero Emissions

Net-Zero Energy

Net-zero Operational Carbon

Zero Carbon Building

Net-zero Energy Ready

Carbon Neutral

Near to zero



BILL C-12
CANADIAN NET-ZERO EMISSIONS
ACCOUNTABILITY ACT

S.C. 2021, c. 22

Assented to 2021-06-29

Act respecting the accountability of the Government of Canada in Canada's efforts to achieve net-zero greenhouse gas emissions by 2050

Preamble

Whereas the science clearly shows that human activities are driving unprecedented changes in the Earth's climate system, which poses significant risks to human health and security, to the environment, including biodiversity, and to economic growth;

Whereas Canada has ratified the Paris Agreement, done in Paris on December 12, 2015, which entered into force in 2016, and under that Agreement has committed to set and communicate ambitious national objectives and undertake ambitious national measures for climate change mitigation;

Whereas the Paris Agreement seeks to strengthen the global response to climate change and reaffirms the goal of limiting global temperature increase to well below 2°C above pre-industrial levels, while pursuing efforts to limit that increase to 1.5°C;

Whereas, the Intergovernmental Panel on Climate Change concluded that achieving net-zero greenhouse gas emissions by 2050 is key to keeping the rise in the global-mean temperature to 1.5°C above pre-industrial levels and minimizing climate-change related risks;

Whereas the Government of Canada is committed to achieving and exceeding the target for 2030 set out in its nationally determined contribution communicated in accordance with the Paris Agreement.



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Where is the North?

→ Depends on the context

→ Canadian/American building science context = climate zones 7 and higher

→ Also defined by challenges

- Cold
- Dark
- Big
- Remote
- Decentralized
- Lacks resources



ASHRAE

CZ - 7

CZ - 8

CZ - 4

CZ - 5

CZ - 6

CZ - 7a

CZ - 7b

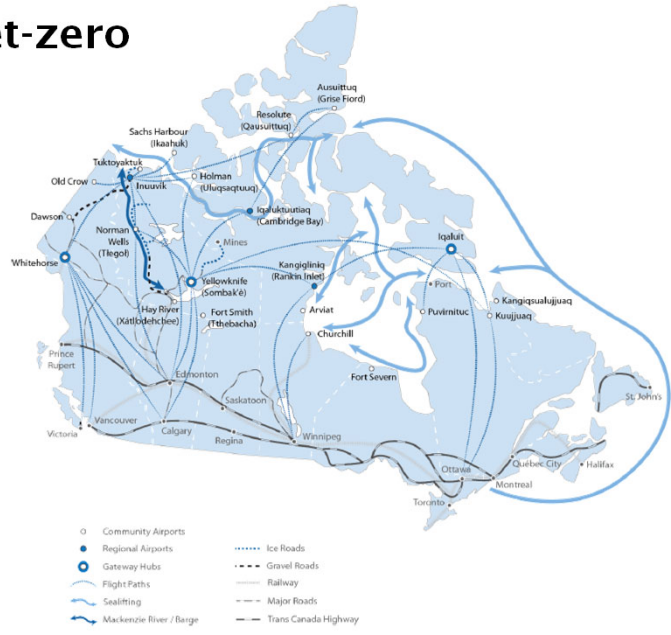
CZ - 8



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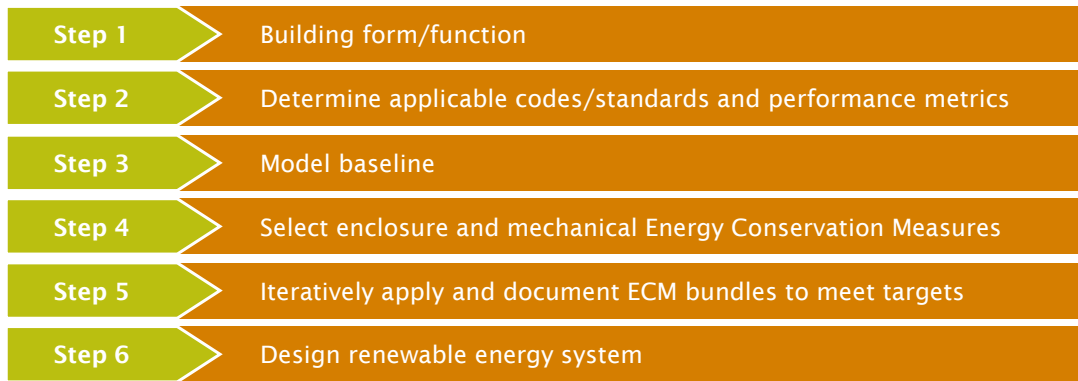
How do we approach net-zero design in the North

- Approach net-zero design the same for all regions
- Specific considerations have to be taken into account that inform design
 - Site
 - Transportation
 - Practical limitations
 - Building season
 - Energy production capacity
 - Building standards
 - Cost



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Approach for Net-zero Energy

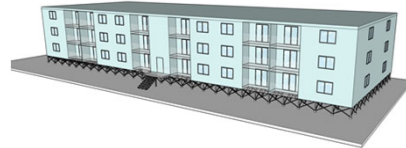
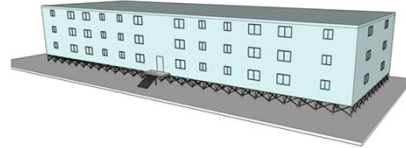


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Net-zero Energy

Step 1: Design building form and function

- Type
- Functional program
- Massing
 - Articulations matter!
 - Fenestration/door-to-wall ratio (FDWR) and orientation matter!
- Material selection



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Net-zero Energy

Step 2: Determine applicable codes/standards and performance metrics

- Code minimum
- Choose the right performance metrics

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Energy efficiency building direction

Net-zero Energy

- Canada
 - National Building Code (NBC) 2020
 - BC Step Code 2018 (Steps 1-5)
 - National Energy Code for Buildings (NECB)
 - Passive House Institute (PHI)/PHIUS
 - Municipal bylaws/requirements

- Alaska
 - Patchwork of building codes by municipality/borough (International Building Code 2018)
 - Alaska Housing Building Energy Efficiency Standard (not-statewide, required for state financial assistance)
 - PHI/PHIUS



Government of Canada

Canada.ca > Natural Resources Canada > Canada's national energy efficiency strategy

The energy efficiency strategy

The National Energy Code for Buildings (NECB) applies to provinces and territories elect to w... Provinces and territories may also choose to... For more information, visit the Canadian Codes Centre website.

Alberta Building Code

- Alberta Building Code
- Safety Codes Act

British Columbia Building Code

- BC Building Code
- BC Energy Step Code
- Building Act 2000
- White papers: Net-zero Energy Buildings
- Government of British Columbia
- City of Vancouver

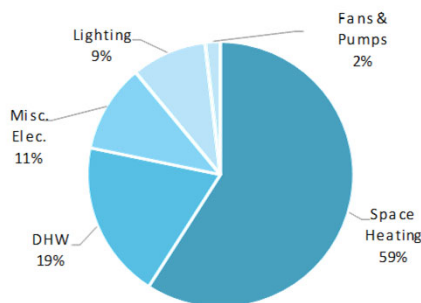
| ASSEMBLY | EFFECTIVE RSI [m ² K/W] | EFFECTIVE R-VALUE [ft ² °F/htu] |
|--------------------------------------------------|------------------------------------|--------------------------------------------|
| Walls (above grade) | 5.28 | 30 |
| Walls (below grade) | 4.96 | 28 |
| Attic ceilings/roof | 10.6 | 60 |
| Cathedral ceilings/roof | 7.0 | 40 |
| Slab on ground | 5.64 | 32 |
| Exposed floor | 7.0 | 40 |
| Floors above unheated space | 6.28 | 35 |
| Insulation skirt extending horizontally (3m out) | 5.64 | 32 |
| | EFFECTIVE USI [W/m ² K] | EFFECTIVE U-VALUE [btu/ft ² °F] |
| Doors excluding glazing | 0.91 | 0.16 |
| Windows and glazed doors | 1.00 | 0.18 |

Table 2: PART 9 PERFORMANCE PATH VALUES

| METRIC | TARGET |
|-------------------------------------|----------------------------|
| TEDE | 105 kWh/(m ² a) |
| %-Ref (no 9.36.5 or ERS base loads) | -25% |

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Step 3: Model baseline



City of Vancouver (and District Electoral Area and District Electoral Area)

ENERGY MODELLING GUIDELINES

Version 2.0

Effective March 17, 2017
Amended July 17, 2017
(These guidelines are referenced in the Green Building Policy for Vancouver.)
Enacted on November 29, 2016

Net-zero Energy

Division 8

8.36.4.6.

8.36.4.6.1. Before Building Permit Equipment Controls

(1) The building permit application shall be supported with:

- (a) a load calculation and performance report that shall allow the owner to be notified of any equipment that may be required to be installed;
- (b) a report on the equipment that shall be required to be installed;
- (c) a report on the equipment that shall be required to be installed.

(2) Pumps and heaters shall be designed to meet the requirements of Table 2 and Table 3, and shall be designed to meet the requirements of Table 2 and Table 3.

8.36.5. Energy Performance Compliance

8.36.5.1. Simple and Application

(1) This subsection is intended to be used with the energy performance of buildings that are subject to the requirements of Table 2 and Table 3, and shall be designed to meet the requirements of Table 2 and Table 3.

(2) The building permit application shall be supported with:

- (a) a report on the equipment that shall be required to be installed;
- (b) a report on the equipment that shall be required to be installed;
- (c) a report on the equipment that shall be required to be installed.

8.36.5.2. Definitions

(1) For the purposes of this section, the term "performance report" shall mean a report that shall be required to be installed.

(2) For the purposes of this section, the term "performance report" shall mean a report that shall be required to be installed.

8.36.5.3. Compliance

(1) The performance compliance report shall determine the overall energy performance of the building.

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Net-zero Energy

Step 4: Select appropriate enclosure and mechanical Energy Conservation Measures

→ Refer to baseline model

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Net-zero Energy

ECM selection

- Building enclosure ECMs as levers to reduce loads
 - R-values within wall, roof, floor assemblies
 - Airtightness
 - Window U-values (double, triple, quad pane)
 - FDWR and orientation
- Mechanical system ECMs to improve energy use
 - Heating systems - fuel, electric resistance, heat pumps
 - Domestic hot water - fuel, electric, heat pump
 - Heat Recovery

- **Thermal (Enclosure ECMS)**
- Reduce loads
- TEDI

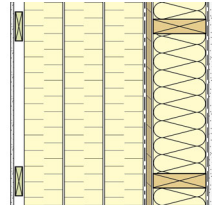
- **Mechanical**
- Improve energy usage
- MEUI/TEUI

- **Renewable energy**

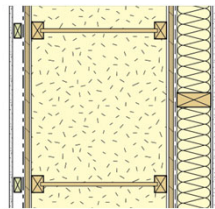
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Net-zero Energy

Practical limits



Constructability limits & depreciating returns to insulation thickness



Technology limits to triple/quad glazing, HRV efficiency and pre-heat



Technology limits to cold climate performance of heat pumps



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Net-zero Energy

Practical limits continued...

| Component | Upper Limit of Performance & Why |
|-------------------------|---------------------------------------------------------------------------------------------|
| Roof R-value | R-100 (36" of fibrous insulation) |
| Wall R-value | R-80 (2x6+16" ext. insulation w/ long screws or 24" double wall) |
| Slab on Grade R-value | R-40 (8-10" of foam) |
| Suspended Floor R-value | R-80 (24" deep truss) |
| Window U-value | U-0.12 (best available quad pane unit) |
| Door R-value | R-8 (best available insulated units) |
| Airtightness | Large commercial 0.15 to 0.30 ACH ₅₀ Small SFD 0.30 to 0.60 ACH ₅₀ |
| Space Heating | Up to 1.5-2.1 COP CCASHP |
| HRV Efficiency | Up to 81% (best avail cold-climate w/o pre-heat) |
| DHW | Up to CO2 Heat Pump, 2.5-3.0 COP |
| Drain Water HR | 65% |



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Net-zero Energy

Step 5: Iteratively apply and document ECM bundles to meet performance target minimums

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Net-zero Energy

Step 6: Design renewable energy generation system

- Buildings in the North always use more energy in the winter than they can produce
- Seasonal demand/supply are inverse
 - Cold temps
 - Higher occupancy loads (plugs, lighting, DHW, etc.)
 - Less sun
- ***Need to think bigger than the building***

| | |
|------------------------------------------------|---------------|
| | Winter |
| Annual Solar Generation Potential - Whitehorse | Nov |
| | Dec |
| | Jan |
| | = 4% |
| | Summer |
| | May |
| | June |
| July | |
| = 41% | |

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What does Net-zero Energy look like?

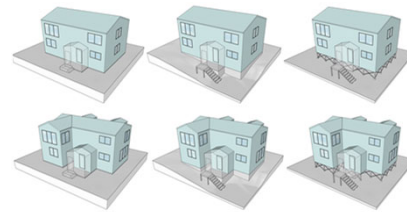
- RDH feasibility study
- Examined three archetypes for four locations
- **Can buildings meet net-zero energy requirements in the North?**
- **What are the practical limitations?**
- **What considerations must be taken into account?**



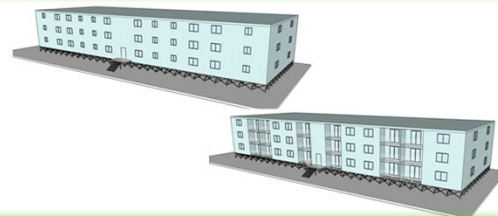
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Representative archetypes

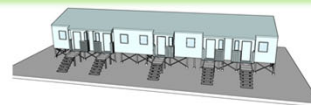
- **Single Family Dwelling (SFD)**
 - Simple & Articulated Form Factors
 - Slab on grade, footing on bedrock and elevated permafrost foundation options by location



- **Multi-Unit Residential Building (MURB)**
 - Simple & Articulated Form Factors



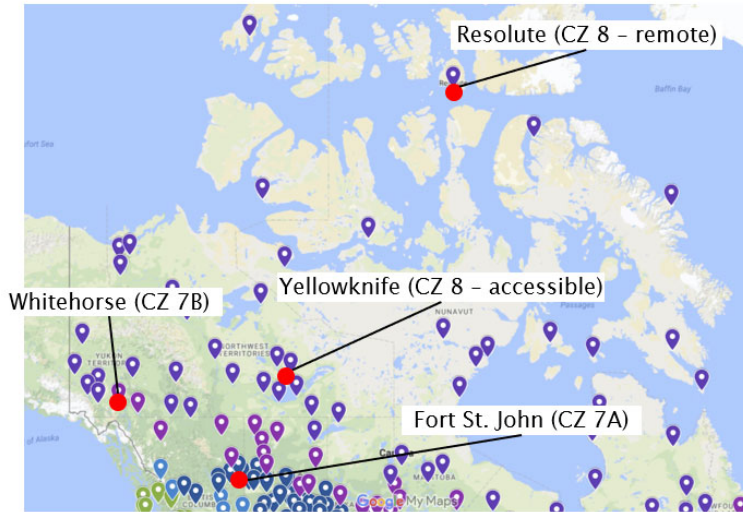
- **5-Plex Row House**



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Locations for Energy and Cost Analysis

- **Fort St. John**
 - CZ - 7a
 - 5750 HDD
- **Whitehorse**
 - CZ - 7b
 - 6580 HDD
- **Yellowknife**
 - CZ - 8
 - 8170 HDD
- **Resolute**
 - CZ - 8
 - 12 360 HDD



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Performance Metrics – BC Step Code as Goals for Net Zero Ready

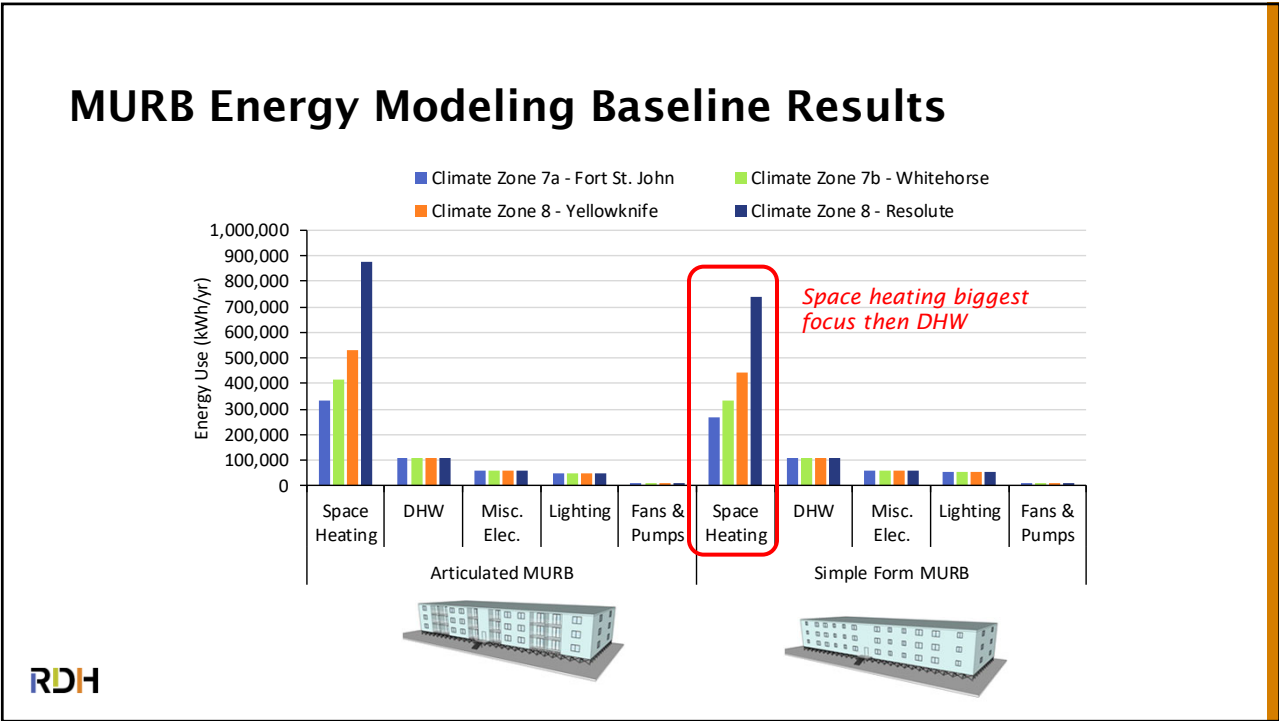


| | Airtightness | Equipment & Systems | Thermal Performance |
|-----------------------------------|-----------------------------|-------------------------------------------------|-------------------------------------------------|
| Step Code for SFD: Step 5 | $\leq 1.0 \text{ ACH}_{50}$ | $\text{MEUI} \leq 55\text{-}75 \text{ kWh/m}^2$ | $\text{TEDI} \leq 15\text{-}60 \text{ kWh/m}^2$ |
| Step Code for MURB: Step 4 | N.R. | $\text{TEUI} \leq 100 \text{ kWh/m}^2$ | $\text{TEDI} \leq 15 \text{ kWh/m}^2$ |

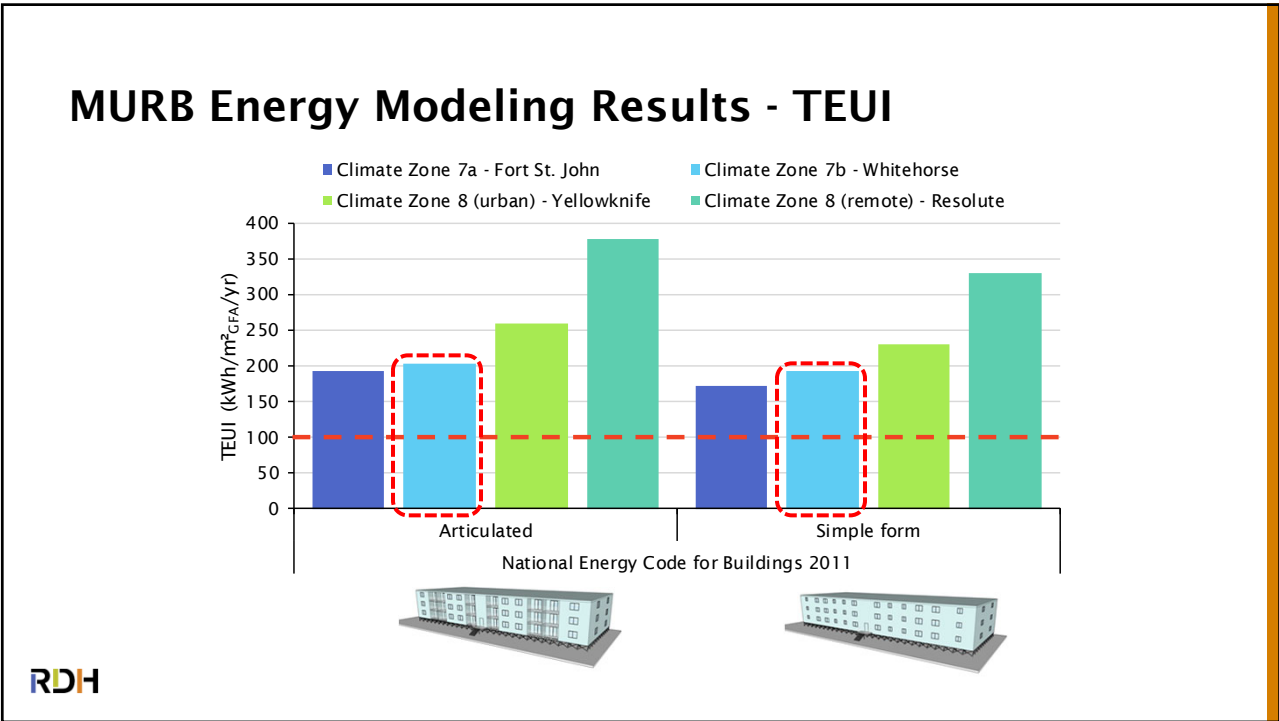
MEUI = Mechanical Energy Use Intensity
 TEDI = Thermal Energy Demand Intensity
 TEUI = Total Energy Use Intensity



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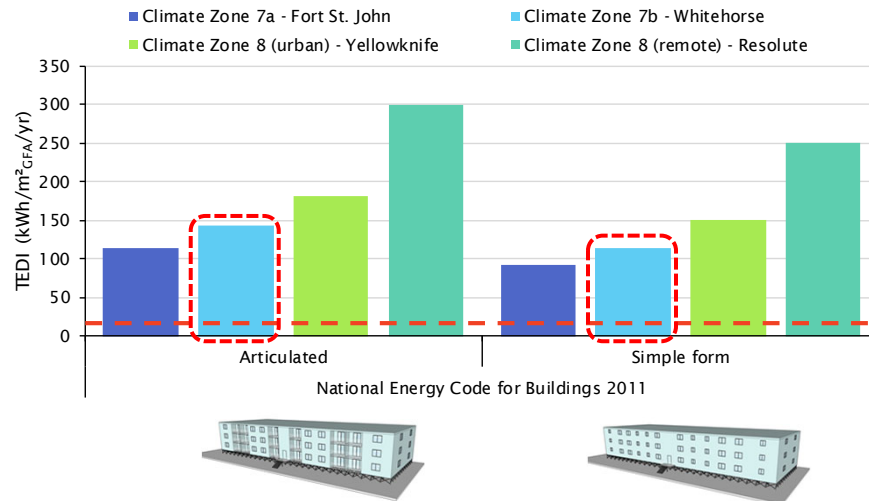


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MURB Energy Modeling Results - TEDI



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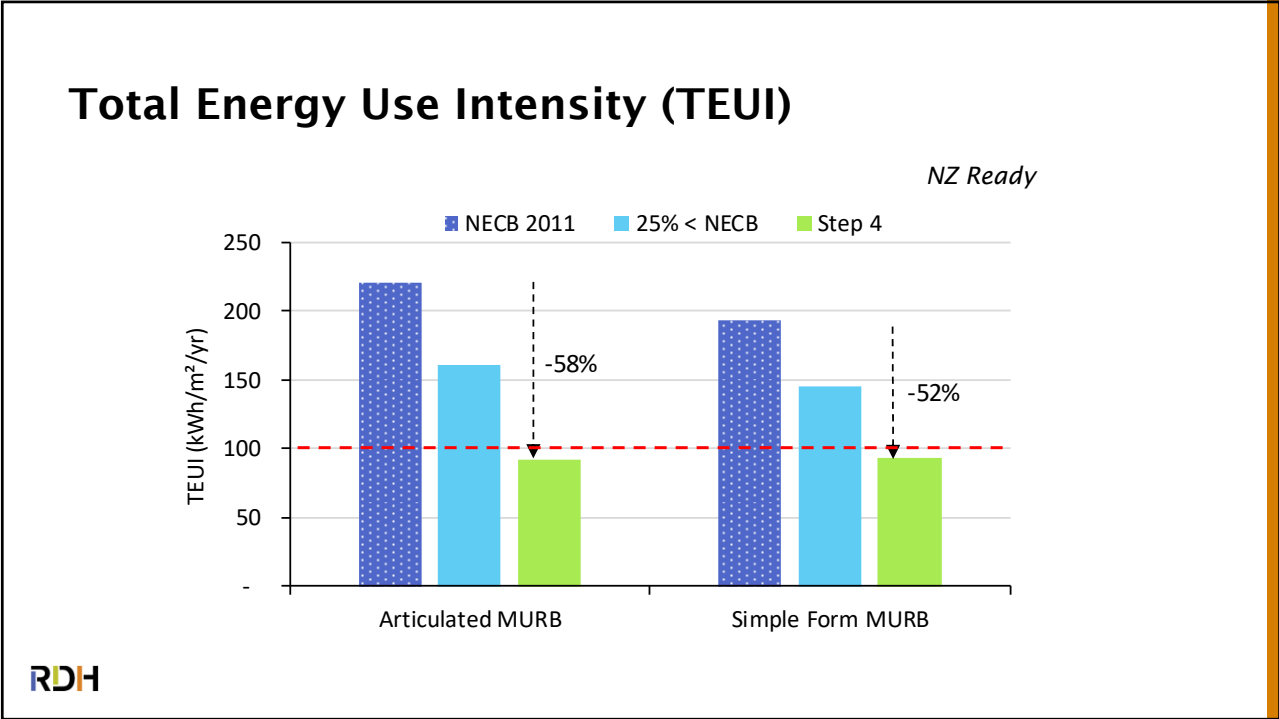
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Upper Step of Energy Step Code – Near Net Zero

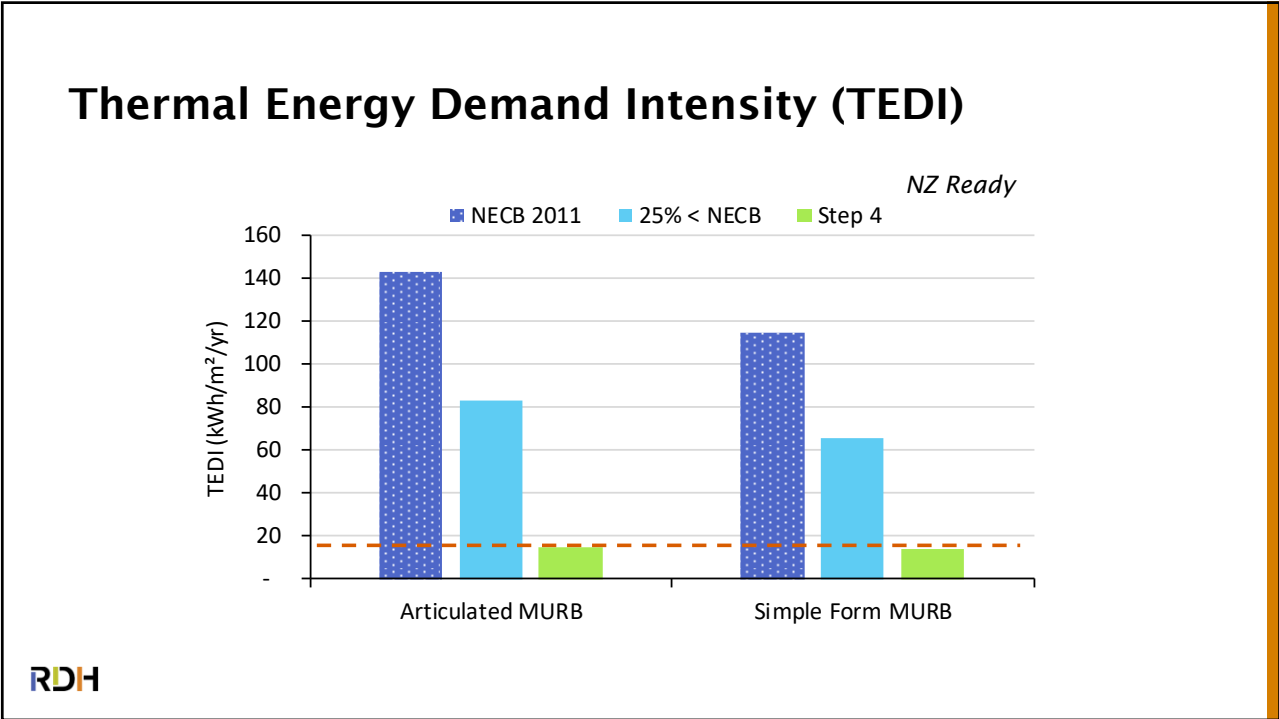
- MURB Baseline, NECB 2011
- Air Tightness: from 2.2 ACH50 to 0.15 ACH50
- Insulation:
 - Roof from R-40 to R-76 (articulated) or R-48 (simple form)
 - Walls from R-31 to R-61 (articulated) or R-40 (simple form)
 - Exposed floors from R-40 to R-70 (articulated) or R-41 (simple form)
 - Windows from double glazed (U-0.39) to quadruple glazed (U-0.12)
- Ventilation strategy changed from in-suite HRVs and MAU supplying corridors to centralized/zoned ventilation system with 81% heat recovery (by dual core units with no preheat required) for suites and corridors.
 - Reduced make-up air flow rate to corridor from 20 cfm/door to 10 cfm/door (articulated)

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Climate Zones 7a, 7b results

| | | BC STEP CODE (2018) | |
|---------------------|--------------------|---------------------|--------|
| | | Step 4 | Step 5 |
| Fort St. John CZ 7a | SFD - articulated | YES | YES |
| | SFD - simple | YES | YES |
| | MURB - articulated | YES | n/a |
| | MURB - simple | YES | n/a |
| | 5-Plex | YES | YES |
| Whitehorse CZ 7b | SFD - articulated | YES | YES |
| | SFD - simple | YES | YES |
| | MURB - articulated | YES | n/a |
| | MURB - simple | YES | n/a |
| | 5-Plex | YES | YES |



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Climate Zone 8 results

| | | BC STEP CODE (2018 rev) | |
|------------------|--------------------|-------------------------|--------|
| | | Step 4 | Step 5 |
| Yellowknife CZ 8 | SFD - articulated | YES | YES |
| | SFD - simple | YES | YES |
| | MURB - articulated | YES | n/a |
| | MURB - simple | YES | n/a |
| | 5-Plex | YES | YES |
| Resolute CZ 8 | SFD - articulated | YES | YES |
| | SFD - simple | YES | YES |
| | MURB - articulated | YES | n/a |
| | MURB - simple | YES | n/a |
| | 5-Plex | YES | YES |



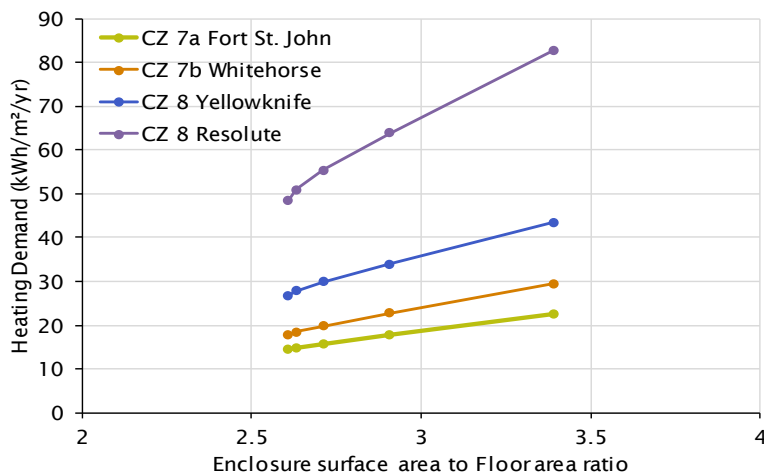
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Net-zero Energy design takeaways

- Metrics and Practical Limitations
- Articulation
- FDWR and orientation
- Diminishing insulation returns
- Air tightness
- Electrical generation

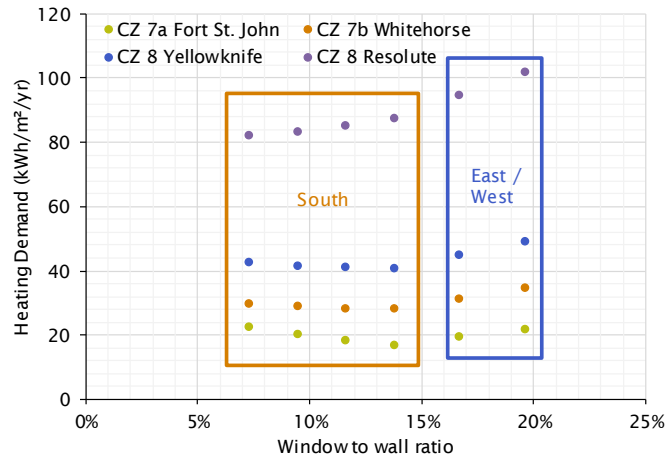
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Impact of Articulation on Heating Demand



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Window to Wall Ratio is Critical

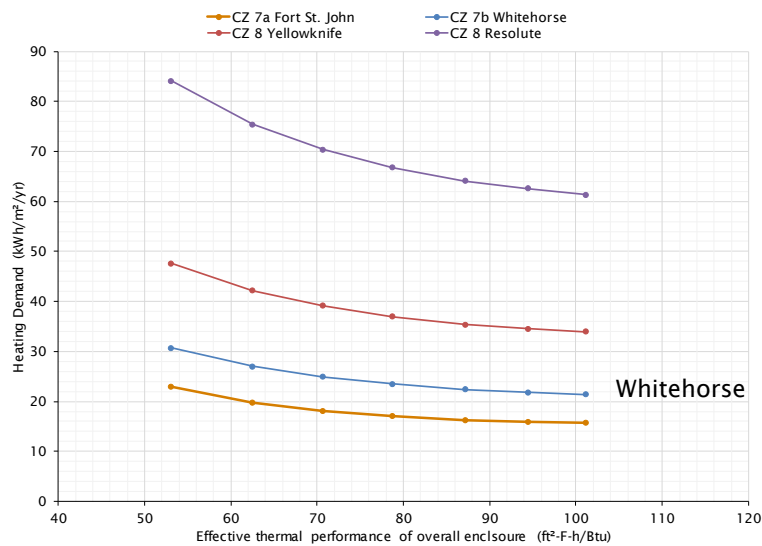


Heating Demand versus window to wall ratio for the simple form SFD in Yellowknife. Each dot represents an addition of a 1.5m x 1.9m window to the façade as indicated on the graph.



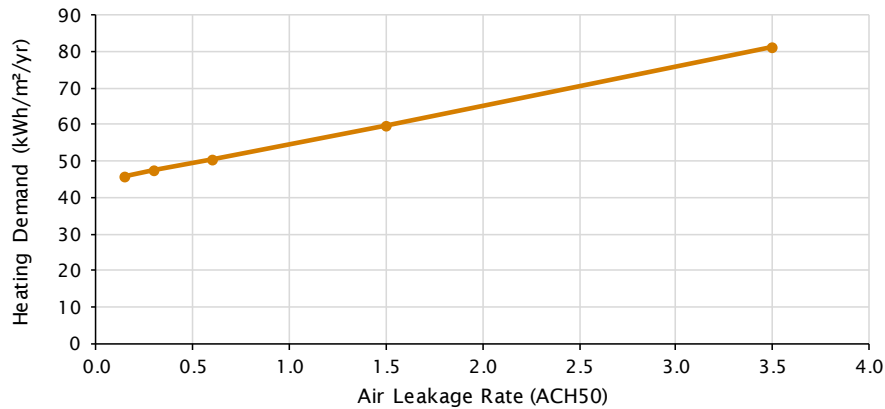
38

Depreciating Returns



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The Continued Importance of Airtightness

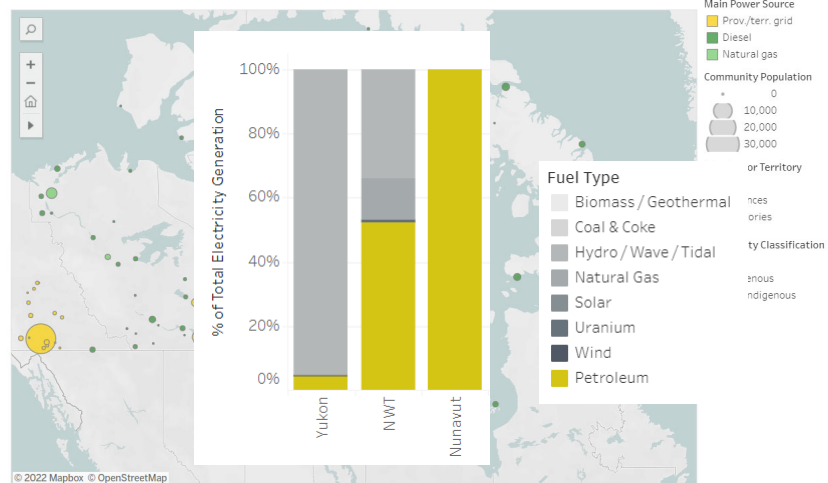


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Stand alone electrical grid

Government of Canada, C. E. R. (2022, July 8). *Canada energy regulator / Régie de l'énergie du Canada. CER.*

- Much of the North is not grid connected to the rest of Canada
- Same for Alaska with the lower 48
- Inverse power/consumption relationship for solar
- Power Corps have generation caps



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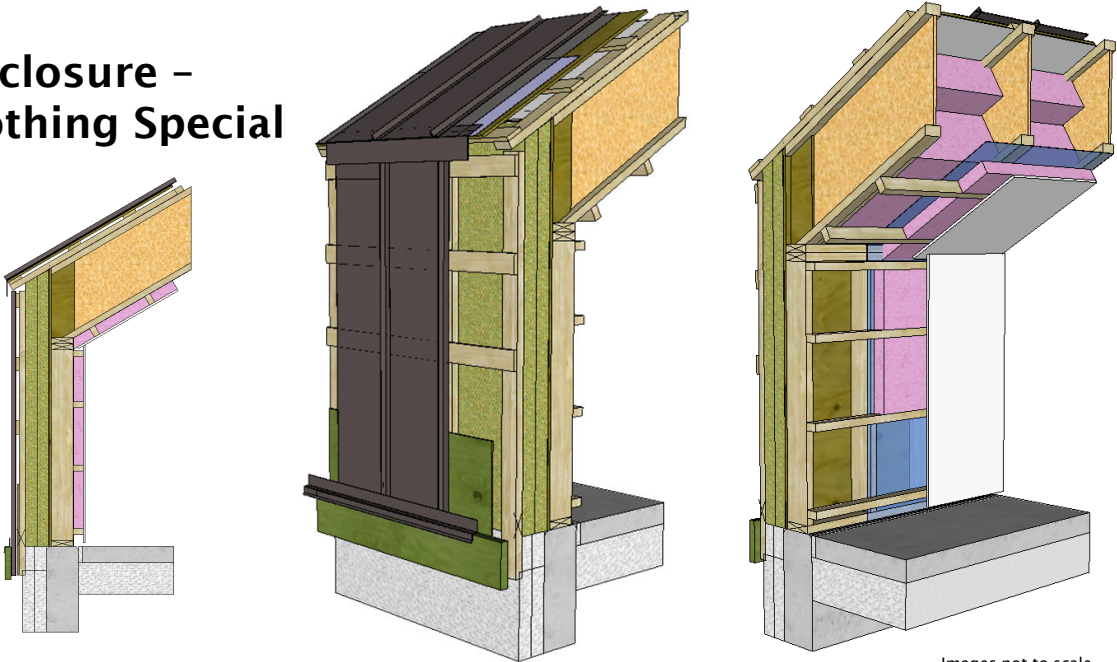
Step 5 SFD in CZ 7b - Case Study



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Enclosure - Nothing Special



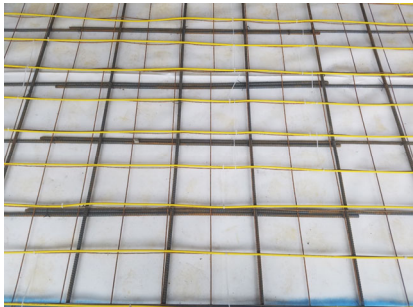
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Images not to scale

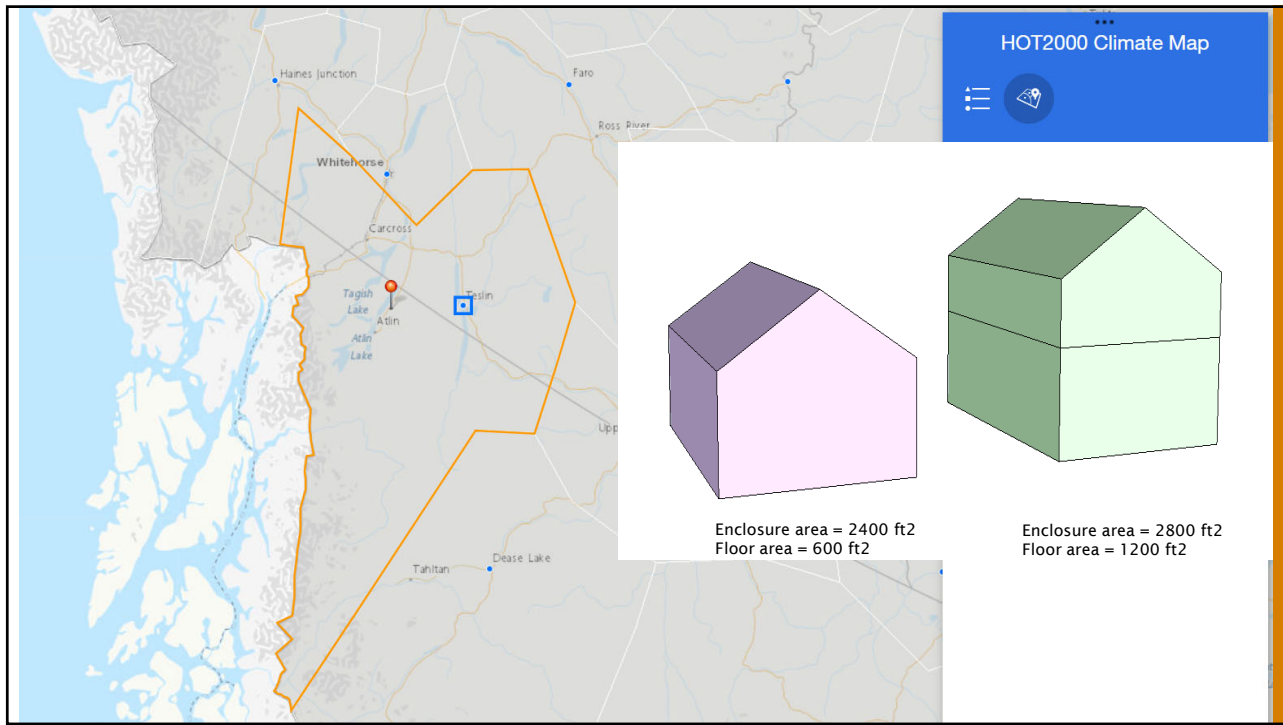
43

Mechanical – Nothing Special

- Electric radiant heat
- ERV
- Wood stove
- Conventional electric water heater



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Performance

National Building Code 2020

| | Proposed House | Reference House |
|--------------------------------|----------------|-----------------|
| Within Scope | Yes | |
| Annual Energy Consumption (GJ) | 35.38 | 105.07 |
| Gross Space Heat Loss (GJ) | 56.53 | 131.63 |
| Peak Cooling Load (W) | 2236 | 2611 |
| Airtightness (ACH @ 50 Pa) | 0.78 | 2.5 |

| | |
|--------------------------------------------|------|
| Overall Energy Performance Improvement (%) | 66 |
| Envelope Performance Improvement (%) | 57 |
| Peak Cooling Validation | Pass |
| Energy Performance Tier | 1 |

Other Compliance Metrics

| | | |
|------------------------------------------------------------------------------------|----|------|
| Thermal Energy Demand Intensity (kWh/(m ² .year)) | 28 | ≤ 50 |
| Mechanical Energy Use Intensity (kWh/(m ² .year)) | 48 | ≤ 65 |
| Greenhouse Gas Emissions Intensity (kg of CO ₂ /(m ² .year)) | 1 | |

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Atlin, BRITISH COLUMBIA, V0W1A0

ENERGUIDE

Data collected: September 3, 2022
File number: 12345
Evaluated by: Robin Urquhart

61 This house
GJ/year

▲ 0 GJ/year Best energy performance ▲ 131 GJ/year Uses most energy

One gigajoule (GJ) equals the energy from two BBQ propane tanks

| Rated Annual Energy Consumption | | Breakdown of Rated Annual Energy Consumption: | |
|----------------------------------------|-------|-----------------------------------------------|-----|
| - Electricity | 61 | A. Space heating | 34% |
| On-site renewable energy contributions | -0 GJ | B. Space cooling | 0% |
| - Electricity | 0 | C. Water heating | 23% |
| - Solar water heating | 0 | D. Ventilation | 1% |
| | | E. Lights & appliances | 19% |
| | | F. Other electrical | 23% |

Rated Energy Intensity: 0.30 GJ/m²/year
Rated Greenhouse Gas Emissions: 0.2 tonnes/year

The energy consumption indicated on your utility bills may be higher or lower than your EnerGuide rating. This is because standard assumptions have been made regarding how many people live in your house and how the home is operated. Your rating is based on the condition of your house on the day it was evaluated.

Quality assured by: RDH

Visit NRCan.gc.ca/myenerguide

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Why are we trying to save energy

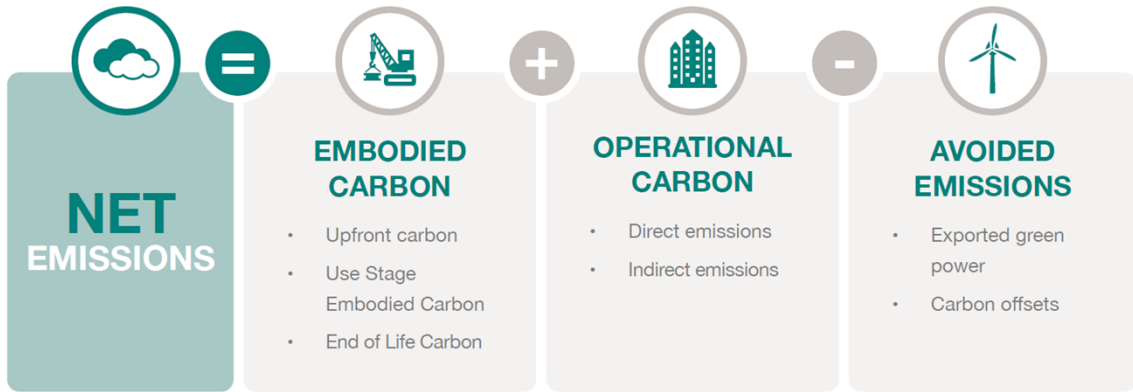
- Save money
- Reduce environmental impact
- Reduce/eliminate greenhouse gas emissions (GHGs)
- Energy as proxy for GHGs

The most energy efficient building is often not the most carbon efficient building

| Enclosure Step | Total life cycle carbon intensity (kgCO ₂ eq/m ²) |
|------------------|--------------------------------------------------------------------------|
| Step 3 Enclosure | 108 |
| Step 5 Enclosure | 123 |

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Goal for Low Net Carbon Emissions Buildings

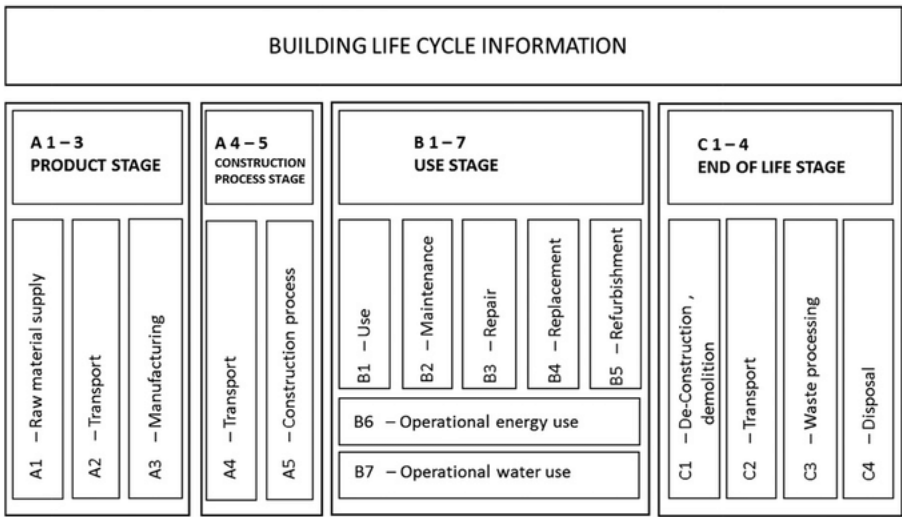


Source: Canadian Green Building Council (CaGBC) Zero Carbon Building Standard V2



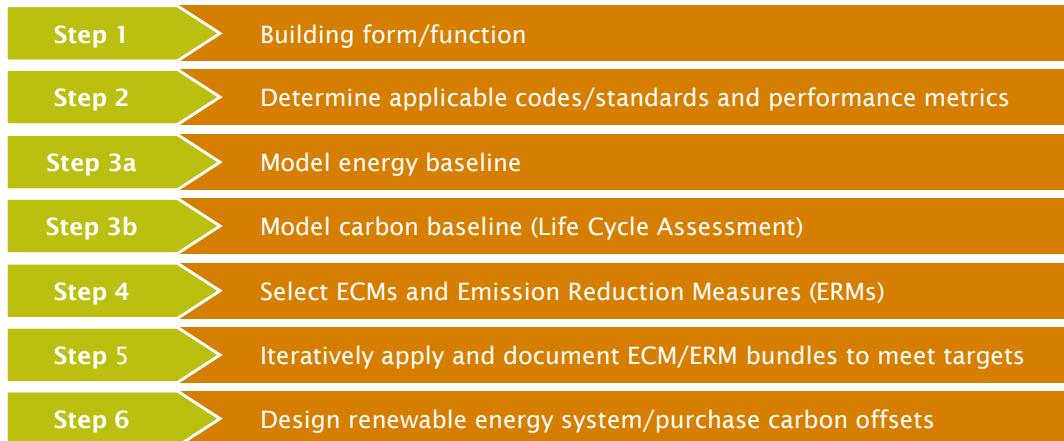
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Building Life Cycle



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Approach for Net-zero Carbon



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Step 2: Determine applicable codes/standards and performance metrics

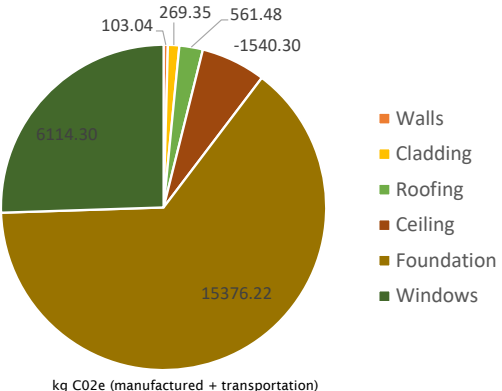
- Code minimum
- Choose the right performance metrics
- *CaGBC Zero Carbon Building Standard*

| | | ZCB-Design v2 |
|-----------------------|-------------------------|----------------------------------------------------------------|
| | | One-time certification for new buildings and major renovations |
| Carbon | Zero carbon balance | Model zero carbon balance |
| | Embodied carbon | Report embodied carbon |
| | Refrigerants | Report total quantity |
| | RECs and carbon offsets | Provide quote |
| | Onsite combustion | Provide transition plan |
| Energy | Energy efficiency | Meet one of three approaches |
| | Peak demand | Report seasonal peaks |
| | Airtightness | Report and justify modelled value |
| Impact and Innovation | | Apply two strategies |

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Step 3: Model baseline

- Model energy baseline
 - Output energy intensity and greenhouse gas emissions
 - Depends on emissions factors (how dirty/clean energy source is)
- Model carbon baseline
 - Conduct life cycle assessment (LCA)
 - Athena, MCE2, BEAM

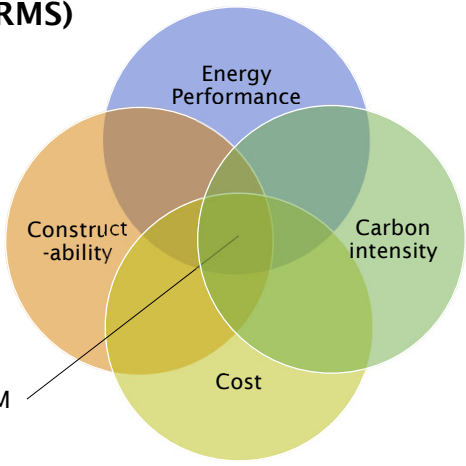


| Component | Value |
|------------|----------|
| Foundation | 15376.22 |
| Windows | 6114.30 |
| Walls | 561.48 |
| Cladding | 103.04 |
| Roofing | 269.35 |
| Ceiling | -1540.30 |

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Step 4: Select appropriate Energy Conservation Measures (ECMs) and Emission Reduction Measures (ERMS)

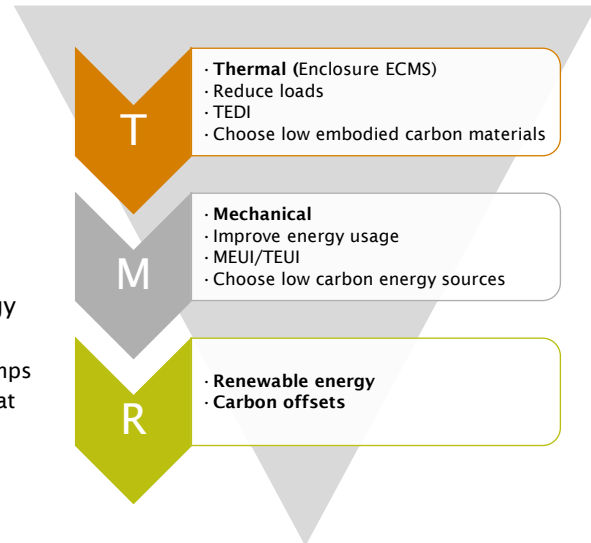
- Refer to baseline models
- Select low carbon materials
- Select low carbon energy sources



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ECM selection

- Building enclosure ECMs/ERMs as levers to reduce loads
 - R-values within wall, roof, floor assemblies
 - Airtightness
 - Window U-values (double, triple, quad pane)
 - FDWR and orientation
 - Low carbon intensity materials
- Mechanical system ECMs/ERMs to improve energy use
 - Heating systems – fuel, electric resistance, heat pumps
 - Domestic hot water – fuel, electric, heat pump & heat recovery
 - Heat Recovery Ventilation
 - Low emission factor energy sources



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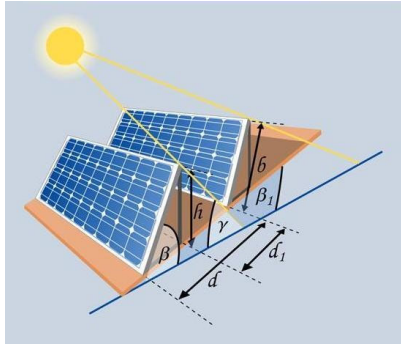
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Step 5: Iteratively apply and document ECM/ERM bundles to meet performance target minimums

- Refer to baseline to see where energy/carbon intensity is high

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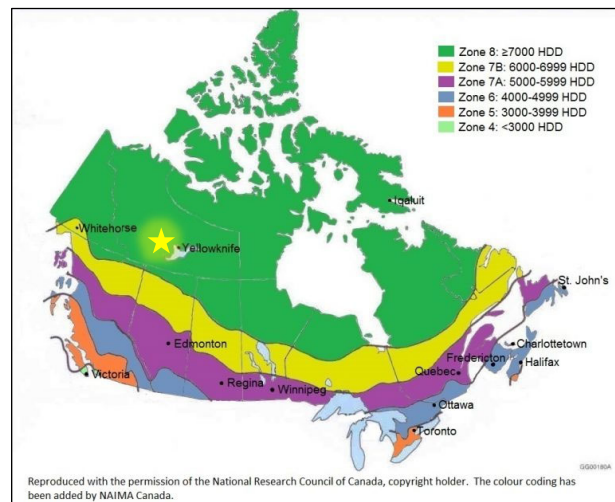
Step 6: Design renewable energy generation system and/or purchase carbon offsets



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Net-zero Carbon Case Study

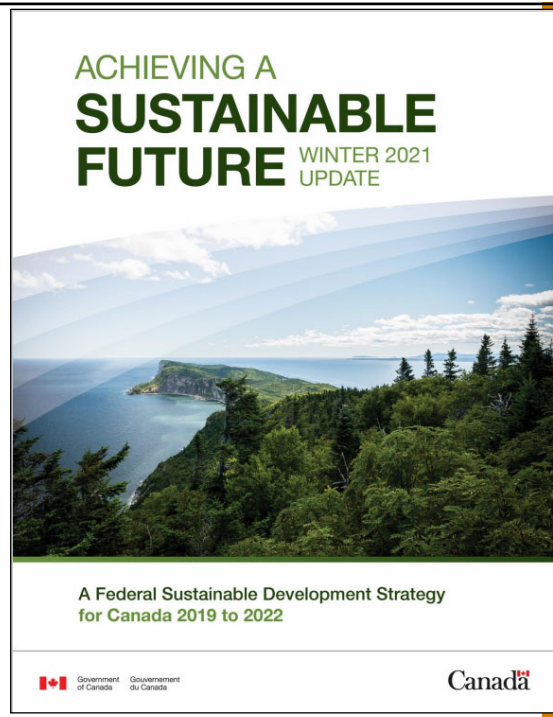
- 2 new construction
- 2 existing construction
- Remote location in Northwest Territories
- No road access
- Isolated grid
- Climate zone 8: ≥ 7000 HDD
 - HDD 8300



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Performance metrics

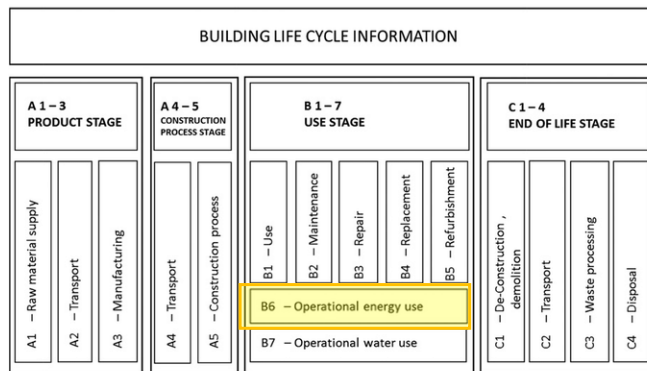
- Federal Government has net-zero carbon mandate
 - **FSDS** – Federal Sustainable Development Strategy
 - **DSDS** – Departmental Sustainable Development Strategy
- Owner’s Statement of Requirements
 - Net-zero emissions
 - Energy metrics
 - BC Energy Step Code 5 – new buildings
 - BC Energy Step Code 3 – existing buildings



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Energy vs Carbon

- BC Energy Step Code targets impossible to meet
- Client confirmed only GHG emissions during building operation (NZOC)
 - tonnes of equivalent carbon dioxide (tCO2e)
 - Does not take embodied carbon of materials into account
- Minimize carbon offset purchase

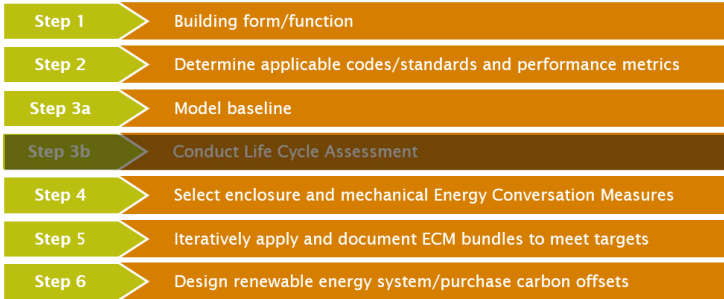


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Energy vs Carbon

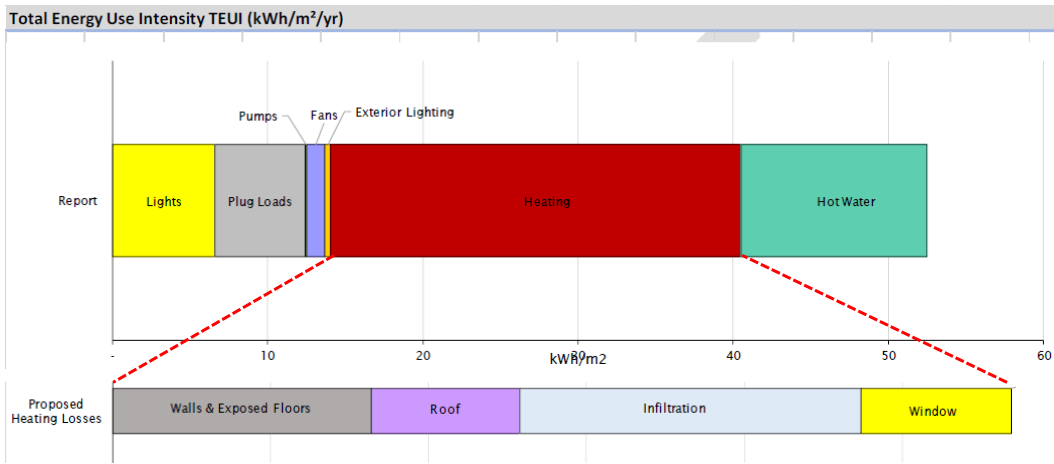
→ NZOC means maximizing energy efficiency and minimizing operational emissions

- Maximize insulation (don't need to target low carbon materials)
- Maximize air tightness
- Select low carbon energy sources (heat)
- Maximize renewable energy production



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Building 1 - performance



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Energy source emissions factors for NWT

| FUEL SOURCE | GHG/Unit | ENERGY DENSITY | GHG kgC02e/GJ |
|----------------|-----------|-------------------------|---------------|
| Electricity | 200 g/kWh | 2.78E-04 (kWh/GJ)/(g/t) | 55.6 |
| Wood pellets | 131 g/kg | 18 MJ/kg | 7.3 |
| Wood chips | 18 g/kg | 10 MJ/kg | 1.8 |
| Light Fuel oil | 2762 g/L | 35.7 MJ/L | 77.4 |

| | Electricity | Combustion |
|--------------------|-------------|------------|
| Consumption (GJ/a) | 61.9 | 169.0 |
| GHGs (kgC02e/a) | 3400 | 1200 |



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Offsetting carbon

→ Net metering and carbon equivalent offsets

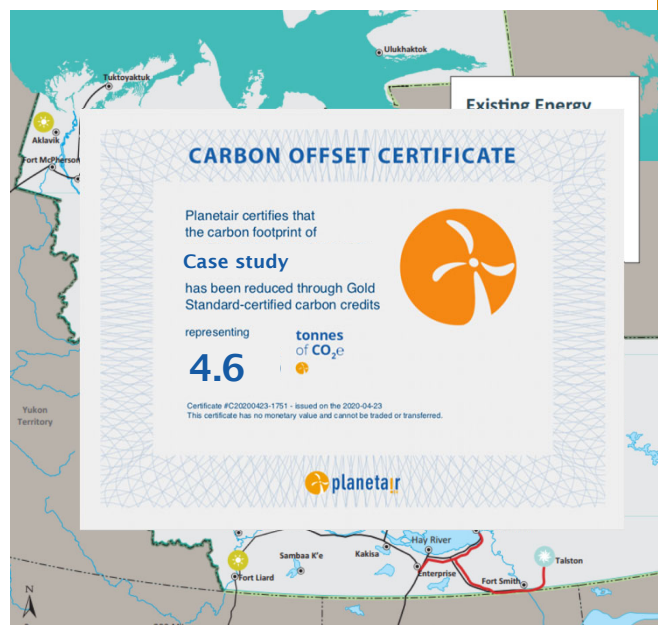
- Not possible in many communities in NT
 - Closed grid
 - NTPC limits uninterrupted power generation

→ Carbon offset purchasing

- Supports offset projects in other regions
 - Solar farm in India to replace coal-fired generators
 - Reforestation in Brazil
 - Wind farm in Dawson Creek

→ 2023 market price = \$21.00/tC02e

→ ~ \$98/a for 4.6 tC02e



Opsit. Government of Canada. Slide 41

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Life Cycle Cost Analysis

→ Carbon offsetting may be more economical than choosing more energy efficient materials/technology

Life Cycle Cost =

Capital investment + operating cost + maintenance cost + disposal cost - residual value

→ Used to compare materials, technologies, etc.

→ Can be used to compare ECM bundles including carbon as a shadow cost (\$/tCO₂e)

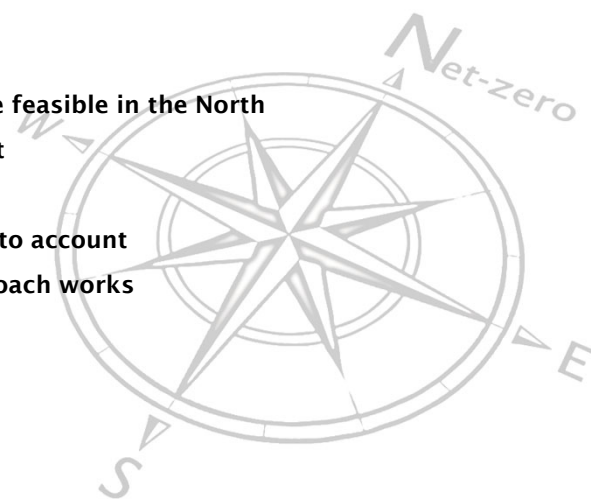
→ Treasury Board of Canada sets out a carbon price of \$300/tCO₂e



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Key takeaways

1. Net-zero Energy and Net-zero Carbon are feasible in the North
2. Define Net-zero at the outset of a project
3. Use metrics judiciously
4. Take northern-specific considerations into account
5. Don't get lost in the noise - simple approach works
6. Need to think bigger than the building
7. The aim is not always the goal



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Discussion + Questions

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