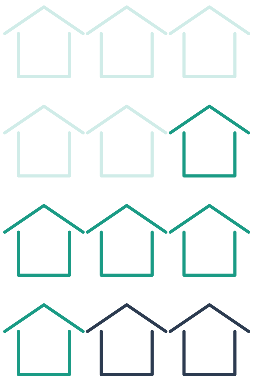
Building Better in the Kootenays

A Free Embodied Carbon Consultation Case Study



12 Projects

5 at the Schematic Design Stage
5 at the Building Permit Stage
2 at the Post Construction Stage

Phase II of the City of Nelson's Low Carbon Homes Pilot (LCHP) aimed to apply the findings of the research conducted in Phase I*. **One strategy employed to operationalize these findings was to offer free embodied carbon analyses and consultations to building projects within the Kootenays. The intention of this work was to increase awareness of the topic, build capacity, and facilitate embodied carbon emissions reductions.** The project team collected building data, analyzed it, and presented recommendations to homeowners and building professionals that encouraged low operational and embodied carbon decision making.

The intention of this brief is to summarize lessons learned from this pilot. The key findings from this pilot will be summarized within the four main phases of work: recruitment, analysis, consultation, and follow-up. This brief will focus exclusively on the 10 schematic design and building permit stage projects. The pilot will be assessed with both a customer experience lens (i.e., homeowner and builder perspective) and a municipal and project management lens.

* *See the City of Nelson's Benchmarking Report and Materials Guide for a summary of these findings.*

Pilot Recruitment

All participant recruitment was done through email and word of mouth. Building community members from across the region were invited via email to participate in this free offering. The offering was also presented directly to those who attended City of Nelson Embodied Carbon Advisory Group meetings. This recruitment strategy was valuable to get early buy-in. This pilot did not limit its services to building projects in Nelson because the project team felt that there was a lot of value to spreading the knowledge across the region. Although the building professionals were approached first in all but one instance, homeowners had the final say over whether they participated and were the ones who signed the consent forms.

Due in part to the fact that this pilot employed a snowball sampling research technique, where study participants help recruit further participants through their own networks, **the sample size is likely more environmentally-minded than the average builder and/or homeowner in the region**. Although this offering was free, it did also require people to be willing to contribute their time, without compensation, to compile some data and learn about ways to reduce their embodied carbon emissions. It should therefore be acknowledged that participants of this pilot were likely more willing than most to make changes to their projects. In future iterations of this offering, it may be helpful to find ways to engage with a broader swath of builders and/or homeowners - especially those that may not normally volunteer to be involved in this type of work.

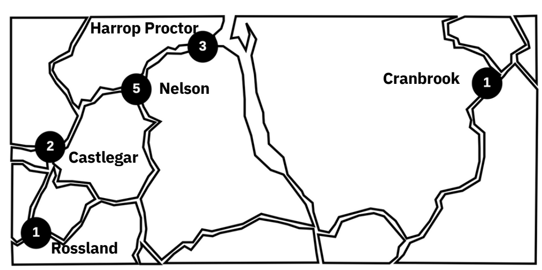


Figure 1. This map show the general location of each of the 12 projects that received a free embodied carbon analysis and consultation through Phase II of the Low Carbon Homes Pilot.

Analysis

After signing a data-sharing waiver, participants **submitted building drawings** so the project team could determine prospective material quantities and types. With this data, an embodied carbon analysis was conducted using the freely available BEAM (Building Emissions Accounting for Materials) estimator tool.

This tool accounts for the product stage emissions, otherwise known as A1 to A3, of a building materials life cycle (i.e., raw material sourcing, transportation to a manufacturing facility, and the manufacturing process). BEAM includes many common construction materials and their associated carbon footprint. This information comes from Environmental Product Declarations (EPDs) that are third party reviewed and contain Global Warming Potential (GWP) data for each product.

By **inputting the amounts and material types for the foundation, walls, floors, windows, and roof, the tool is able to estimate the total Material Carbon Emissions** (MCE) for the project. In the context of BEAM, MCE refers only to the upfront emissions associated with a build's materials. In our analysis, the project team relied more heavily on the Material Carbon Intensity (MCI) metric. This number is calculated by dividing the MCE by total useable floor area. The MCI metric allows for comparison between different-sized projects and seems most likely to be the metric used in the event of any future embodied carbon code requirements. The total MCE is still very valuable to ensure overall material consumption is kept in mind.

For each of the projects, an embodied carbon analysis was done on the prospective build. Due to the fact that material selection rarely stays static through the building process, it should be noted that there are inevitably assumptions being made to the prospective materials selected. After an estimation of the prospective emissions associated with the current design was calculated, the project team then made a series of material substitutions, and tracked their impact on the overall project emissions. The project team prioritized material substitutions that had the largest reductions, were feasible and affordable, and used locally available materials.

In future iterations of this pilot, it is recommended that the project team find ways to more formally integrate consideration of building material longevity and recyclability despite not being integrated into the BEAM estimator tool.

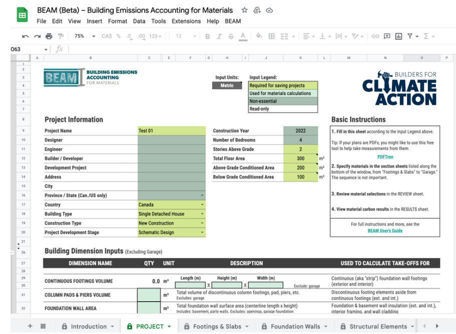


Figure 2. A screenshot of the BEAM estimator tool. It was built to be accessible and dynamic and is therefore hosted on google sheets.

Do you want to offer similar consultations to your local building community?

Don't hesitate to reach out to the City of Nelson's Climate & Energy team to obtain a waiver template, draft slide decks, and any other resources that we can help you with.

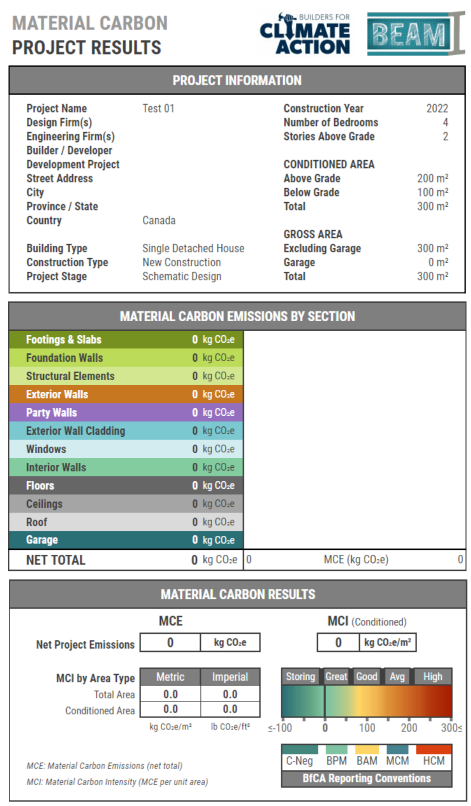


Figure 3. A screenshot of the results page of the BEAM estimator tool.

The analyses demonstrated that the initial project designs had MCI scores that were slightly higher than the Nelson and Castlegar average but still lower than the Toronto and Vancouver average. It showed that the MCE for the initial project designs were also higher than the Nelson and Castlegar average but had a slightly larger average floor area as well. Due to the small sample size and the informal study format, no formal conclusions are being drawn from this data.

In an effort to assess the relative impact of this type of consultation, the project team conducted a series of rough calculations to determine the emissions impact if all their recommendations had been applied.

- For the schematic design phase projects, the changes would have on average **reduced the MCI of each project by ~66%** and would have resulted in a **total MCE reduction of ~30 tonnes of CO_2e across all the projects.**
- For the building permit phase projects, the changes would have on average **reduced the MCI of each project by ~56%** and would have resulted in a **total MCE reduction of ~95 tonnes of CO_2e across all the projects.**

The project data showed that **changes to the exterior walls and roofing** (e.g., ICF to staggered stud, spray foam or rigid foam to blown cellulose, metal to asphalt shingles, etc.) **and insulation and foundation** (e.g., rockwool to cellulose, XPS to EPS, fibreglass batts to blown cellulose, slab on grade to pier foundation, etc.) **resulted in the largest projected emissions reductions.**

Consultation

After an analysis was completed, a consultation between the project lead, embodied carbon analyst, homeowner, and building professional (e.g., builder, building designer, and/or architect) was scheduled. These consultations were hosted virtually and lasted approximately 1-hour. During the consultation, the project team (i.e., project lead and embodied carbon analyst) introduced the concept of embodied carbon, presented the findings of the embodied carbon analysis, and recommended a series of actions to reduce the embodied carbon emissions associated with the project (see Appendix for all the recommendations made to the schematic design and building permit phase projects). Despite the recommendations being based on BEAM data (i.e., only taking into account upfront embodied carbon emissions), discussion often revolved around balancing the BEAM data with an overarching understanding of the need to reduce waste and consume less.

The discussion portion of the consultation surfaced many of the factors most important to homeowners including aesthetics, material availability, cost, health, and fire resilience. Balancing all these considerations with embodied carbon can be difficult, as the lowest carbon material option does not always align with other project goals. **It was the experience of the project team that having open and honest conversations about these conflicting concerns led to more trust building and productive conversations about solutions**. By providing a list of options for each project, homeowners had the chance to pick and choose which recommendations were most feasible and worked with their other project goals.

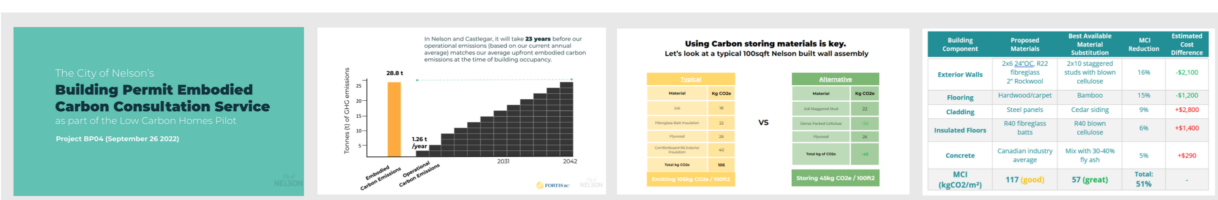


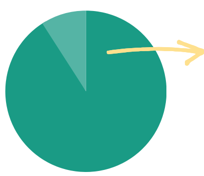
Figure 4. A sample set of the slides presented to the participants as part of the free embodied carbon consultations.

The project team gave study participants the opportunity to email the embodied carbon analysts for several weeks following the consultation. This option was not well utilized except in one instance. Moving forward, this part of the consultation process may not be offered. Instead, time and funds may be better spent building the capacity of the building professionals (e.g., energy advisor, builder, architect, etc.) so that they can offer more targeted recommendations throughout the building process.

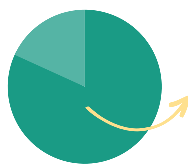
This consultation process reinforced the importance of educating people about embodied carbon early in the design phase to enable the most substantial overall emissions savings. It also showed the benefits of the Integrated Design Process where collaboration and whole building system thinking is core to the design and construction of a project. This early integration of embodied carbon considerations is undoubtedly most impactful, but it also makes it hard to measure impact of a consultation process like this. This should be kept in mind while reviewing the following findings.

Follow-Up

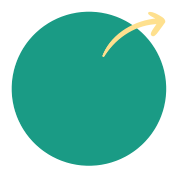
Preliminary findings from this work suggest that this consultation was useful to participants and led to some prospective emissions reductions. Here is a summary of the findings from an online survey that was conducted after the consultations occurred. Approximately 65% of all participants of the consultations responded to the follow-up survey with at least one response from each project. These findings include feedback from both homeowners and building professionals.



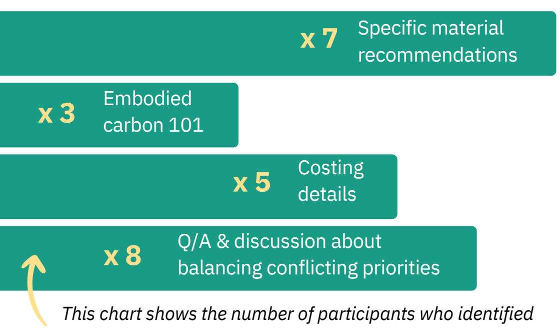
91% of the survey respondents indicated that they learned something new and found this service offering helpful.



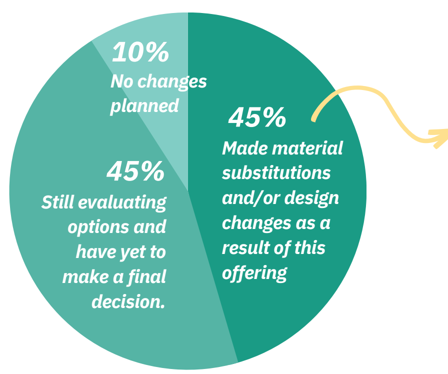
82% of the survey respondents felt that the consultation offered them reasonable options to reduce emissions.



100% of the survey respondents supported the continuation of this free educational offering to other interested homeowners and builders.



This chart shows the number of participants who identified specific components of the presentation as being most helpful.



- *3 project selected different insulation*
- *1 project moved to a stepped foundation*
- *4 projects switched to a higher fly-ash concrete mix*
- *1 project switched from fiber cement to cedar siding*
- *1 project moved from ICF to timber frame*

In summary, this free embodied carbon analysis and consultation offering proved invaluable to the City of Nelson. It helped build capacity in the building community and increase awareness of the topic in the public, and offered helpful insights to the City as we begin to assess how best to integrate embodied carbon considerations into local policy and programming.

Underlying all this work is an ardent commitment to foster collaborative and multi-disciplinary work (e.g., utilizing Integrated Design Processes) to achieve meaningful embodied carbon reductions without compromising work to reduce operational carbon. This offering has demonstrated the benefits of informal conversation and trust building to advancing ambitious low carbon and resilient building strategies and can be seen as an effective first step at building both City and community capacity on the topic of embodied carbon emissions.

Low Carbon Homes Pilot Project Team

This project was funded by a FortisBC grant.

Mike Coen
Build Environmental
Builder & Embodied Carbon Specialist

Michele DeLuca
Harmony Engineering
Energy Advisor & Embodied Carbon Specialist

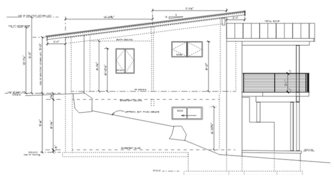
Natalie Douglas
City of Nelson
Climate Resilience Planner & Project Lead

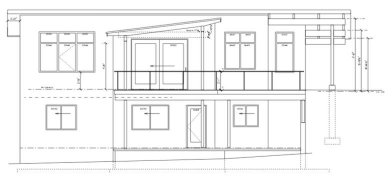
Appendix

This section contains details on each of the participating schematic design and building permit phase projects (e.g., the recommendations made to them and key topics of conversations during the consultation).

BUILD ENVIRONMENTAL

PD01 New Build at the Schematic Design Stage





2 Bedrooms

1 Dwelling Unit

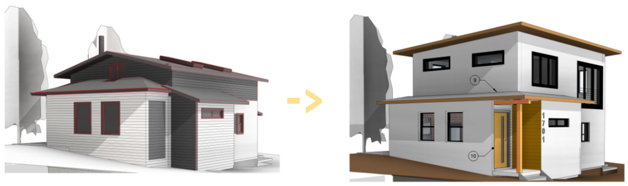
	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	ICF	High performance staggered 2x8 wall. Dense packed cellulose	19,512 kgCO_2e	$13,000 saving
Roof	2x6 Closed Cell Spray foam	Trussed roof, blown cellulose	12,238 kgCO_2e	$3,200 saving
Concrete mix	Canadian standard mix	30-40% fly ash mix	2,502 kgCO_2e	+ $500
Siding	Metal	Cedar	2,763 kgCO_2e	+$2000
Total Material Carbon Intensity	**297 kg CO_2e / m2**	**112 kg CO_2e / m2** **62% Reduction**		
Total Material Carbon Emissions	**60.657 t of CO_2e**	**22.779 t of CO_2e** **22% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- How Nelson compares to other communities regarding embodied and operational emissions
- How SCM content influences **concrete** strength
- **Longevity** questions regarding a staggered stud wall versus an ICF build
- How material rankings will change as products change, industry adapts, and lower carbon practices are adopted
- Low carbon and **fire resilient** siding and roofing options
- Making sure to account for **end of life emissions**, re-use, and **recyclability** despite the BEAM calculator not considering emissions beyond the A1-A3 life stages
- Interest about emissions associated with **interior finishes**
- Interest about the comparatively small impact of **transportation** on the whole lifecycle emissions of a product

BUILD ENVIRONMENTAL

PD02 Renovation at the Schematic Design Stage



2 Bedrooms

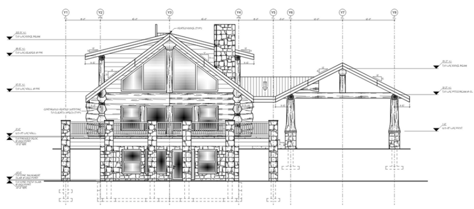
1 Dwelling Unit

	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	2x6, fibreglass batt, R6 exterior insulation	High performance, staggered 2x8 wall. Dense packed cellulose	2,000 $kgCO_2e$	n/a
Cladding	Metal	Cedar	1,968 $kgCO_2e$	n/a
Total Material Carbon Intensity	**95 kg CO_2e / m**	**32 kg CO_2e / m²** **66% Reduction**		
Total Material Carbon Emissions	**8.3 t of CO_2e**	**2.8 t of CO_2e** (there is no local or Canadian MCE average for renovations)		

Main Topics of Conversation during the Consultation:

- How to properly account for emissions associated with **biogenic materials** (e.g., wood)
- The impact of **concrete** and the feasibility of concrete piers instead of a foundation wall and the helpfulness of asking for higher SCM concrete mixes
- How to weigh embodied carbon emissions with operational emissions and the limitations and opportunities of the **carbon use intensity** metric
- How to balance carbon reduction and **hazard resilient building** considerations (i.e., measures to mitigate climate change and measures to adapt to climate change)
- The embodied carbon associated with **green roofs** and **solar panels**

PD03 New Build at the Schematic Design Stage



2 Bedrooms

1 Dwelling Unit

	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Foundation	ICF to top of basement walls	standard 8" concrete with 1" styrofoam below to 8" above grade then framed wall	8,194 $kgCO_2e$	50% saving
Concrete	canadian average mix	30-40% fly ash mix	5,267 $kgCO_2e$	+5% cost
Flooring	engineered hardwood	hard bamboo	7,530 $kgCO_2e$	depends on hardwood & bamboo quality
Cladding	fibre cement (hardie)	cedar	3,012 $kgCO_2e$	cost neutral
Insulation	fibreglass	cellulose walls, roof, and floor cavities for comfort	4,362 $kgCO_2e$	
Total Material Carbon Intensity	**156 kg CO_2e / m2**	**66 kg CO_2e / m2** **58% Reduction**		
Total Material Carbon Emissions	**46.9 t of CO_2e**	**6.6 t of CO_2e** **32% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- How to switch from an ICF system to a wood structure without reducing operational efficiency
- **Health** considerations regarding fly ash in concrete
- Balancing **recyclability** with low upfront embodied carbon emissions (e.g., asphalt shingles versus metal roofing)
- The benefits of **bamboo**
- Industry opportunities for a local **hemp insulation** business
- How aesthetic preferences play into decision making
- How **self generated power** may be accounted for in an overall carbon use intensity metric

Harmony Engineering

PD04 New Build at the Schematic Design Stage

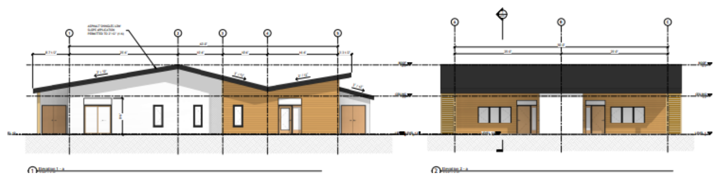
4,639 ft^2
8 Bedrooms
4 Dwelling Units

	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	2x6 framing 24" OC 6" rockwool exterior	2x10 plate with staggered studs, blown cellulose	3,780 $kgCO_2e$	blown cellulose wall > R26 is most affordable system
Roof	6" XPS rigid foam (R30)	Blown cellulose (R30)	19,776 $kgCO_2e$	68% reducation
Concrete	canadian average mix	30-40% fly ash mix	1,380 $kgCO_2e$	5% increase
Flooring	vinyl	bamboo	1,840 $kgCO_2e$	30% increase
Cladding	steel panel cladding	cedar siding	1,840 $kgCO_2e$	41% increase
Total Material Carbon Intensity	**219 kg CO_2e / m2**	**83 kg CO_2e / m2** **62% Reduction**		
Total Material Carbon Emissions	**93.9 t of CO_2e**	**35.3 t of CO_2e** **23% Higher than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- The material impact of the Step Code and highly energy efficient building practices (e.g., how long it would take for the embodied carbon emissions to match the operational emissions of a net zero house in an area with a low carbon grid)
- **Flooring** choices in multi-residential buildings and how it impacts sound proofing and **acoustic** performance (i.e., sound is more resonant with hard surfaces)
- The desire to use less foam and more cellulose where appropriate
- Non proprietary products and the headache and stress that they can cause architects and engineers

PD05 New Build at the Schematic Design Stage



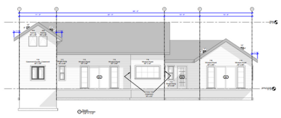
6 Bedrooms
1 Dwelling Unit

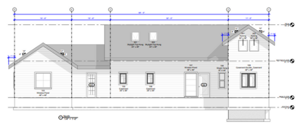
	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	2x6 fibreglass batt (R6), comfortboard (R26)	2x8 with 2x4 staggered stud, dense packed cellulose (R26)	3,325 $kgCO_2e$	10% savings
Roof	metal 22g	asphalt shingles	2,855 $kgCO_2e$	n/a
Concrete	canadian average mix	30-40% fly ash mix	3,292 $kgCO_2e$	n/a
Flooring	vinyl, carpet in bedrooms	linoleum	1,628 $kgCO^2e$	n/a
Cladding	fibre cement (hardie)	cedar	3,479 $kgCO^2e$	cost neutral
Party Wall Assembly	ICF	5/8 , 2x4 wall, cellulose, 2x4 wall cellulose 5/8	9,377 $kgCO_2e$	30% saving
Floor Assembly	slab on grade, EPS, subslab insulation	wood framed, cellulose insulation	16,898 $kgCO_2e$	+15% cost
Total Material Carbon Intensity	**193 kg CO_2e / m2**	**35 kg CO_2e / m2** **82% Reduction**		
Total Material Carbon Emissions	**56.6 t of CO_2e**	**10.2 t of CO_2e** **66% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- How to contextualize these MCE numbers (e.g., relate to the amount of emissions that come from driving a car)
- The importance of addressing our **consumption** patterns to effectively reduce emissions
- **Linoleum**, how it's made, why it's low embodied carbon, and why its sometimes confused with vinyl
- Embodied carbon related **ISO standards** and the National Research Council (NRC)'s recently published National guidelines for whole-building life cycle assessment
- The need for more builder-focused embodied carbon **workshops**

BP01 New Build at the Building Permit Stage





3 Bedrooms
1 Dwelling Unit

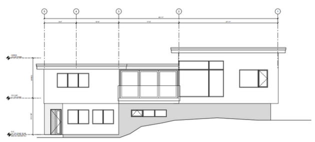
Prospective: Step Code Level: **3** Air Changes per Hour: **2.5** Annual Energy Consumption (GJ/yr): **31**

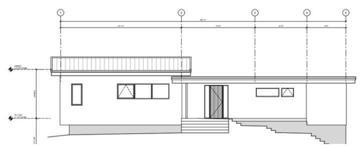
	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	2x6 fibreglass batt (R6), comfortboard (R26)	2x8 with 2x4 staggered stud dense packed cellulose (R26)	3,330 $kgCO_2e$	10% savings
Roof	metal 22g	asphalt shingles	3,779 $kgCO_2e$	n/a
Concrete	canadian average mix	30-40% fly ash	2,482 $kgCO_2e$	+5% cost
Flooring	engineered hardwood	hard bamboo	4,634 $kgCO_2e$	cost neutral
Cladding	fibre cement (hardie)	cedar	5,059 $kgCO_2e$	cost neutral
Insulation (between floors only)	rockwool safe n sound	dense packed cellulose	899 $kgCO_2e$	n/a
Total Material Carbon Intensity	**188 kg CO_2e / m2**	**69 kg CO_2e / m2** **63% Reduction**		
Total Material Carbon Emissions	**44.5 t of CO_2e**	**16.3 t of CO_2e** **44% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- The importance of considering **re-use and recyclability** of materials
- **ICF** and below grade uses of concrete
- The benefits of **bamboo** and the emissions impact of soil disturbance
- How to navigate **greenwashing** in the realm of building materials
- The **health** implications of radon exposure and building practices to reduce risk
- The problem of homes, on average, increasing in size and of **excessive material consumption**
- Emission reduction opportunities in the **concrete & cement** industries

BP02 New Build at the Building Permit Stage





2,079 ft^2
2 Bedrooms
1 Dwelling Unit

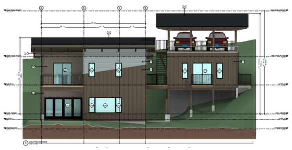
Prospective: Step Code Level: **4** Air Changes per Hour: **1.5** Annual Energy Consumption (GJ/yr): **71**

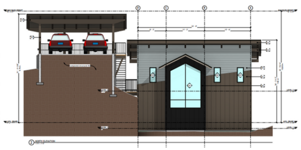
	Proposed Material	**Readily Available Material Substitution**	**Embodied Carbon Reduction**	**Estimated Cost Difference**
Exterior Walls	fibre cement cladding	cedar	2,676 kgCO_2e	+11% cost
Roof	12.25" GPS SIP	trusses 24" OC, R50 blown cellulose	4,907 kgCO_2e	63% savings
Concrete	canadian average mix	30-40% fly ash	2,676 kgCO_2e	+5% cost
Flooring	2" concrete topper, 1.5" rockwool	bamboo flooring, blown cellulose	4,907 kgCO_2e	+60% cost
Insulation (foundation only)	4" XPS	5" EPS	9,813 kgCO_2e	45% savings
Total Material Carbon Intensity	**231 kg CO_2e / m2**	**107 kg CO_2e / m2** **54% Reduction**		
Total Material Carbon Emissions	**44.6 t of CO_2e**	**20.7 t of CO_2e** **29% Lower than the Nelson & Castlegar Average**		

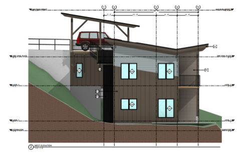
Main Topics of Conversation during the Consultation:

- Regulation regarding **blowing agents** and its impact on insulation companies
- The lack of low carbon options for windows and how this relates to design implications of more energy efficient homes (i.e., less excessive use of windows and glass).
- The benefits and limitations of a **staggered stud wall**
- How to determine which drywall products have lower embodied carbon emissions
- The importance of considering **fire resilient** building practices
- The comparatively small embodied carbon impact of membranes, glues, tapes, etc.
- **Demolition waste and deconstruction policies** and their potential application in Nelson
- The embodied carbon impact of **solar panels**

BP03 New Build at the Building Permit Stage







1,481 ft^2
2 Bedrooms
1 Dwelling Unit

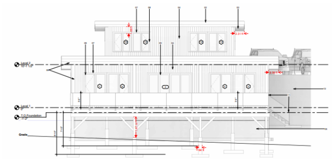
Prospective: Step Code Level: **3** Air Changes per Hour: **2.5** Annual Energy Consumption (GJ/yr): **63**

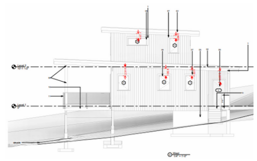
	Proposed Material	**Readily Available Material Substitution**	**Embodied Carbon Reduction**	**Estimated Cost Difference**
Roof	8.25" SIP	trusses 24" OC, R30 blown cellulose	2,194 kgCO_2e	56% savings
Foundation	slab on grade	pier foundation, 11 7/8" TJIs with blown cellulose	7,241 kgCO_2e	n/a
Concrete	canadian average mix	30-40% fly ash	878 kgCO_2e	5% savings
Cladding	fibre cement cladding	cedar	3,072 kgCO_2e	+12% cost
Insulation (Exterior Walls)	2x6 with fibreglass batts	2x6 with blown cellulose	2,194 kgCO_2e	+33% cost
Total Material Carbon Intensity	**159 kg CO_2e / m2**	**46 kg CO_2e / m2** **71% Reduction**		
Total Material Carbon Emissions	**21.9 t of CO_2e**	**6.3 t of CO_2e** **80% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- Appropriate siding in a location with high **fire risk**
- Pier **foundation** versus slab on grade
- Emission implications of aesthetic choices (e.g., exposed beams and high ceilings)
- How **cellulose** is manufactured and why it's considered carbon sequestering
- **Lower carbon concrete mixes**
- The Material Carbon Intensity by Density function and the importance of overall **material consumption/house size**

BP04 New Build at the Building Permit Stage





2,371 ft^2

4 Bedroom

1 Dwelling Unit

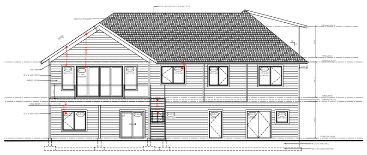
Prospective: Step Code Level: **4** Air Changes per Hour: **1.5** Annual Energy Consumption (GJ/yr): **51**

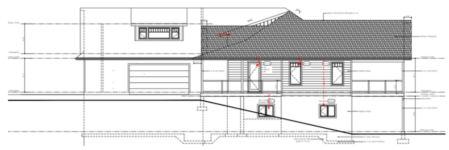
	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	2x6 24" OC, R22 fibreglass, 2" rockwool	2x8 staggered studs with blown cellulose	4,124 $kgCO_2e$	15% savings
Concrete	canadian average mix	30-40% fly ash	1,289 $kgCO_2e$	+5% cost
Flooring	hardwood and carpet	bamboo	3,866 $kgCO_2e$	11% savings
Cladding	steel panels	cedar	2,320 $kgCO_2e$	+40% cost
Insulation (Flooring)	R40 fibreglass batts	R40 blown cellulose	1,547 $kgCO_2e$	+29% cost
Total Material Carbon Intensity	**117 kg CO_2e / m2**	**57 kg CO_2e / m2** **51% Reduction**		
Total Material Carbon Emissions	**25.7 t of CO_2e**	**12.9 t of CO_2e** **57% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- Low carbon and energy efficient **wall assembly** options
- The importance of packing **cellulose** with the right density and the need for more local training on how to effectively install cellulose
- The absence of use, replacement, and recyclability considerations in the BEAM estimator tool
- Lower carbon **concrete mixes**
- **Fire resilient siding** options and the embodied emissions impact of installing a sprinkler system with wood siding
- The overall emissions impact of **green roofs**

BP05 New Build at the Building Permit Stage





3,508 ft^2
2 Bedroom
1 Dwelling Unit

Prospective: Step Code Level: **4** Air Changes per Hour: **1.5** Annual Energy Consumption (GJ/yr): **60**

	Proposed Material	Readily Available Material Substitution	Embodied Carbon Reduction	Estimated Cost Difference
Exterior Walls	2x6 with fibreglass batts	2x6 with blown cellulose	2,715 $kgCO_2e$	+33% cost
Concrete	canadian average mix	30-40% fly ash	2,327 $kgCO_2e$	+5% cost
Flooring	vinyl	bamboo	3,103 $kgCO_2e$	+30% cost
Cladding	fibre cement	cedar	3,490 $kgCO_2e$	+12% cost
Insulation (Roof)	R60 fibreglass batts	R60 blown cellulose	5,042 $kgCO_2e$	29% savings
Total Material Carbon Intensity	**119 kg CO_2e / m^2**	**73 kg CO_2e / m^2** **62% Reduction**		
Total Material Carbon Emissions	**38.8 t of CO_2e**	**23.8 t of CO_2e** **18% Lower than the Nelson & Castlegar Average**		

Main Topics of Conversation during the Consultation:

- Low carbon **siding** options (engineered wood siding versus fiber cement)
- **Recyclability** concerns and the limitations of the BEAM estimator tool
- How different **carbon sequestering building materials** are made (e.g., wood fiber board, cellulose, etc.)
- The impact of flooring choices and the importance of **aesthetic** to a homeowner final decision
- The importance of **fire resilient** building practices