May 2021

Embodied Carbon in Nelson:

Current Work Being Done and Planned Initiatives to Come

Background

In alignment with our new Climate Change Action Plan, Nelson Next, The City of Nelson has been investigating ways to more effectively reduce emissions associated with our building sector. As expressed in Figure 1, there are two emission categories of concern when it comes to buildings: operational carbon (the greenhouse gas emissions produced through energy use associated with building use e.g., heating, cooling, ventilation, lighting etc.) and embodied carbon (the emissions produced through the creation of building materials, construction processes, and material disposal throughout the whole lifecycle of a building)[1].

The BC Step Code has been implemented to reduce operational carbon, but without also attempting to understand and address embodied carbon, we run the risk of promoting energy efficient homes that use carbon intensive construction materials. Or in other words, we risk cancelling out some of the emission reduction benefits of energy efficiency if embodied carbon is not considered in tandem with the Step Code.

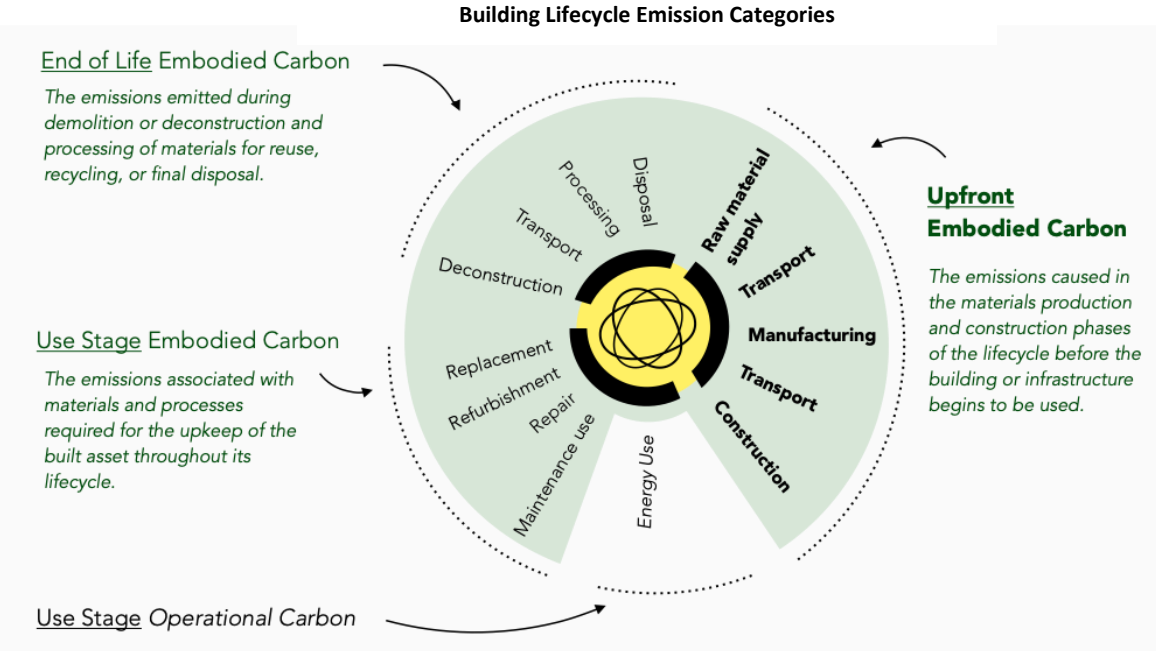

Figure 1 *Lifecycle diagram showing how embodied (sections with green background) and operational carbon are most commonly conceptualized. This diagram has been adapted from one first published by the World Green Building Council in their 2019 "Bringing Embodied Carbon upfront" report (page 18).*

After becoming aware of this risk, and in alignment with Nelson Next, City staff instigated a small-scale study analyzing the upfront embodied carbon of homes recently constructed to high Step Code levels in Nelson. Overall, the goal of this investigation was to verify our assumptions that high efficiency products may also have high amounts of embodied carbon and determine whether a larger-scale study would be

[1] Of Note: Operational and embodied *carbon* can also be referred to as operational and embodied *emissions*. Since this is a relatively new field there are still some issues regarding terminology standardization.

appropriate. *Upfront* embodied carbon refers to the emissions associated with materials used during the building phase of a project. For the purposes of our research, we limited our analysis to upfront embodied carbon. This choice was made because upfront embodied carbon is the focus of the calculator and modelling tool that we had access to, it represents one of the most significant overall offenders regarding the overall lifecycle emissions of a building, and action on it will have the most immediate impact on reducing carbon emissions. It is estimated that upfront embodied carbon "will be responsible for half of the entire carbon footprint of new construction between now and 2050, threatening to consume a large part of our remaining carbon budget[2]"[3] and thus reminds us of the urgency of this action. As we continue to reduce our operational carbon through promoting energy efficiency and low or zero carbon energy sources, embodied carbon is projected to become the dominant overall contributor of emissions associated with the building sector (see Figure 2 & 3). It is important to state that the shift in focus toward the *entire* carbon footprint of a building does not mean that energy efficiency isn't critical – it is. The argument is simply that both types of emissions must be considered and addressed in tandem. Neglecting to understand and address embodied carbon ignores a large part of our overall emissions.

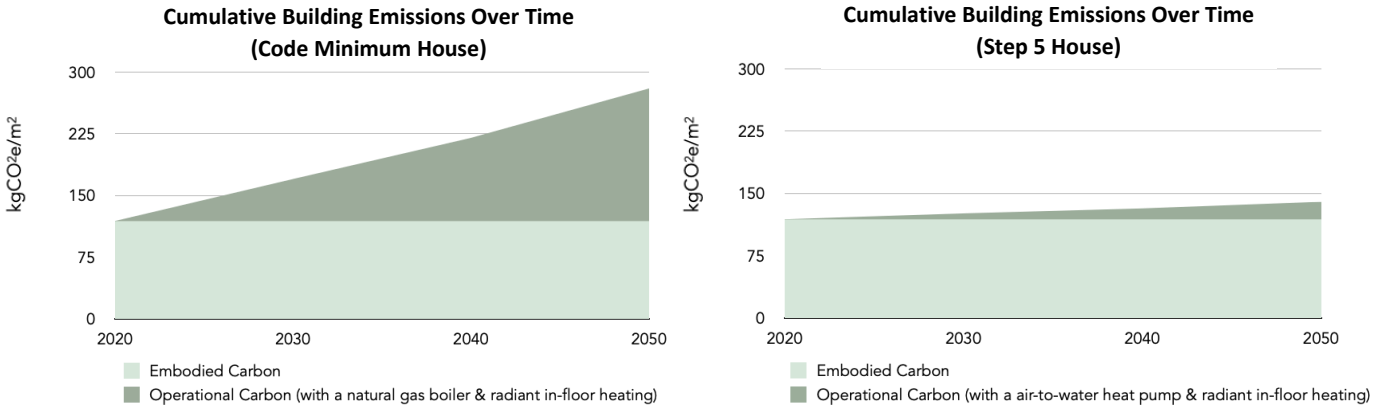

Figure 2 & 3 *These two graphs highlight both the impact that energy efficient choices can have to our overall emissions and the need to address embodied carbon in tandem with these actions.*

Although the Province of BC's Office for Mass Timber and Natural Resource Canada are beginning to incorporate embodied carbon considerations into their research and planning activities, they are not yet at a stage where they can provide clear guidance to municipalities regarding how to measure and reduce embodied carbon. It is likely that embodied carbon will be addressed in the next iteration of BC's Step Code alongside energy efficiency considerations, but due to the increasingly urgent nature of climate change and in order to align with our bold climate targets, we are acting now.

Preliminary Research Findings

The *Analyzing Up-Front Embodied Carbon Emissions for New Construction in Nelson* study is a first in investigating how we can more holistically address building emissions, and it builds on the momentum already created by our capable and forward-thinking building community. The study – summarized below - seeks to examine how both low embodied carbon and high efficiency materials could help reduce the total emissions contributions of our building sector.

[2] A carbon budget is most commonly defined as the cumulative amount of carbon dioxide (CO_2) emissions allowed to be emitted over a period of time to keep within a certain temperature threshold (e.g., limiting warming to 1.5C to avoid significant climate change ramifications).
[3] Quote taken from page 17 of the World Green Building Council's 2019 "*Bringing Embodied Carbon Upfront"* report.

To complete this preliminary investigation, a small sample of three homes in Nelson (constructed to high Step Code targets between 2019-2021) were examined. The embodied carbon associated with the materials used to build the homes were analyzed and compared with low upfront embodied carbon *alternate* materials with the same R-value (a measurement of a material's ability to insulate/resist heat-transfer). Figure 4 visualizes this comparison between the upfront embodied carbon of the homes as they are built (see dark grey bars in Figure 4) with the upfront embodied carbon of the homes as if they had been built with low embodied carbon materials (see light blue bars in Figure 4). The alternate low carbon materials utilized for this study were attainable within the region, cost-equivalent, and performance equivalent. This analysis was used to assess the feasibility of using low-carbon material options and the relationship between the higher efficiency homes and higher embodied carbon numbers.

To determine the amount of embodied carbon associated with certain material choices, a beta version of the Builders for Climate Action BEAM calculator was used. The BEAM calculator is a carbon footprint modelling tool that relies on environmental product declarations (EPDs) for all conventionally used construction materials. While the three sample homes analyzed using the BEAM calculator utilized a variety of different construction materials and attained different Step Code levels, this research is by no means comprehensive. Rather, it begins to reveal a few trends, with the preliminary analysis showing that a) the use of low embodied carbon, alternate materials would have contributed to an average 77% reduction in upfront embodied carbon (while still maintaining equally high R-values), and b) the upfront embodied carbon of homes increased as the Step Code level increased (see Figure 4).

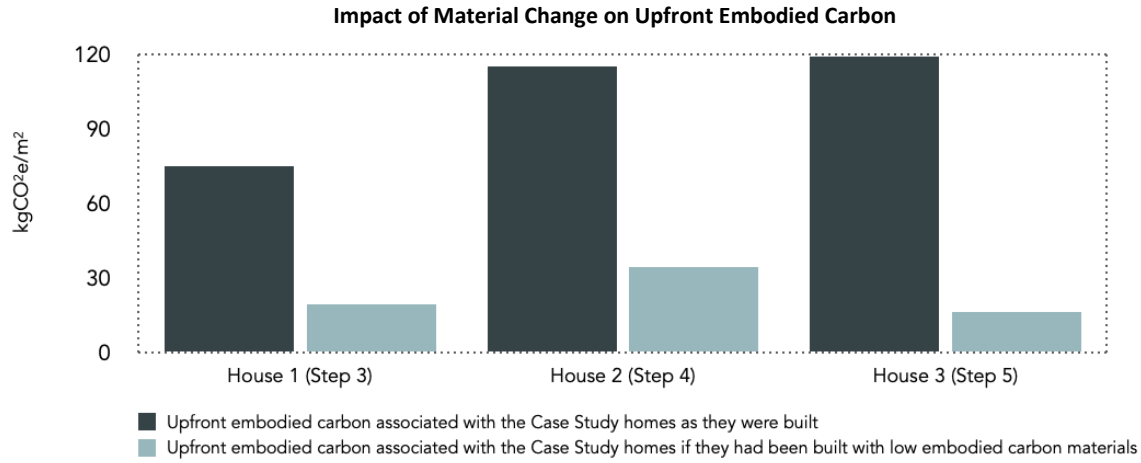

Figure 4 *This graph demonstrates how significant material selection is to the upfront embodied carbon intensity of buildings.*

Unbeknownst to many, some of the worst offenders for upfront embodied carbon are materials that are touted for their superior energy efficiency performance. For example, many foam products have been promoted for their high R-values, but these products also have some of the highest upfront embodied carbon. Without understanding the upfront embodied carbon of conventional construction materials, we may be inadvertently leading builders and homeowners to choose materials that they believe are 'green' (in that they will support energy efficiency) but are in fact only addressing operational carbon, while neglecting embodied carbon.

While these trends are concerning, the good news is that it is absolutely possible to build Step 4 and 5 homes with low upfront embodied carbon, at limited or no extra cost, with materials that are readily available in Nelson and area.

In line with findings from other municipalities communities conducting similar analyses (e.g., outlined in the City of Vancouver's recently completed *Embodied Carbon Strategy*), our preliminary findings suggest that the following material changes have the potential to make the largest impact on reducing upfront embodied carbon:

- **Limit concrete use.** This could be done by designing a home with no basement, supported on piers, or using a treated wood foundation.
- **For necessary concrete use, specify mixes with high percentages of supplementary cementitious materials (SCM).** This will reduce the amount of Portland cement required, which has a high upfront embodied carbon.
- **When possible, choose natural products.** This includes cellulose, timber, wood fiber board, cork, bamboo, among many others. Some significant contributors to upfront embodied carbon in Nelson include vinyl windows, vinyl flooring, and cement board siding, which could all be subbed out for natural alternatives.
- **Avoid foam products**. Though commonly used for sub-slab applications, alternatives like expanded glass aggregate are gaining popularity and availability.

As the province moves to require Step 3 by 2022, which Nelson adopted as of March 2021, and Step 5 by 2032 - concerns about embodied carbon are only going to become amplified, especially as we're learning more about the correlation between high efficiency building materials and high embodied carbon. The '*Analyzing Up-Front Embodied Carbon Emissions for New Construction in Nelson'* study has demonstrated that neglecting to assess up-front embodied carbon in conjunction with operational carbon does have the potential to contribute to increased emissions overall. Due to this conclusion, it is recommended that builders and homeowners take immediate action to select equivalently priced, low-carbon building material options, and that a more robust study with a larger sample size and more extensive materials research be conducted by the City.

Next Steps

In response to this recommendation, the City of Nelson has successfully sought out funding from FortisBC to compile an in-depth embodied carbon and energy efficiency analysis and policy scan - tentatively titled '*Building Better in Nelson: Addressing the Embodied Emissions and Climate Impact of our Housing Stock'*. This project will aim to improve the City's understanding of how to integrate embodied carbon considerations into our local context, and offer related policy and program recommendations and building guidance focused on optimal building materials (aka high efficiency and low embodied carbon). Understanding and quantifying both operational carbon *and* embodied carbon is critical to lowering the overall GHG footprint of our built environment and achieving our ambitious climate action goals. This project aims to help us do that.

The research will involve a larger, more representative analysis of homes in Nelson, integrate best practice research conducted through a partnership with BCIT, and engagement with builders and City staff to determine high-impact policy and/or program recommendations to appropriately address embodied carbon in our city. This analysis will be led by Natalie Douglas (Climate Change Planning Assistant) and Sam Ellison (Senior Building Inspector) at the City of Nelson with help from a number of operational and embodied carbon specialists. The project will take place between May and November, and include data collection, policy research, data analysis, consultation, and content creation (educational and policy). The City of Nelson is well positioned to become a leader in addressing embodied carbon and we look forward to working together to make this a reality.