Building Better in the Kootenays

Addressing Embodied Carbon in Energy Retrofits

Why is it important to address?

To date, much of the work that has been done to reduce the environmental impact of buildings has focused on new construction (e.g., BC Energy Step Code). More recently, this has begun to shift as we approach our 2030 emission reduction targets and as governments begin to allocate significant funding to energy retrofits on existing buildings (e.g., Canada's Greener Homes Grant). As we begin to grapple with the large number of energy retrofits required to improve the efficiency of our existing building stock, another important consideration becomes clear: the emissions impact of material consumption.

Energy retrofits often require the addition of building materials and new mechanical systems, which have a significant emissions impact. Policies and programs aiming to reduce emissions in existing buildings often focus on operational carbon and fail to consider embodied carbon. **There is no doubt that increasing energy efficiency is an incredibly important part of improving the sustainability and resilience of buildings, but pursuing energy retrofits without any consideration of embodied carbon risks contributing an unnecessarily large amount of emissions in the short term.** It is important to remember that *when* greenhouse gas emissions are released, matters. Addressing embodied carbon helps reduce emissions in the short-term, which is immensely important in the fight to limit the worst effects of a warming planet.

The fact that there is a lack of high quality data on the specific types and quantities of materials in energy retrofit projects should not be used as a justification for inaction. Focusing on certain key material categories is a good place to start since energy retrofit projects often rely on many of the same materials (see table below). The upfront embodied carbon data associated with building materials is equally as relevant to retrofits and renovations as it is for new construction. Resources developed as part of embodied carbon research projects intended for new construction (e.g., City of Nelson's Material Carbon Emissions Guide) can and should be used to inform material choice in energy retrofits projects.

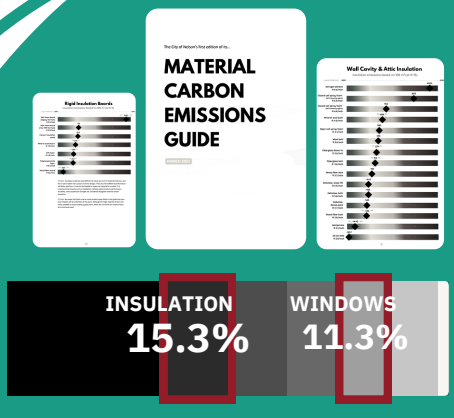
Minor Retrofits	Major Retrofits	Deep Retrofits
e.g., "sealing with caulking or spray foam, adding *insulation*, [and] upgrading lighting systems".	**e.g.,** "replacing *window* glazing and doors, updating inefficient heating and cooling systems, installing low-flow faucets with sensors and automatic shut-offs, [and] installing sub-metering".	**e.g.,** "significantly reconfiguring the interior, replacing the roof, adding or rearranging *windows* for increased daylight, [and] replacing the heating, ventilation, and air-conditioning system with a renewable technology like a ground-source heat pump".

This table uses Natural Resource Canada's categorization of energy retrofits.

Operational carbon refers to the greenhouse gas emissions (GHGs) emitted through building energy use (e.g., heating, cooling, and lighting).

Embodied carbon refers to the GHGs produced through the manufacturing, transportation, installation, maintenance, and disposal of building materials.

Of note:
It's important to remember that energy efficiency measures have the most impact in regions where the grid produces higher emissions. For example, in a region where coal is heavily relied on as the main energy source, reducing energy consumption will result in more significant emissions savings.



This graph shows that insulation and window materials make up, on average, a **quarter** of embodied carbon emissions associated with new low-rise residential construction projects in Nelson and Castlegar in 2020 and 2021. This is intended to demonstrate the relative emissions intensity of building materials commonly used in retrofits.

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What actions can we take?

To increase the likelihood that an energy retrofit project reduces overall GHG emissions, try to use more bio-sourced materials, re-use materials where appropriate and safe, and avoid the worst offenders (e.g., avoid hydrofluorocarbons - commonly referred to as HFCs - that are used as blowing agents in spray foam and as synthetic chemical refrigerants in heat pumps).

Like in all aspects of our society, **excessive material consumption in energy retrofit projects must be interrogated with more scrutiny. This process of inquiry will require more collaboration between homeowners, governments, and building professionals**. It will require that we collect more data about the materials used in energy retrofits and assess what the embodied carbon emissions associated with these choices are so that we can make more informed choices.

Accounting for emissions is complex and it must be acknowledged that as manufacturing processes, technological innovations, and government regulation evolve, the performance of different material categories will shift over time. In the meantime, however, here are a **series of recommendations to reduce the embodied carbon associated with energy retrofit projects based on the best available research in early 2023:**

If you're located in the Regional District of Central Kootenay, you can access the **Regional Energy Efficiency Program**. This program seeks to assist homeowners navigate the complex world of energy retrofits. For more information on incentives, contractors, and mechanical system choices, you can sign up at rdck.ca/reep.

Regional Energy Efficiency Program

Insulation

- ***Use bio-based materials*** like cellulose, wood fiber, wool, straw bale, and hempcrete. They are all insulation materials that can sequester carbon and are thus recommended as a good low-carbon option.
- ***Limit or avoid petroleum-based compounds*** like spray foam and XPS foam. If needed, polyiso and EPS have slightly lower embodied carbon emissions.

Windows

- The question of whether the move from double to triple pane windows is worth the small embodied carbon cost remains somewhat controversial. In regions where the grid remains carbon intensive, triple-pane windows seem to be worth it.
- Research on the emissions significance of framing is not yet conclusive but preliminary investigations suggest that ***wood framing*** contributes fewer emissions than fiberglass, aluminum, and vinyl framing.

Siding

- ***Reusing siding materials*** wherever possible will contribute to the most significant emission reductions associated with siding.
- Wood siding has lower embodied carbon emissions but may not be appropriate in areas where wildfire risk is high.

Interior Wall Finishes

- If using gypsum board/drywall, ***refer to Environmental Product Declarations (EPDs)*** to determine which products have the lowest emissions.
- Some alternatives to drywall include plywood, wood planks, and various types of plaster. Due to a lack of embodied carbon data on different types of interior wall finishes, there are no clear recommendations.

HVAC (Heating, Ventilation, and Air Conditioning)

- ***Use a refrigerant with a lower GWP*** and avoid refrigerants that are particularly emissive (i.e., some refrigerants can be up to 1,000 times more impactful to global warming than comparable volumes of CO_2). If you're purchasing a heat pump, ask the question of what refrigerant it's using. *Refer to the table on the next page to see the Global Warming Potential of different refrigerants.*
- ***Reduce refrigerant leakage*** by specifying factory-sealed equipment (this reduces chance of leakage during transportation and installation) and being sure to take the necessary steps to capture and recover all the refrigerant at the end of the equipment's life. If you're using a piece of equipment that uses refrigerants, you can limit the changes of leakage by using an HVAC contractor with appropriate training (e.g., TECA certification).

Low Carbon Homes Pilot Project Team

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Highest GWP ⟵ ⟶ Lowest GWP

	R12	R22	R407c	R401a	R123a	R32	R1234ze	R1233zd	R290 (Propane)	R744 (CO_2)	R717 (Ammonia)
Global Warming Potential	10,700	1,810	1,774	2,088	1,430	677	1	1	4	1	0

This table ranks different refrigerants by their Global Warming Potential with the least impactful options shown at the right end of the table. This table was adapted from a more detailed graphic published in Elementa's 2020 Refrigerants & Environmental Impacts Best Practice Guide. Read the full report to see how these refrigerants compare in terms of pressure, freezing and boiling points, toxicity, flammability, and more.

This brief was compiled with information from the following sources:

Academic Papers

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