Minimizing Embodied Carbon

Strategies for low-rise MURBs

To support the outcomes of the Paris Agreement, buildings need to become more efficient and produce fewer greenhouse gas emissions (GHGs). A holistic approach to reducing emissions needs to consider the whole building lifecycle, including construction, maintenance, operations, and deconstruction. A large portion of the emissions during a building's lifecycle come from the manufacture, installation, maintenance, and replacement of building materials. For example, the manufacturing of brick involves mining for clay, crushing it, forming it, and heating it to a high temperature in a kiln. Each of these steps produces carbon emissions along the way.

The subset of emissions related to building materials is typically referred to as embodied carbon to distinguish it from the operational carbon associated with powering and heating buildings.

Through research and iterative design studies, Kindred Works has identified a set of measures with potential to meaningfully reduce the embodied carbon of multi-unit residential buildings (MURBs). Kindred Works is actively deploying these measures on sites to achieve its goal of producing 80% less embodied carbon in construction than current industry standards.

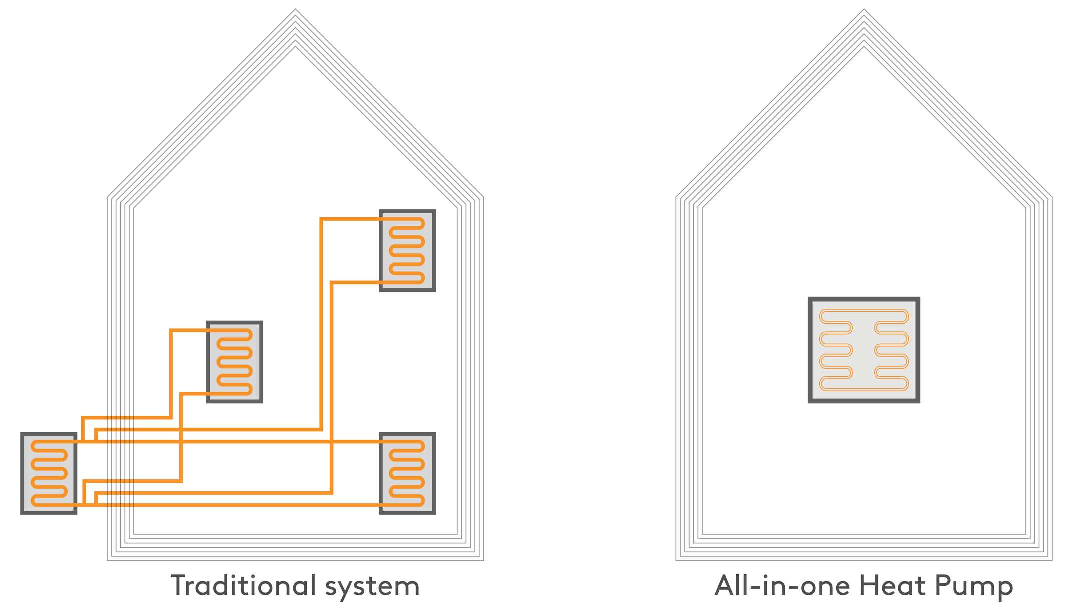
KINDRED WORKS

This diagram was partially funded by CMHC's Affordable Housing Innovation Fund which supports new ideas that will drive change and disrupt the industry, including ideas and approaches that will evolve the affordable housing sector and create the next generation of housing in Canada.

1 Canada Green Building Council. (2024). Zero Carbon Building - Design Standard Version 4.
2 London Energy Transformation Initiative. (2020). Embodied Carbon Primer.
3 Turnbull, G., Graham, J., Constable, D., & Dharmaraj, S. (2021). Embodied carbon values of common insulation materials. Canadian Architect.
4 Optimum insulation thickness depends on project-specific factors such as the insulation material used, climate, building heating/cooling systems, and carbon intensity of building fuel sources.

Minimize Refrigerant Leakage

4 metric tonnes avoided CO2 per residential unit

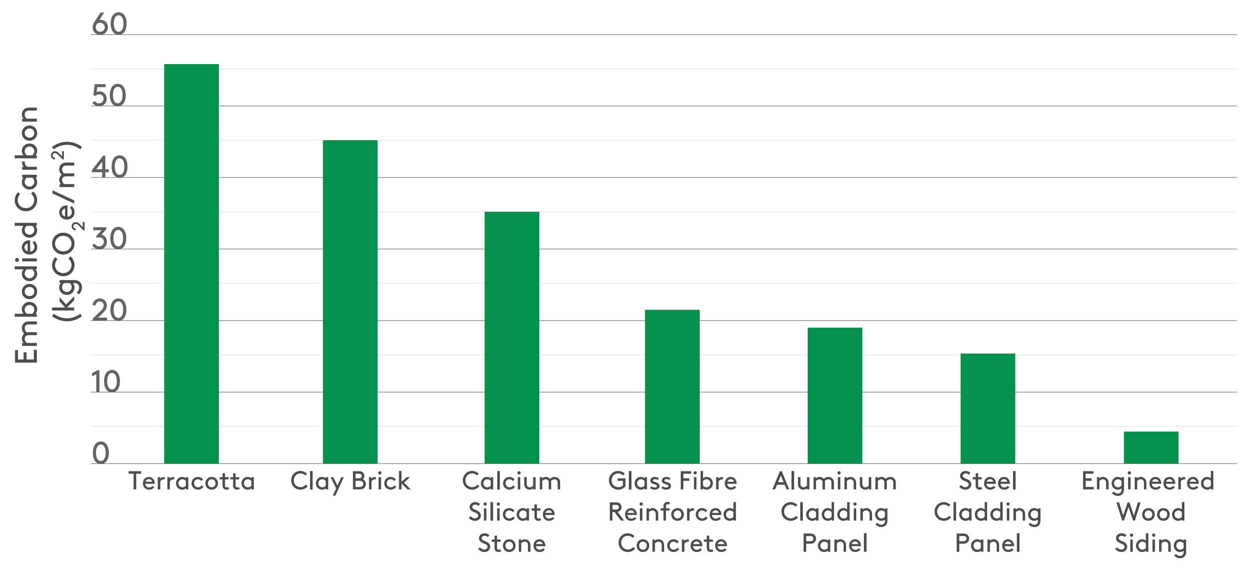


Air conditioners and heat pumps contain a gas that, over time, leaks out into the atmosphere. This is a problem because the gas, called refrigerant, happens to be an extremely potent greenhouse gas. Some refrigerants have nearly 2000 times the global warming impact of carbon dioxide[1].

The harm done by refrigerants can be mitigated by choosing the right mechanical system. Split-type heat pumps require more refrigerant and have many site-assembled connections which increase the potential for leakage. Compact, all-in-one heat pumps require less refrigerant and come pre-charged from the factory, limiting the potential for leakage during installation.

Robust & Low GWP Cladding

Up to 100 kilograms avoided CO2 per square meter of facade

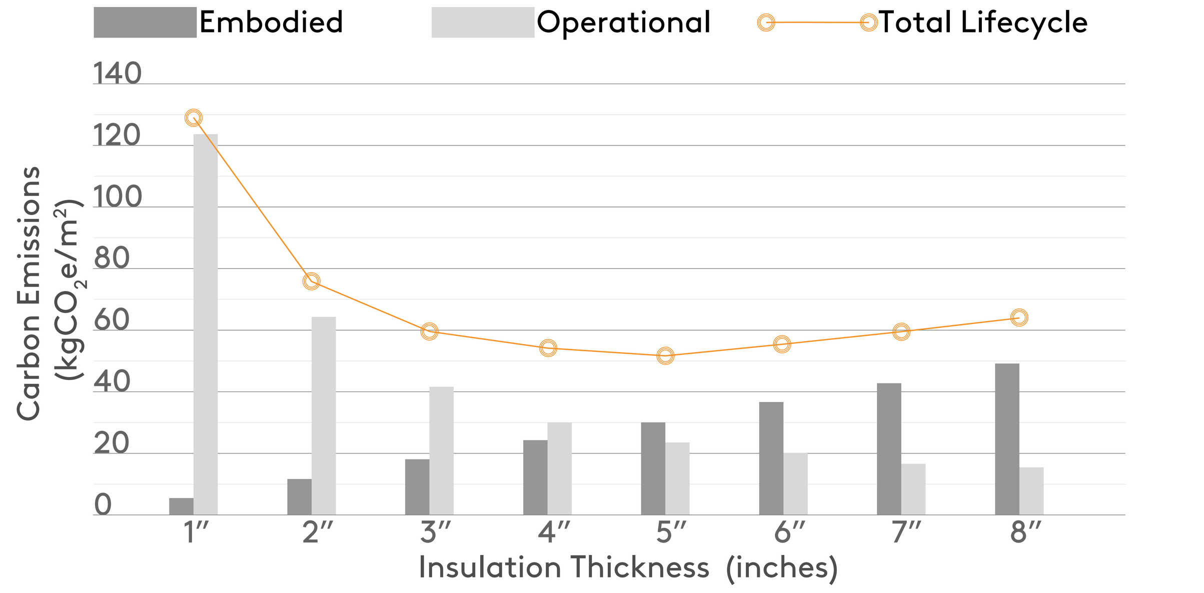


Cladding is a wall's first line of defence against the elements. It protects all the components underneath – including insulation and structural framing – from deterioration. Given this important role, it makes sense to use a robust material for cladding. Poor quality cladding will require more frequent replacement throughout the building lifecycle, subsequently adding to lifecycle carbon emissions.

Certain cladding materials – such as precast concrete or terra cotta – are robust but have a high GWP (global warming potential) due to the manufacturing processes involved. Treated wood cladding, on the other hand, has a low GWP and can last many decades when used as part of a ventilated rainscreen design.

Optimize Insulation Thickness

9 kilograms avoided CO2 per square meter of insulated wall



The purpose of insulation is to resist heat flow. Thicker insulation is inevitably better at resisting heat flow and subsequently saves more energy and operational carbon. However, as more insulation is added, more embodied carbon is added. Beyond a certain point, the operational carbon savings do not warrant the added embodied carbon[3]. Iterative design studies, coupled with energy simulations, can reveal the optimum insulation thickness for minimizing lifecycle carbon emissions.

Wood Structure

17 kilograms avoided CO2 per square meter of framed wall

Lightweight wood framing and mass timber construction can save a large amount of embodied carbon compared to other structural systems, such as steel framing and/or reinforced concrete. This is largely because wood products (e.g., glulam beams), require minimal processing and manufacturing of the raw, natural materials. Mass timber structures are also lightweight, which can reduce the volume of concrete used below-grade as foundations.

Minimize Below-grade Concrete

3 metric tonnes avoided CO2 per omitted basement

Due to its abundance in buildings, concrete tends to be a significant contributor to overall embodied carbon[2]. A large portion of concrete is used below-grade to form foundations, basements, and parking garages. Adapting building programs to minimize basements and underground parking is an effective way of minimizing total embodied carbon.