Embodied GHG of Missing Middle

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Summary

Urban communities today are facing the concurrent and critical challenges of a growing demand for housing and the need to reduce material consumption to mitigate the impacts of climate change. This research quantifies the impact of residential form on embodied emissions. Specifically, it examines the potential of "missing middle" (low-rise multi-unit) housing to reduce embodied emissions compared to single family and mid/high-rise buildings, while identifying opportunities for optimizing efficiency within forms. *Embodied Emissions* refers to the CO_2eq emissions generated during the upstream processes of manufacturing a product (such as in mining, manufacturing, transportation, and installation).

Drawings for 39 missing middle, 41 single family homes and 22 tall buildings were compared for this research. For each building, material volumes and material mass were calculated. That data was then converted using emissions factors for common construction materials to determine the building's embodied CO_2eq mass.

Key Findings:

1. The embodied GHG efficiency of missing middle is highly variable across buildings - between 5540 and 39,600 CO_2eq/bedroom.
2. Multi-unit missing middle housing has lower mean embodied efficiency per bedroom than single-family buildings (averaging 12,700 kgCO_2eq/bedroom compared to 17,000 kgCO2eq/bedroom, respectively).
3. Laneway suites are the least efficient form of missing middle housing. This is largely because many laneways dedicate their ground floor to parking for the primary residence. This uses a lot materials for parking rather than housing and requires additional insulation. Eliminating parking and adding bedrooms would transform the results for laneway suites.
4. Concrete, thermal, and waterproofing elements drive emissions in all forms. Reducing substructure construction (i.e. basements and parking garages) has significant potential to reduce embodied emissions in all forms.
5. Observed embodied emissions vary more within forms than between forms (30% - 51% variation within forms vs. 20% variation between the mean of each form). Therefore, strategies for reducing the embodied GHG of housing should emphasize best-in-class construction along with sustainable form selection.
6. Tall buildings can be (often are) low embodied GHG, it is more dependent on design than form.

Constructing missing middle buildings with optimal design choices could reduce embodied GHG emissions in future residential housing. Best-in-class design would include limiting the substructure, limiting structural steel, limiting step backs, and choosing low-GHG insulation elements. By building 1st quartile missing middle buildings, Ontario could reduce embodied residential GHG emissions by 46.7%.

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