

Embodied GHG Emissions in Buildings: Where Regulations Stand, What Science Demands, and the Gap Between Them

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Summary

The need for housing is increasing globally at a time that climate science requires reductions in all sectors. This paper asks if current regulations for embodied GHG in building codes can meet science-based carbon budgets to keep global warming 'well below 2°C'. The study reviews 18 regulations and frameworks as applied in 12 countries and compare the maximum allowable embodied carbon for new housing contained within each regulation or framework against targets based upon carbon budgets for the construction sector.

This paper first evaluates how regulations define and regulate embodied GHG emissions, what life cycle stages are covered, whether compliance with the regulatory rules are voluntary, mandatory or a mix of both, what kind of functional units are employed (kgCO_2/m^2 , per year or material-specific), as well as how mechanical, electrical and plumbing (MEP), refrigerants, and on-site construction energy are accounted for.

Second, science-based benchmarks are derived downscaling from existing construction sector carbon budgets and spreading that over projected floor area under equity-per-capita (EPC) - every person on the planet is allocated the same allowable emissions - and grandfathering (GRA) - countries start reducing from their current emissions - allocation scenarios.

When policy regulatory caps are compared with these benchmark results, they highlight that policy benchmarks are more permissive than science-based targets across all six national frameworks reviewed Canada, Finland, France, Germany, Sweden and United Kingdom. Assuming business-as-usual (BAU) future housing delivery, the gap between the policy and science-based caps ranges from 5–65%. These gaps increase when accelerated (ACC) housing delivery scenarios are considered, a scenario where more homes are built to meet population growth. As the same total carbon budget must cover more dwellings and floor area, the allowable per- m^2 emissions decrease. In contrast the regulatory caps are not tied to construction quantities and remain fixed. The size of the gap between regulation and science-based targets is very sensitive to the size of future housing as illustrated in the error bars in the figure below. Smaller average dwelling size, by reducing the total amount of m^2 constructed, makes it easier to align housing construction with science-based targets.

None of Canada, Germany, Finland, and the UK have regulations that align with climate science under any of the ACC scenarios tested. Climate-compatible policy would therefore need dynamic benchmarks that reduce as housing delivery accelerates, with explicit controls on total floor-area growth and typical dwelling size.

To align regulations with climate targets they must a) consider total emissions across the sector and adjust accordingly b) have regularly updating targets that consider shrinking budgets and total construction and c) adjust for total floor area in a proposed project rather than just emissions per m2.

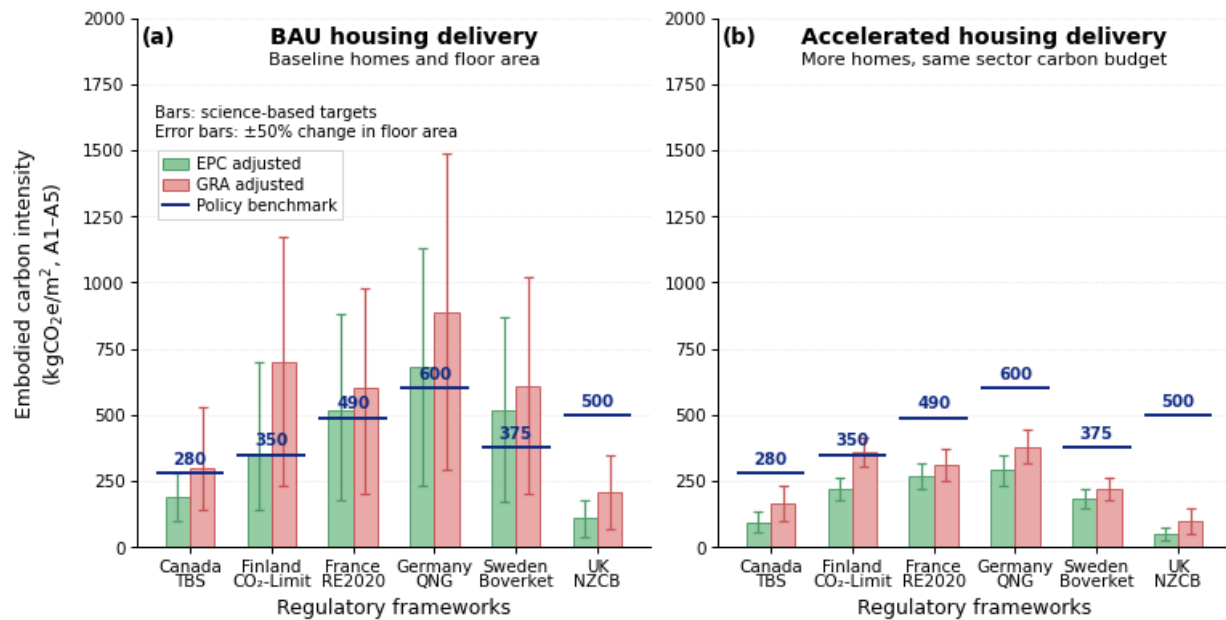


Figure 1. Sensitivity of science-based embodied carbon targets to housing delivery assumptions across six scenarios (kgCO₂e/m², A1–A5). Showing $\pm 50\%$ BAU, and ACC cases.