A future infrastructure growth model for building more housing with less embodied greenhouse gas

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A growing number of countries are facing two conflicting challenges: the need to build much more new housing and infrastructure to meet demand, and the need to reduce construction emissions to limit climate change. Here we develop a new approach, the Future Infrastructure Growth (FIG) model, to find pathways for building enough housing and infrastructure while reducing material emissions to meet climate commitments. FIG simulates material emissions at any scale (neighbourhood up to country scale) while retaining high levels of detail. We demonstrate the model on Canada to explore how the country can build affordable housing while still meeting its emissions reduction targets.

The key idea behind FIG is that it calculates the greenhouse gas (GHG) required to build existing neighbourhoods as if they were constructed now - or in the future - and uses repetition of existing neighbourhoods to model future growth. The model uses open input data on the arrangement of infrastructure, the materials used in construction and GHG impacts of materials.

When applying FIG to Canada, we find three striking results:

1) Suburban, single-family neighbourhoods have higher embodied emissions across both buildings and infrastructure. Shifting away from single-family construction towards multi-unit neighbourhoods, whether low or high-rise, can greatly reduce emissions (Figure 1).

2) If Canada builds more but keeps building like it does now, construction emissions will overshoot Canada's reduction targets by >400% in 2030. The best way to reduce construction emissions in the next decade is to make technically simple building design changes (e.g. building less underground, building smaller homes, reducing circulation space, avoiding transfer slabs) and to build more multi-unit neighbourhoods.

3) It is possible to build enough housing to restore affordability while meeting climate commitments, but it requires dramatic changes in how Canada builds its homes. It requires almost no new single-family construction, better building designs (in line with the best 25% of buildings built now), optimistic material production improvements, avoiding building new roads, and a doubling the re-use of existing buildings (Figure 2)

Figure 1 – Example of embodied GHG emissions in neighbourhoods per capita (if they were built today).

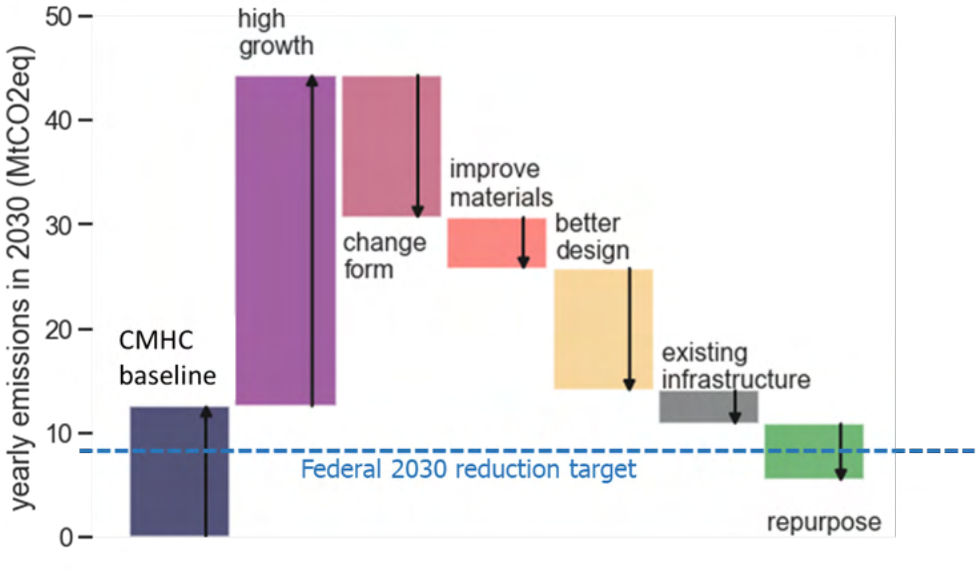

Figure 2 – How Canada could build affordable housing while still meeting proportional greenhouse gas reduction goals in 2030