

Meeting Conflicting Targets

By 2050, the United States is projected to add 121 billion ft² of buildings—equivalent to constructing New York City every year for the next 20 years. However, to meet climate change goals the U.S. building sector must also significantly reduce its greenhouse gas (GHG) emissions. In this brief, we investigate which GHG mitigation solutions could help meet these GHG targets even as the nation experiences such unprecedented construction.

A Set of Scenarios

To model the effects of potential mitigation solutions, a variety of residential and commercial buildings and different design scenarios were used

as reference buildings. The design scenarios included several GHG mitigation strategies targeted at lowering the impact of building materials and energy consumption (**Table 1**). We conducted analyses using these buildings in 14 cities from different climate zones over a life span of 50 years. We then scaled the results from these reference buildings and cities using projections of new construction between 2016 and 2050.

This allowed us to estimate the contribution of embodied (materials and construction) and operational (energy consumption) impacts to the overall carbon footprint of new construction in the building sector while evaluating the potential for the strategies to lower GHG emissions.

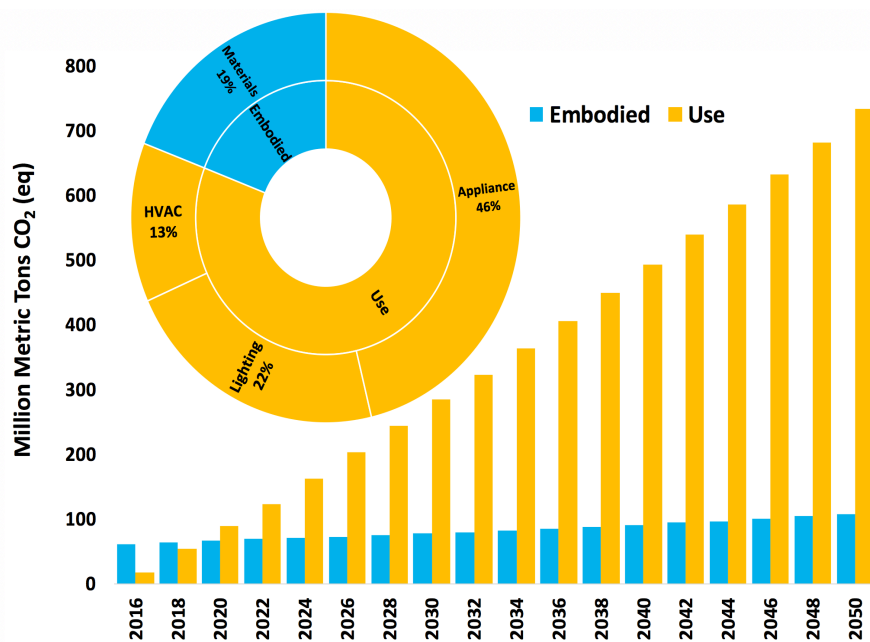


Figure 1: Total expected GHG emissions from newly constructed buildings in the U.S. from 2016 to 2050 if no GHG mitigation solutions were implemented.

Halving Emissions

We found that if no GHG mitigation strategies were implemented, embodied carbon emissions would represent 19% of cumulative new construction emissions between 2016 and 2050. The remaining impacts would derive from the operational emissions of buildings—in particular, from appliances and lighting (**Figure 1**).

We compared this no-change scenario to a scenario in which several GHG mitigation strategies were implemented (**Figure 2**). Here, the most impactful strategies included the decarbonization of the electricity grid and improvements to the energy efficiency of appliances and lighting.

Increased HVAC efficiency and improvements to thermal insulation, including the use of insulated concrete forms, led to the remaining operational emissions reductions. The decrease in the embodied emissions in this scenario derived solely from the use of low carbon concrete in new buildings—even in those not primarily made of concrete.

Without implementing these mitigation strategies, cumulative GHG emissions generated from newly constructed buildings between 2016 and 2050 will reach 17.6 Gt of CO₂ (eq). However, if implemented, GHG emissions over that same period would fall to 9.6 Gt of CO₂ (eq)—a reduction of around 8 Gt of CO₂ (eq).

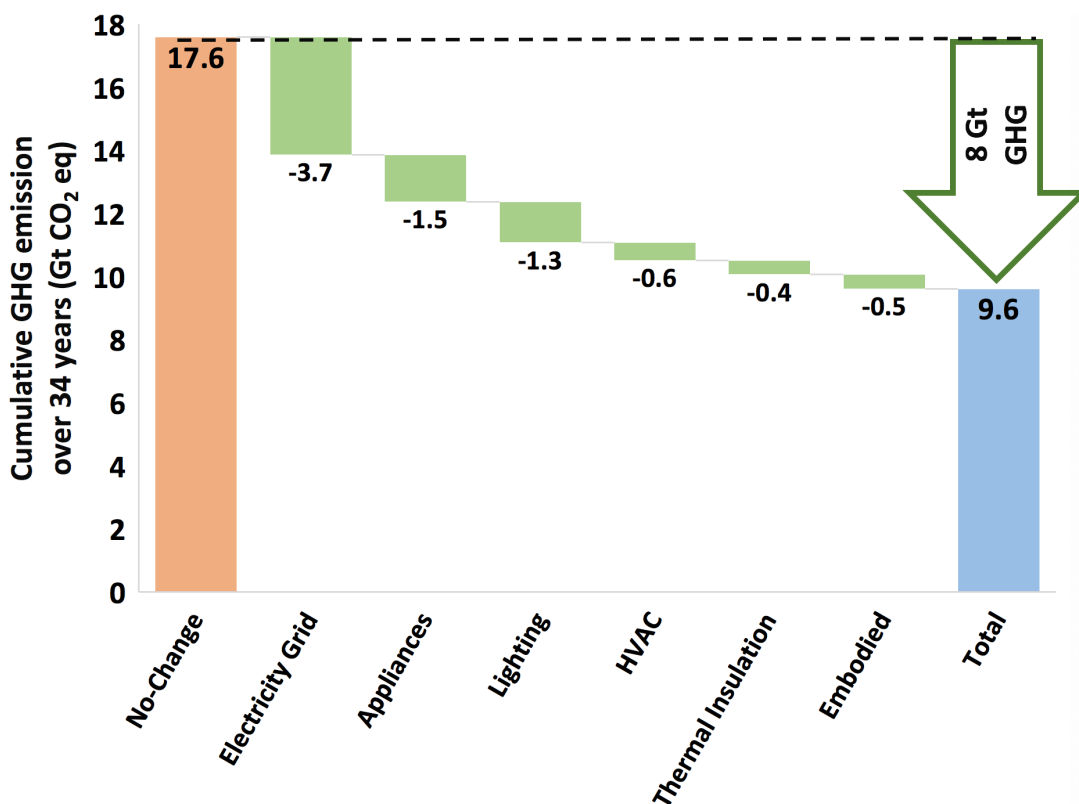


Figure 2: Cumulative GHG emissions in newly constructed buildings over 34 years (2016-2050) and the impacts of various mitigation solutions.

Table 1. The various GHG mitigation solutions modeled in this case study. Bold terms refer to energy code standards.

Emissions Sources	Mitigation Solutions
Electricity Grid	Grid decarbonization following the US EIA projection for New York (NYLI) which based on a 33% reduction in GHG emissions.
Appliances ¹ , Lighting ² , HVAC ³ , and Thermal Insulation ⁴	<ul style="list-style-type: none"> • Start in 2016 with 60% IECC 2015 & 40% IECC 2009 • 100% IECC 2015 adoption in 2025 • 100% EE adoption in 2035
Embodied Impacts	GHG emissions in concrete mix production will be reduced by linearly implementing 50% low-carbon binders by 2022 as well as CCUS by 2035, which involves carbon capture for cement plants and utilization of captured carbon for aggregate production.
<p>1. IECC 2009 & IECC 2015: refrigerator: 434 kWh/year, cooking range: 500 kWh/year, dishwasher: 167 kWh/year, washer & dryer: 46 kWh/year, EE: refrigerator electricity usage: 348 kWh/year, cooking range: 400 kWh/year, dishwasher: 83 kWh/year, washer & dryer: 37 kWh/year</p> <p>2. IECC 2009 & IECC 2015: 66% Incandescent, 21% CFL, 13% LFL (1964 kWh/Unit/year), EE: 100% LED (1056 kWh/Unit/year)</p> <p>3. IECC 2009: 7ACH50-Air Leakage, IECC 2015: 3ACH50-Air Leakage, EE: 1ACH50-Air Leakage, Furnace-IECC 2009: 80% Fuel utilization efficiency (FUE), IECC 2015: 95% FUE, EE: 98% FUE</p> <p>4. Wall, slab, and roof insulation were considered according to IECC codes requirements for buildings envelope characteristics.</p>	

Key Takeaways:

- This research models how the U.S. can accommodate unprecedented construction while meeting emissions targets.
- If no solutions were implemented, embodied carbon emissions would constitute 19% of all emissions from new construction between 2016 and 2050.
- A number of interventions—chiefly to the electricity grid and appliances and lighting—could nearly halve the emissions of buildings constructed between 2016 and 2050.

Related Links:

- [CSHub Building Life Cycle Analysis Research](#)

Citation:

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