Net-Zero Buildings at HBS: Embodied Carbon

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Harvard Business School (HBS) and Harvard more broadly have made significant strides in reducing the fossil-fuel emissions associated with campus educational and research activities; **the University has achieved a 30% reduction in emissions** through a combination of cleaner grid energy and significant investment in sustainable projects on campus.

Harvard's investment in greener buildings has allowed for significant progress in reducing emissions from "Building operations" (depicted below as ≥20% of global CO2 emissions); an additional 8% of the planet's emissions, however, are associated with the actual construction of the buildings themselves. We examined this notion of "embodied carbon" in the context of HBS construction projects and identified both specific components that are responsible for large percentages of a project's emissions as well as what data are available to guide relevant purchasing decisions.

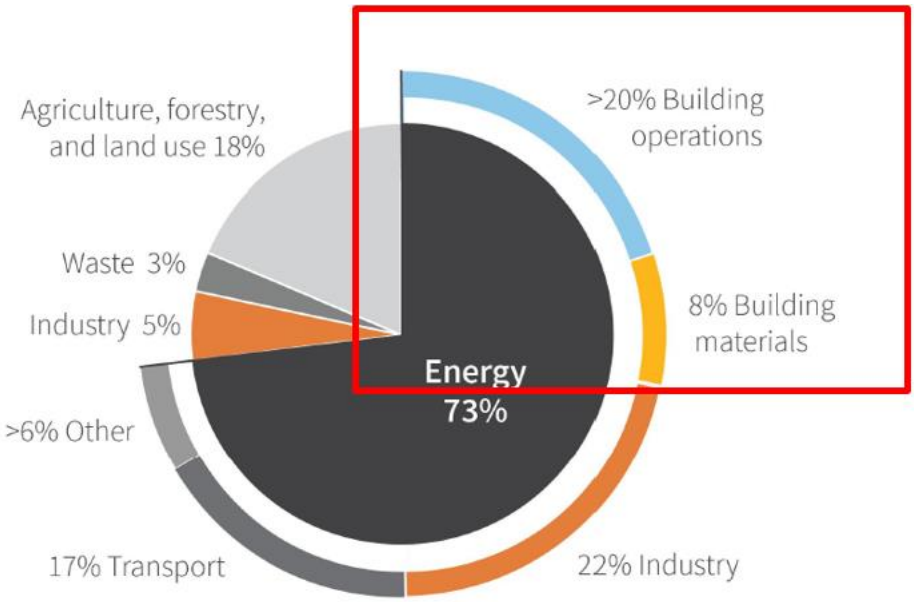
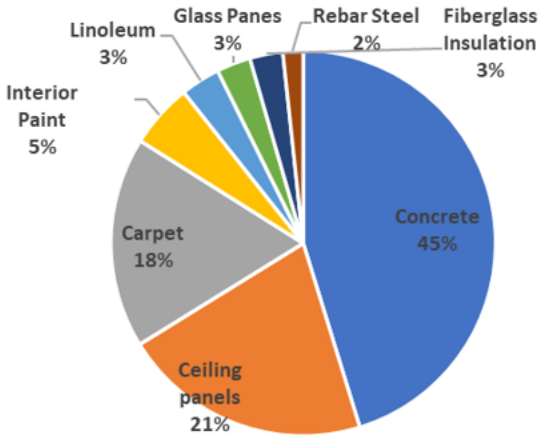


Figure 3. Global CO_2 emissions by sector. Adapted from the UNEP 2019 Global Status Report and OurWorldInData.org based on data from Climate Watch, the World Resources Institute. Building material emissions also occur in the Industry and Energy > Industry sectors.

Target Materials

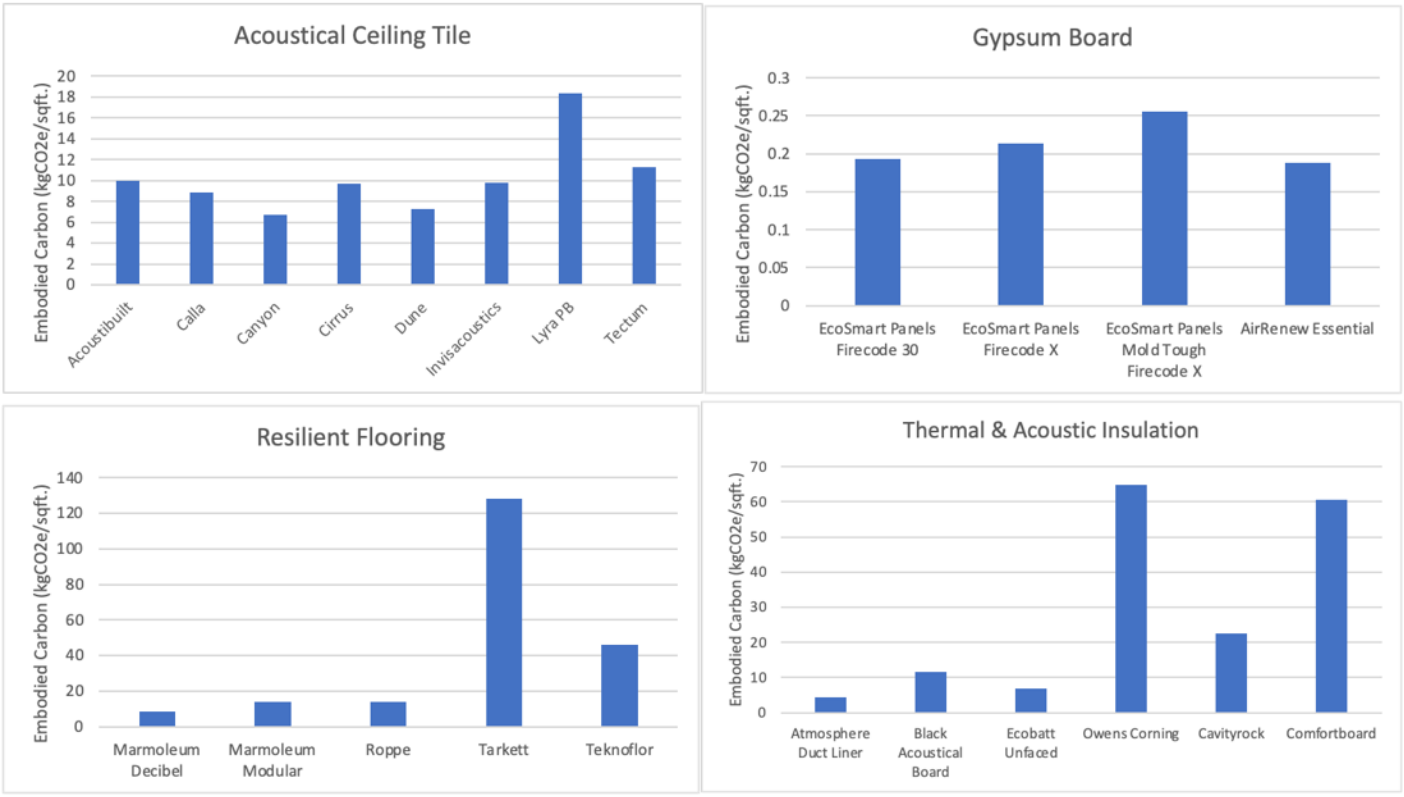


	Lifespan (yrs)	Quantity	Metric	# times replaced in 100yrs	Conservative Emissions	Emissions over 100yr
Concrete	100	2.17	tonne	1.0	1040.0	2256.8
Ceiling panels	15	100	1ft2	6.7	1.6	1045.3
Carpet	8	50	1ft2	12.5	1.4	883.8
Interior Paint	10	37	m2	10.0	0.7	270.1
Linoleum	25	50	1ft2	4.0	0.8	165.9
Glass Panes	30	50	1lbs	3.3	0.9	142.9
Fiberglass Insulation	100	380	1ft2	1.0	0.4	138.2
Rebar Steel	100	0.05	tonne	1.0	1700.0	85.0

Analyzing the embodied carbon in various construction materials and their relative lifespans produces a force-ranked list of building components' emissions intensities and an estimate of the potential reduction in impact should a more sustainable alternative become available. Unsurprisingly, concrete is responsible for a large fraction of embodied carbon emissions in buildings. New advances in concrete production (including pozzolan and other materials) allow for lower emissions intensities, and we recommend that HBS continue to evaluate how applicable these new technologies are for capital improvements in the future.

More immediately actionable, however, are results demonstrating that ceiling panels and carpet also make up large fractions of the embodied carbon in buildings. The frequency with which these components are replaced would allow HBS to evaluate the market for more sustainable options and then act comparatively quickly to reduce the embodied carbon of its facilities.

Embodied Carbon Data



The materials previously shortlisted for preferred use by Harvard University were analyzed using Building Transparency's Embodied Carbon in Construction Calculator (EC3). This data revealed that even within these curated lists, there is heterogeneity in embodied carbon. HBS could reduce embodied carbon in ceiling tile by ~60% by selecting lower intensity ceiling tile products, for example.

The coverage of materials in the EC3 database is not complete, and more analysis is called for to both broaden the list of building components with known impact and to gain the ability to tailor recommendations to specific construction projects and supply chain constraints. However, the above results represent an exciting step in HBS's journey towards a more sustainable campus and driving forward the global need to reduce embodied carbon in buildings.