

CASE STUDY

Using Cost and Carbon Data to Guide Design

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Comparing different building schemes early in the design process helps clients understand tradeoffs between embodied carbon emissions, overall project costs, and key goals. When done well, comparative analysis can guide teams toward optimal project schemes that reduce embodied carbon emissions with little or no increase in costs.

The Challenge

The effectiveness of this comparison relies on clear definitions of project scope and functional equivalence between building design options. For a valid comparison, design variations must include the same physical project scope, account for the same LCA modules, and meet the same performance criteria, even if their materials and layouts differ.



The Approach

Aligning scope requires careful attention to several building systems, including:



Structural Systems: When evaluating different structural systems (e.g. concrete flat slab vs. mass timber post-and-beam), teams must account for obvious performance requirements, such as gravity and lateral load resistance, as well as secondary impacts to other building systems, like fire performance, acoustic performance, floor-to-ceiling heights, and integration of mechanical, electrical, and plumbing (MEP) systems.



Enclosure Systems: When comparing insulation materials, the analysis must consider how varying R-values per inch determine wall cavity thickness, which, in turn, affects usable floor area and overall building volume.

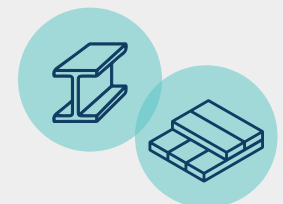


Finish Materials: Analyses should consider the level of interior finish provided by different design alternatives. Higher-quality finishes command higher property values and rents, but they also typically cost more upfront. As such, a valid comparison would consider equivalent levels of interior finish or remove finish materials from the scope of assessment.

Expanding the scope of analysis and building performance variables can provide a more holistic view, but it can also increase the complexity and cost of the analysis. The goal is to find a balance where the analysis provides sufficient clarity for client decision-making without overextending preconstruction resources.

Proof of Concept: The Washington CDHY Classroom Wing Expansion

A recent project led by [Skanska](#), a global project development and construction company, exemplifies this methodology in action. Skanska led the design-build process for a K-12 classroom wing as part of a campus expansion for the Washington Center for Deaf and Hard of Hearing Youth (CDHY) in Vancouver, Washington. Early in the design phase, Skanska challenged the project team to explore low-carbon design options beyond the business-as-usual steel-frame building that might have been proposed on a low first-cost basis. They provided a conceptual estimate of the costs and embodied carbon emissions of functionally equivalent steel and mass timber buildings to help the owner make informed decisions.

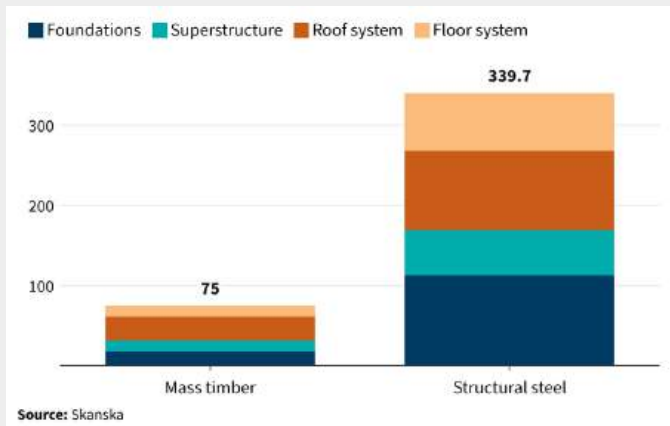


Results: The comparison results, illustrated in the Exhibit 1, demonstrate that the mass timber frame option cut emissions by 78% with only a 1.25% increase in initial costs. All building components examined – foundation, structure, roof, and floor – achieved emissions reductions of over 60%, with the largest savings in the foundation (84%) and structure (81%).

Proof of Concept: The Washington CDHY Classroom Wing Expansion (cont.)

A cascading structural benefit drives this efficiency: replacing a structural steel system with a lightweight mass timber system significantly reduces the building's self-weight, enabling a ~70% reduction in the size of spread footings. Skanska also found that replacing steel buckling-restrained braces (BRBs) with large plywood shear panels reduces the mat foundation size by nearly 90%. This method was practical for the two-story CDHY building, resulting in significant savings in foundation materials, though the emissions reductions from foundations may be lower in taller multi-story buildings.

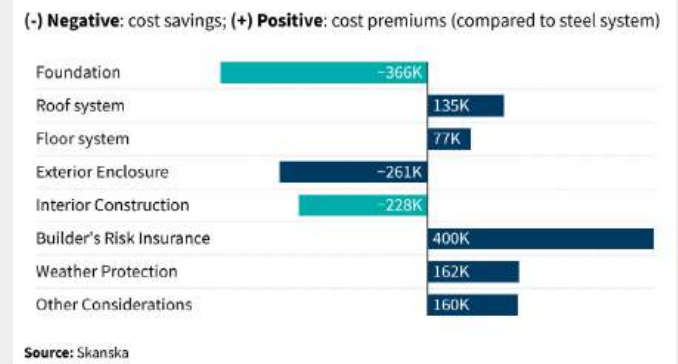
Exhibit 1: Embodied Carbon Emissions (MT CO₂e) of Different Structural Systems



Cost considerations: Exhibit 2 shows the cost premium for mass timber systems compared with structural steel. Positive values indicate the more expensive mass timber categories, such as the roof system and floor system. Negative values indicate a cost premium for steel. This premium includes higher costs for the foundation, exterior enclosure, and interior. Compared to mass timber, additional material would be needed to reach the same level of interior finish for the library, atrium, and conference rooms, where wood finishes were desired for improved acoustics and a warmer aesthetic.

The largest premium for a mass timber building is for a builder's risk policy, due largely to conservatism in the insurance industry which views mass timber with a similar risk profile to stick framing. As more mass timber buildings enter the market, this premium is expected to drop. The Other Considerations category includes sanding costs for exposed mass timber surfaces and added costs to safely mount exposed MEP systems that acoustic ceiling panels would typically cover in a steel building.

Exhibit 2: Mass Timber System Cost Differences



Beyond the primary metrics of cost and carbon, the Skanska study identified critical secondary benefits that strengthened the case for mass timber design. One such benefit is the material efficiency highlighted above, owing to timber's lightweight advantage – namely, the significant (\$366,000 or 5%-6% of total project cost) cost reduction from smaller, less carbon-intensive foundations.

Further, by serving as both a structural system and a finished surface, mass timber eliminates the need for additional interior finish materials. Skanska estimates that installing equivalent interior wood ceilings throughout the steel frame building could add more than 7% to the total project cost, making the steel building design cost more up front than the mass timber variant.

-78% ↓
EMISSIONS SAVINGS

+1.25% ↑
COST INCREASES

Outcome: Ultimately, the client selected the mass timber option because the exposed timber surfaces would provide better acoustics, visual warmth, reduced stress, and a sense of calm and belonging for the students, and it offered lower carbon emissions for a comparable cost.

When cost and carbon comparisons are integrated into the design process, it is easier to make informed decisions about the tradeoffs between design alternatives. This case study showed a small cost premium for a structurally equivalent mass timber system over a conventional steel design, but significant potential tradeoffs associated with the emissions and other non-energy benefits of choosing a mass timber building.

ADDITIONAL RESOURCES

[Embodied Carbon Assemblies Comparison \(Kaleidoscope\)](#)

[Embodied Carbon Intensity Diagrams of Typical Framing Schemes \(SE 2050\)](#)

[Data-Driven Building Decarbonization Tool \(C.Scale\)](#)

[Exterior Wall Compositions Embodied Carbon Comparison \(Colorado Embodied Carbon Collaborative\)](#)

[EC3 Embodied Carbon in Construction Calculator \(Building Transparency\)](#)