



FIRE HALL

Case Study

City of

NELSON

What this firehall study taught us about cost, carbon, and design choices.

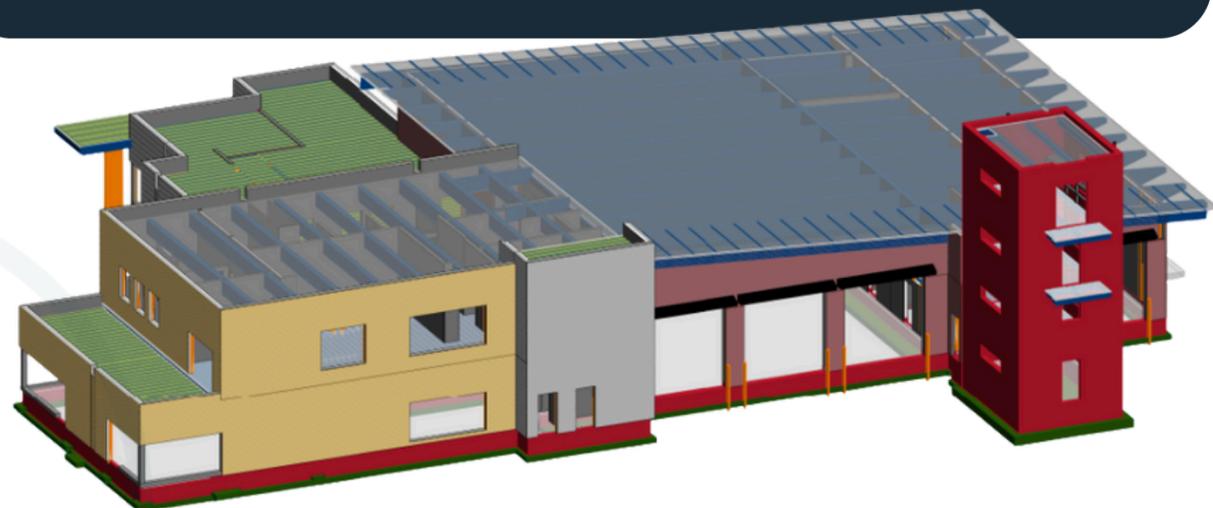
A real project comparison showing why early decisions matter more than material swaps.



The decision being faced

Vision

- Nelson is planning a new civic firehall as part of its broader Low Carbon Homes Pilot
- The City aims to lead by example in low-carbon public infrastructure
- Early decisions on structure, materials, and delivery strategy will shape long-term carbon and cost impacts



Why this study?

Nelson is planning a **new civic firehall**.

Like many communities, the City wanted to understand **how early design and material decisions could affect both cost and embodied carbon**.

To inform those decisions, Carbon Wise analyzed a comparable firehall project that was designed in timber but ultimately built in concrete.

The goal was not to “pick a winner,” but to understand **what actually drives outcomes**.

The Key Insight



Material choice alone did not determine cost or carbon performance.

Design integration and delivery strategy did.

In this case, the concrete option achieved lower construction cost because it was developed as a coordinated, prefabricated system. Structure, enclosure, and insulation were combined into fewer assemblies, reducing material duplication, trade coordination, and on site labour.

However, this same system resulted in higher embodied carbon than the timber option, reflecting the carbon intensity of concrete and steel.

The timber option delivered **lower carbon intensity, but higher cost**, because it was not designed as a fully integrated system. Layered assemblies, additional trades, and site-built construction reduced cost efficiency and limited the carbon advantage associated with timber.



What was compared?

What is WB-LCA?

A Whole Building-Life Cycle Assessment (WB-LCA) quantifies greenhouse gas emissions (kgCO₂e) **across all life stages of a building**, from raw material extraction to end-of-life.

What we looked at

We compared two real designs for a functionally similar firehall:

- A timber-based design
- A tilt-up concrete design

We assessed:

- Embodied carbon across the building lifecycle
- Construction costs, normalized by floor area

Both designs were evaluated using consistent assumptions and industry-standard methods.

Detailed methodology is available in the full technical summary.

What Drove Carbon Outcomes



On a per-square-metre basis, the timber design showed lower embodied carbon.

When only core life cycle stages were included, the timber design was 11% lower in carbon intensity than the concrete design. This difference was meaningful but modest.

When biogenic carbon storage and end-of-life reuse were included, the modeled difference increased substantially. Under these assumptions, the timber design shifted from slightly lower to dramatically lower carbon intensity.

The magnitude of the difference depended heavily on:

- how efficiently building systems were integrated
- whether biogenic carbon was included
- whether circular reuse at end of life was assumed

Key lesson: When timber is paired with integrated design and credible circular strategies, its climate benefit is strong. Carbon outcomes are shaped early, long before construction begins.

GWP

Modules A-C only (per m²)

**11%
LOWER**

- Timber: 242 kgCO₂e/m²
- **Concrete: 272 kgCO₂e/m²**



What this means

Modules A–C capture emissions from material production through construction and end of life. They exclude biogenic carbon storage and future reuse assumptions.

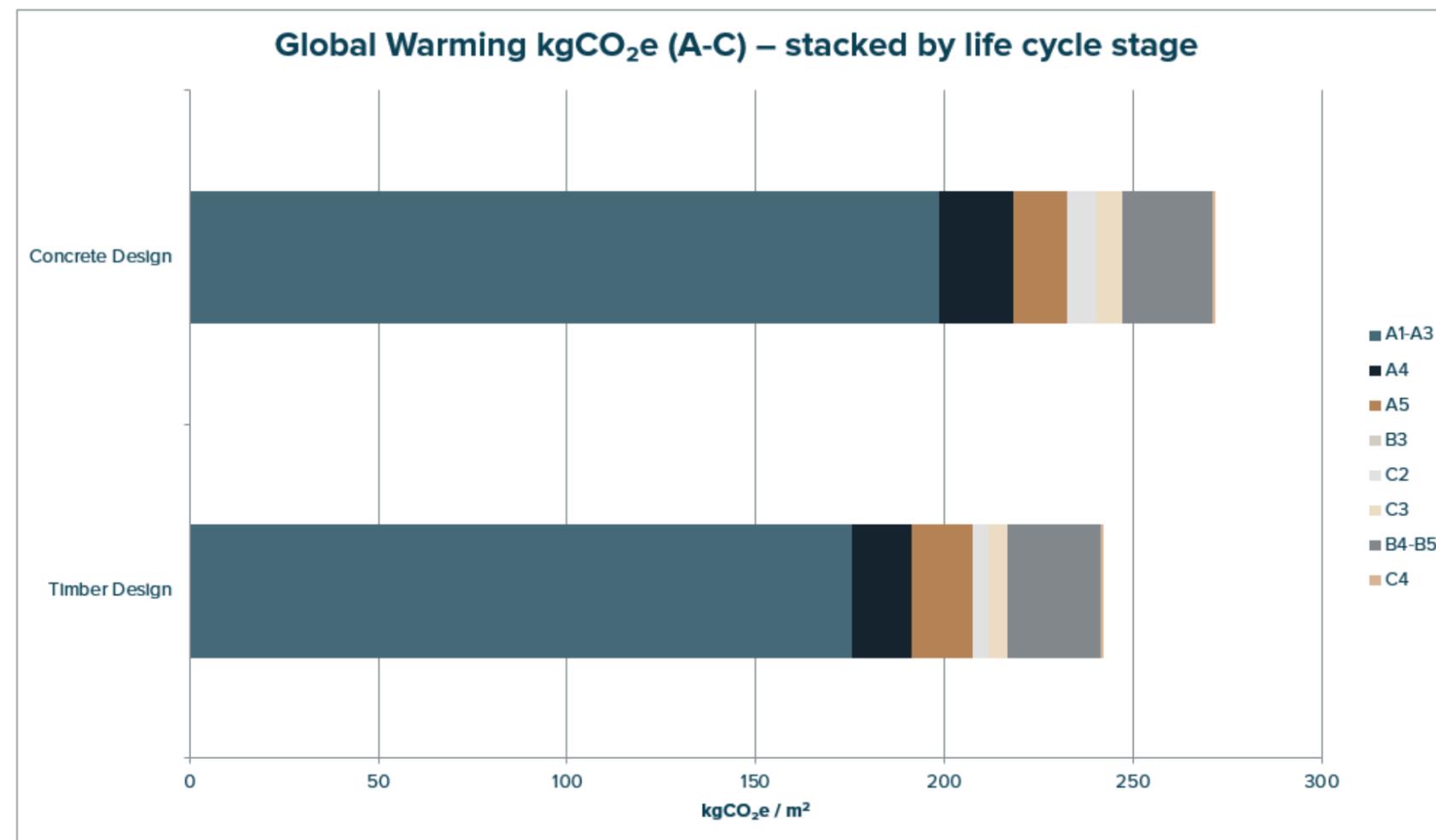
- Timber showed a modest carbon advantage at this stage
- The gap is smaller than often assumed
- Design inefficiencies limited timber's potential

Better integration would likely increase the difference.

GWP

Modules A-C only (per m²)

This chart shows embodied carbon intensity per square metre across core life cycle stages (A–C). For both designs, material production dominates total emissions. Timber shows a modest carbon advantage, reinforcing that **early design and material decisions shape most embodied carbon impacts**.



GWP

Modules A-D (per m²) - circularity Credits

105%
LOWER

- Timber: -10 kgCO₂e/m²
- Concrete: 219 kgCO₂e/m²



What this means

For timber, Module D adds large modeled credits based on assumed circular outcomes, which significantly increases the apparent carbon advantage.

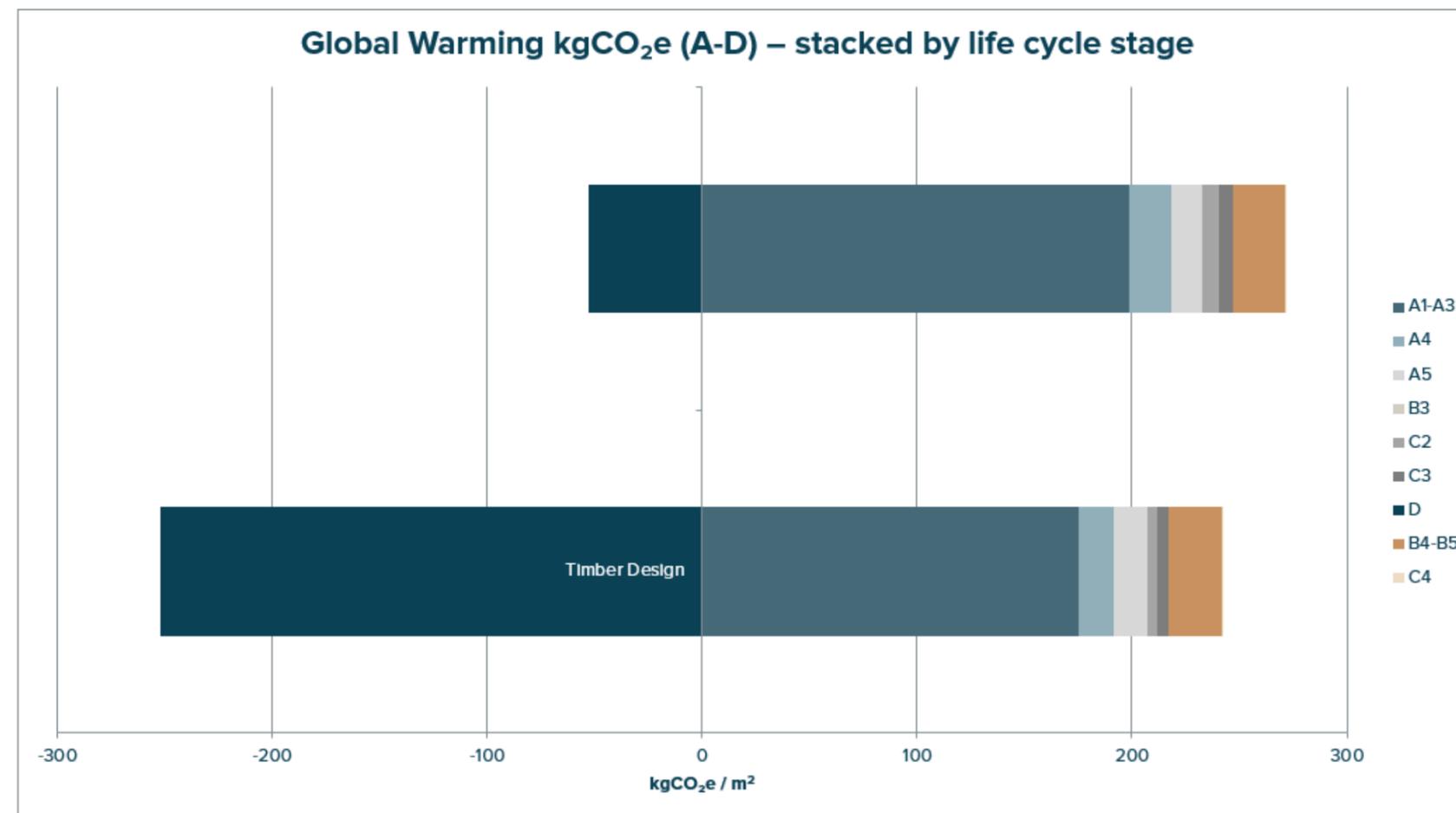
These credits depend on future design for disassembly, recovery pathways, and real-world reuse practices.

Without intentional circular design, these reductions may not be realized.

GWP

Modules A-D (per m²) - circularity Credits

This chart includes Module D, which models potential end-of-life reuse and recycling benefits. Timber receives large circularity credits under these assumptions, driving the large reduction shown. These outcomes are theoretical and depend on future material recovery and reuse.



GWP

Modules A-C (per m²) - with biogenic 

122%
LOWER

- Timber: -60 kgCO₂e/m²
- Concrete: 272 kgCO₂e/m²



What this means

These results include biogenic carbon, which accounts for carbon absorbed during tree growth and stored in timber products at the product stage (A1–A3).

This carbon remains stored only while the material is in use and may be released at end of life if materials are not reused.

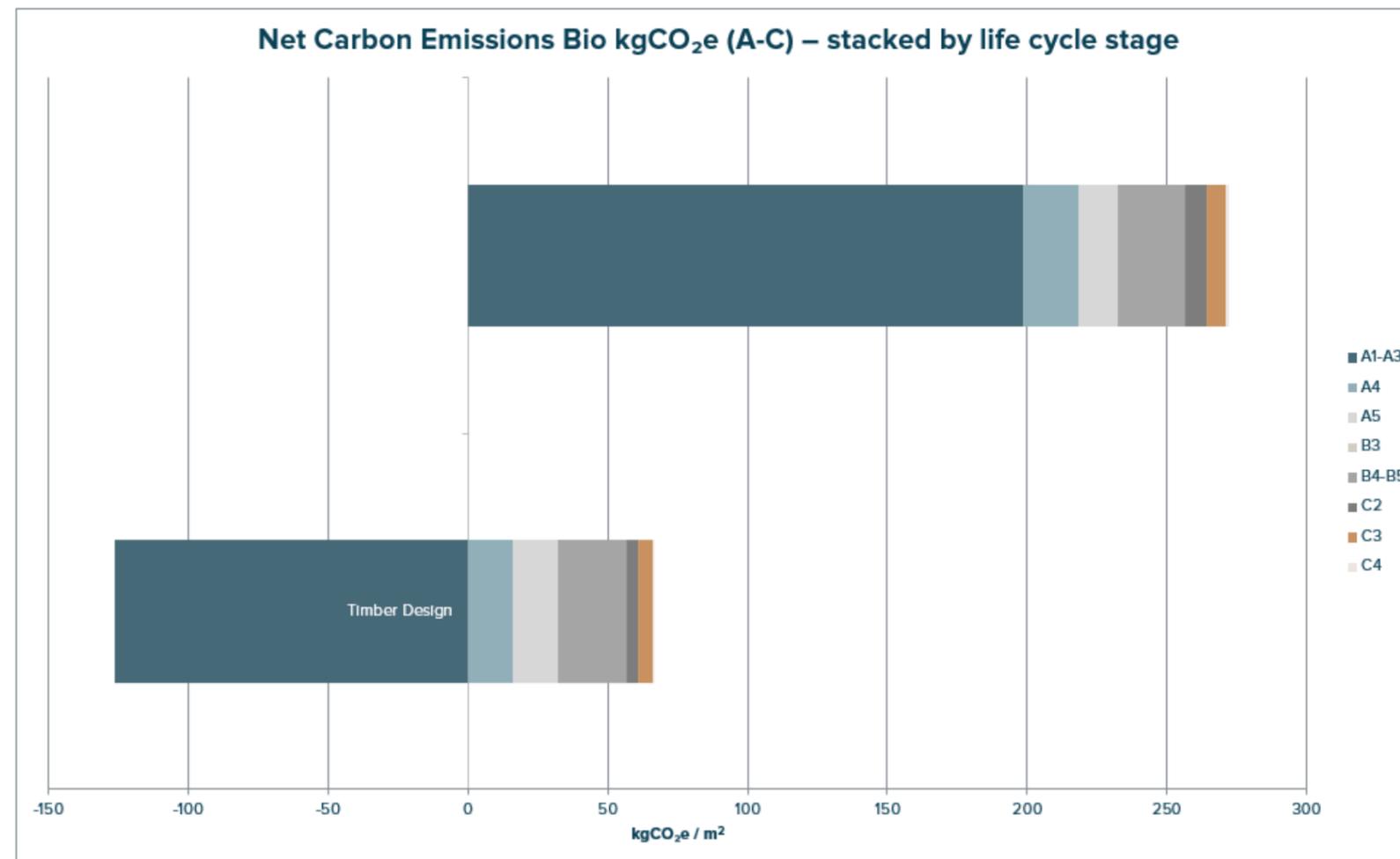
Long-term benefit depends on durability, reuse, and end-of-life treatment.

GWP

Modules A-C (per m²) - with biogenic

This chart includes biogenic carbon stored in timber during growth (A1–A3). This storage lowers the timber design's early life-cycle carbon intensity, but the benefit is temporary and depends on how materials are treated at end of life.

These scenarios are shown to illustrate the range of possible outcomes, not to predict what will happen.



GWP

Modules A-D (per m²) - with biogenic 

24+2%
LOWER

- Timber: -312 kgCO₂e/m²
- Concrete: 219 kgCO₂e/m²



What this means

Biogenic carbon and Module D model potential end-of-life benefits, including reuse and recycling.

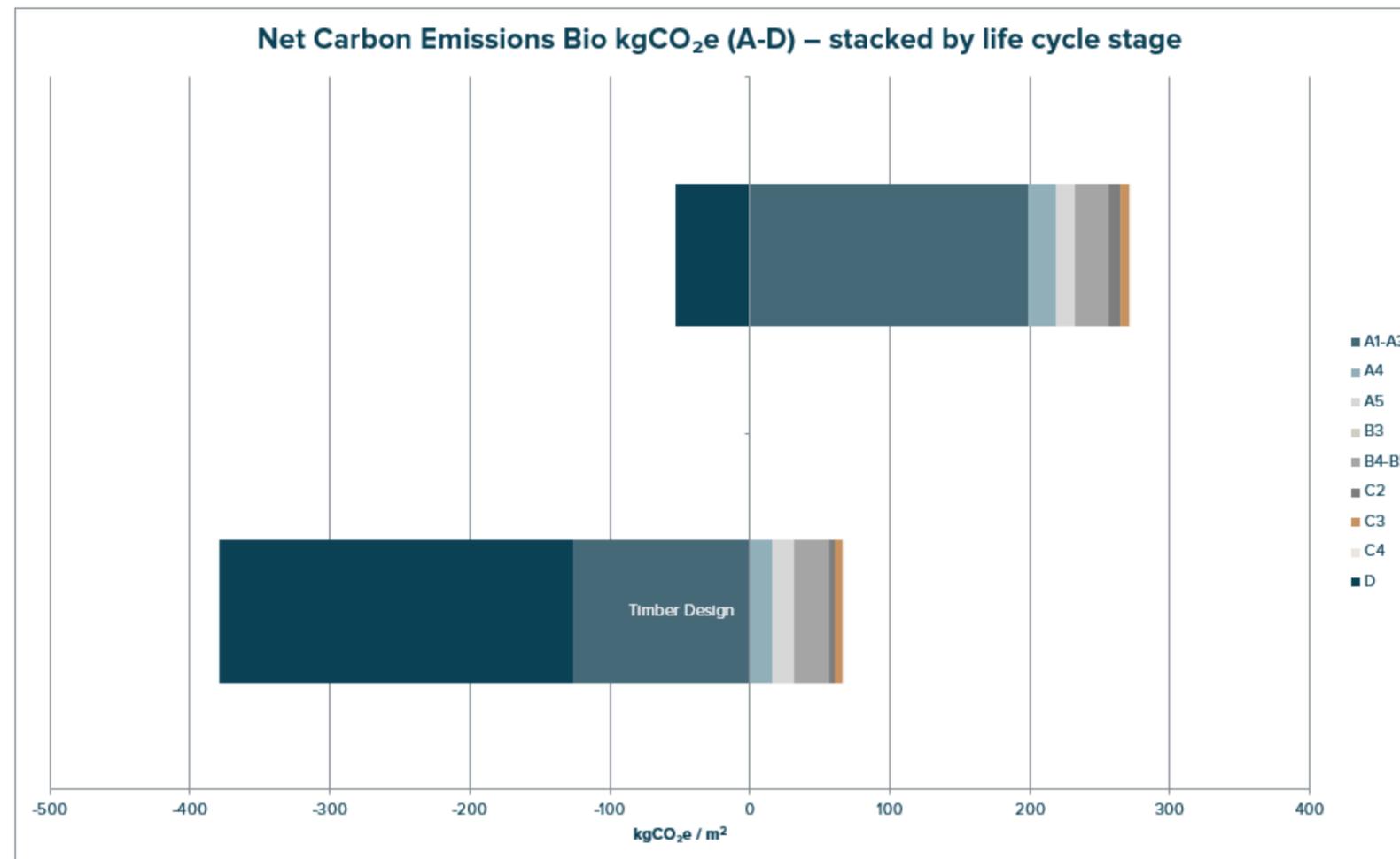
These outcomes are theoretical and depend on future circular design and real-world material recovery. They are not guaranteed.

Without design for disassembly and reuse, these benefits may not occur.

GWP

Modules A-D (per m²) - with biogenic

This chart combines biogenic carbon storage with modeled end-of-life reuse benefits (Module D). Together, these assumptions produce very large credits for timber, showing its maximum potential climate performance. The results are theoretical and depend on future circular outcomes.



What Drove Costs Outcomes



The timber design came in higher on a cost-per-square-metre basis.

Cost outcomes showed a different pattern than carbon, but were driven by the same underlying issue: system design, how the system was designed and delivered, not by timber itself.

Key cost drivers included:

- A lower level of design development
- Layered assemblies rather than integrated systems
- Greater reliance on site-built construction and trade stacking

In contrast, the concrete design integrated structure, enclosure, and insulation into prefabricated panels. This reduced material overlap, coordination effort, and on-site labour.

Key lesson: cost outcomes were shaped by system integration and execution, not material choice alone.

Costs

Normalized

35%
HIGHER

- Timber: \$1,718/m²
- Concrete: \$1,271/m²



What this means

Timber was about 35% higher on a per-m² basis due to design immaturity and layered, site-built assemblies.

The concrete design benefited from integrated, prefabricated systems reducing trade interfaces and on-site effort.

Cost-effective timber requires early system integration and prefabrication, not late-stage material substitution.

What this study does not say

Important Context

This comparison does not represent a fully optimized mass-timber building.

This study also does not test **what an early, purpose-designed mass-timber firehall could achieve** in terms of cost, constructability, or carbon performance. It reflects a comparison between two specific design pathways at different levels of system development.

The timber option relied largely on site-built assemblies and did not benefit from the prefabrication, coordination, or exposed-structure strategies typical of mass timber systems.

As a result, these findings should not be read as “timber vs concrete,” but as a lesson in how design strategy affects outcomes.

Taken together, these findings point to clear design and delivery actions for future projects.



Recommendations

Based on these findings, the following recommendations focus on design and delivery decisions that most strongly influence cost and carbon outcomes.

01

Design for system integration, not layered assemblies

02

Leverage prefabrication to reduce trades and site risk

03

Treat circularity as a design requirement, not a future hope

04

Engage suppliers early to align design with fabrication

05

Commit to mass timber early if it is the chosen strategy

What early LCA enables in practice

What should a smart project team actually do differently?

This study shows why Life Cycle Assessment is most valuable early to:

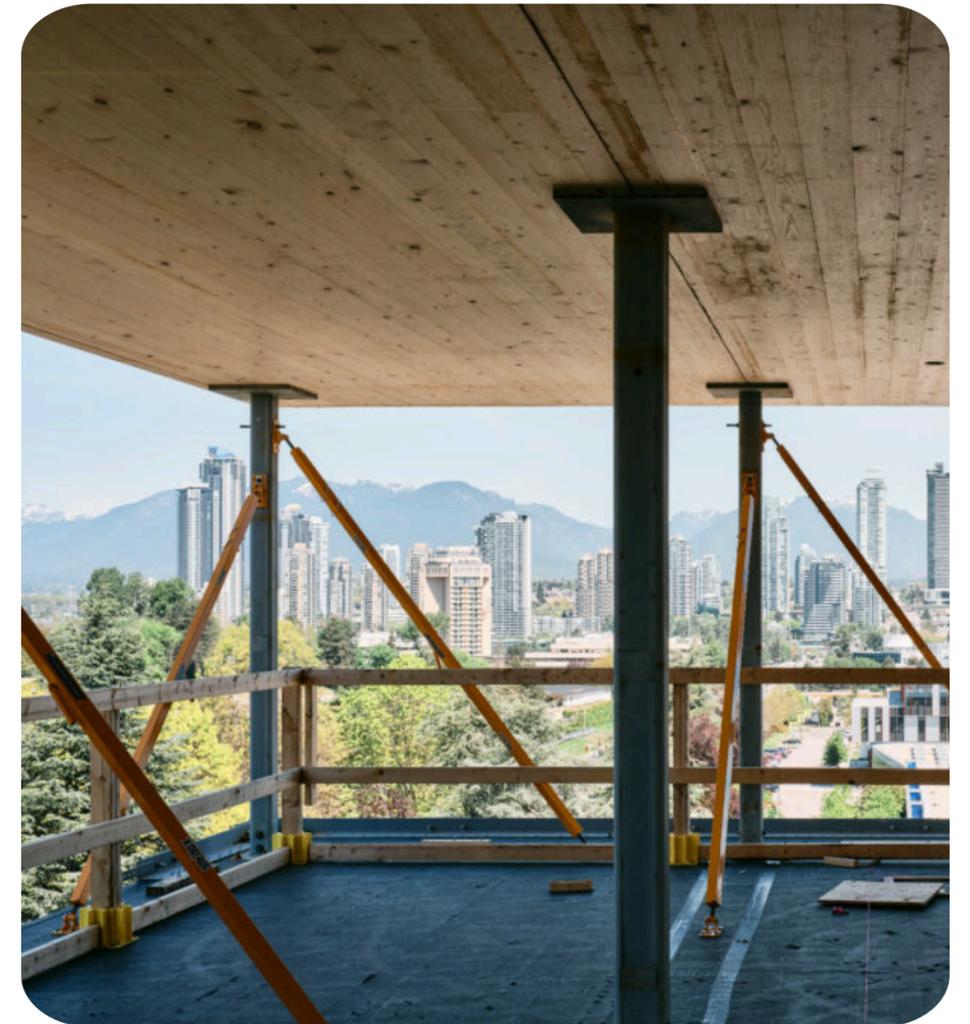
Clarify trade-offs early: Test cost, carbon, and constructability together before design paths are locked in.

Compare systems, not assumptions: Use consistent methods across projects to evaluate structural and enclosure strategies side by side.

Reduce risk in major decisions: Identify where integration, prefabrication, or delivery strategy will affect outcomes most.

Align goals across the project team: Create a shared evidence base for designers, owners, and builders early in the process.

Early analysis improves decisions long before it reduces emissions.



How Carbon Wise Supports Better Decisions

Carbon Wise helps project teams use LCA early to guide design decisions before costs and carbon are locked in. If you're planning a civic, commercial, or multi-unit building and want clarity early, we can help.



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