

Whole Building Life Cycle Assessment of a cross-laminated timber house

including & excluding biogenic carbon

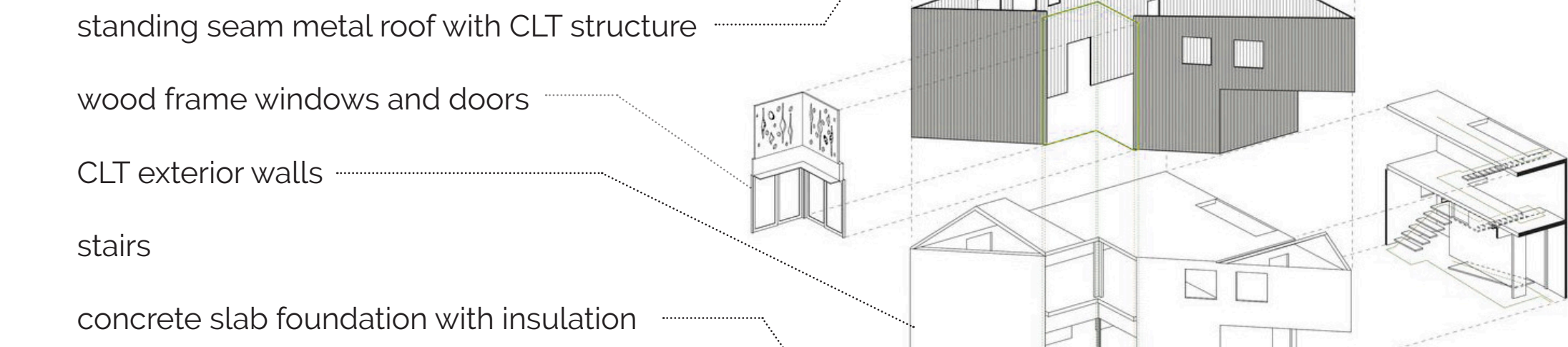


exterior photo of CLTHouse © Lara Swimmer Photography

Whole Building Life Cycle Assessment

Several whole building life cycle assessments (WBLCA) were carried out for the BC Passive House Factory using two different WBLCA softwares: Tally software (from KT Innovations), and the Athena Impact Estimator for Buildings (from Athena Sustainable Materials Institute). This poster details the results calculated using KT Innovation's Tally® software, with a result including and excluding biogenic carbon.

Scope includes structure, foundation, roof, exterior and interior assemblies.

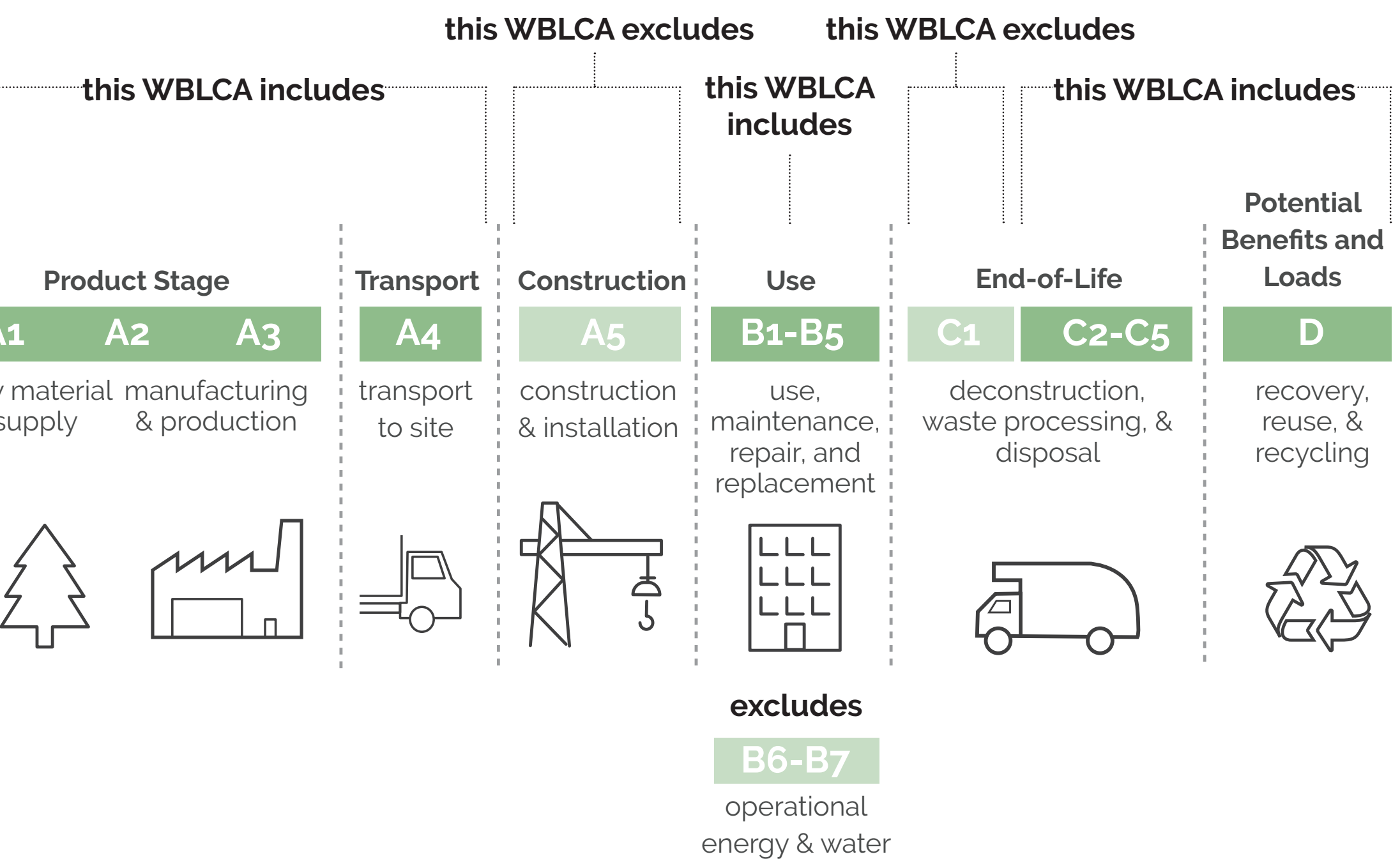


Scope excludes:

mechanical, electrical & lighting, plumbing, connections, fasteners, and sitework

CLT House

Location: Seattle, WA
Architect: atelierjones, llc
Structural Engineer: Harriot Valentine Engineers
General Contractor: Cascade Built
Gross Area: 1,483 ft² (137.8 m²)
Height: 27 ft (8.2 m)
Use: Single family residential
Reference Service Life for WBLCA: 75 years



excluding biogenic carbon

Embodied Carbon

building size 137.8 m² (1,483 ft²)

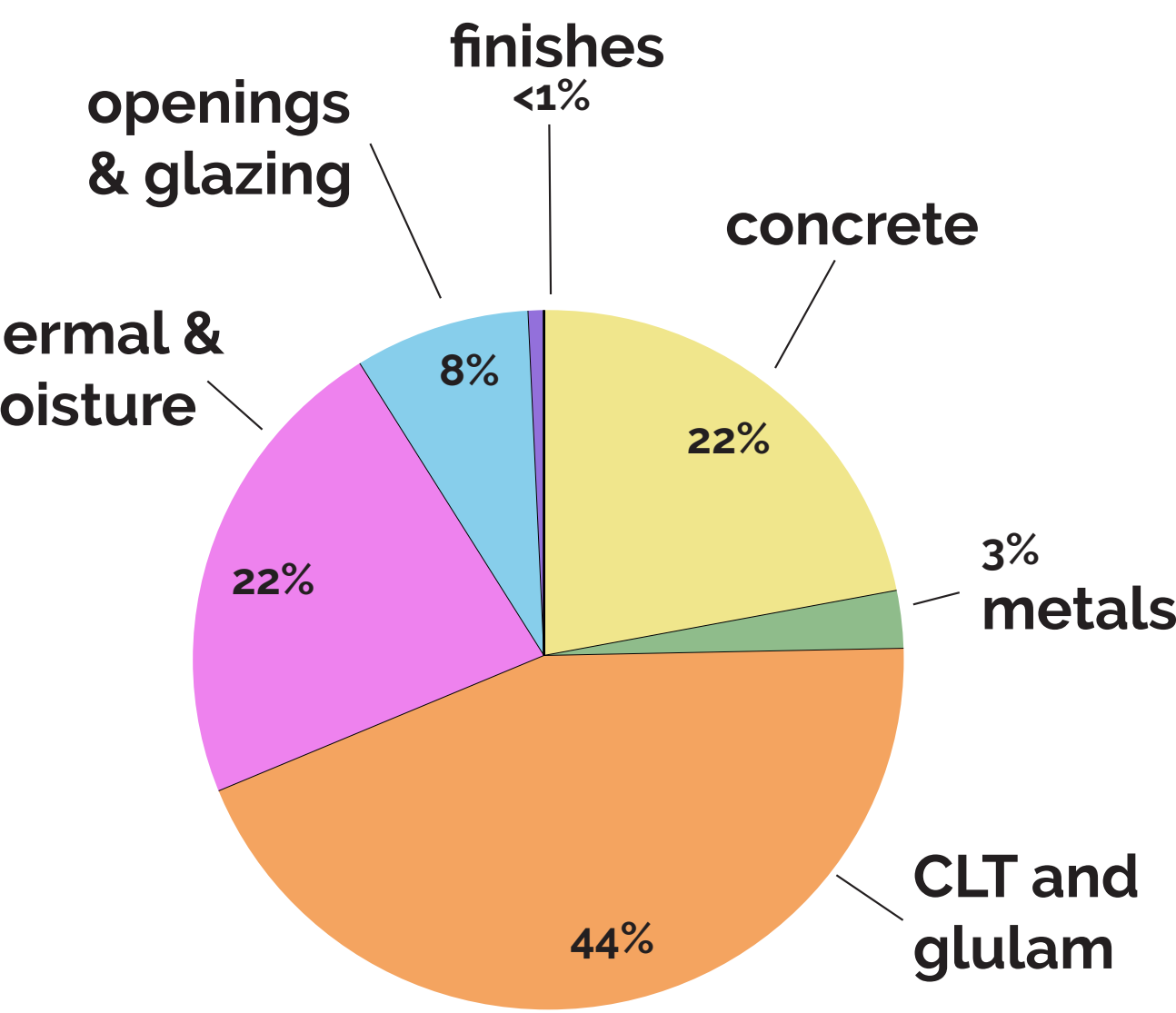
global warming potential kg CO₂eq per m²

initial **GWP** 390

total **GWP** 557

GWP per material

CLT, Glulam, and Wood	44%
Concrete	22%
Metals	3%
Thermal & Moisture Protection	22%
Openings and Glazing	8%
Finishes	<1%

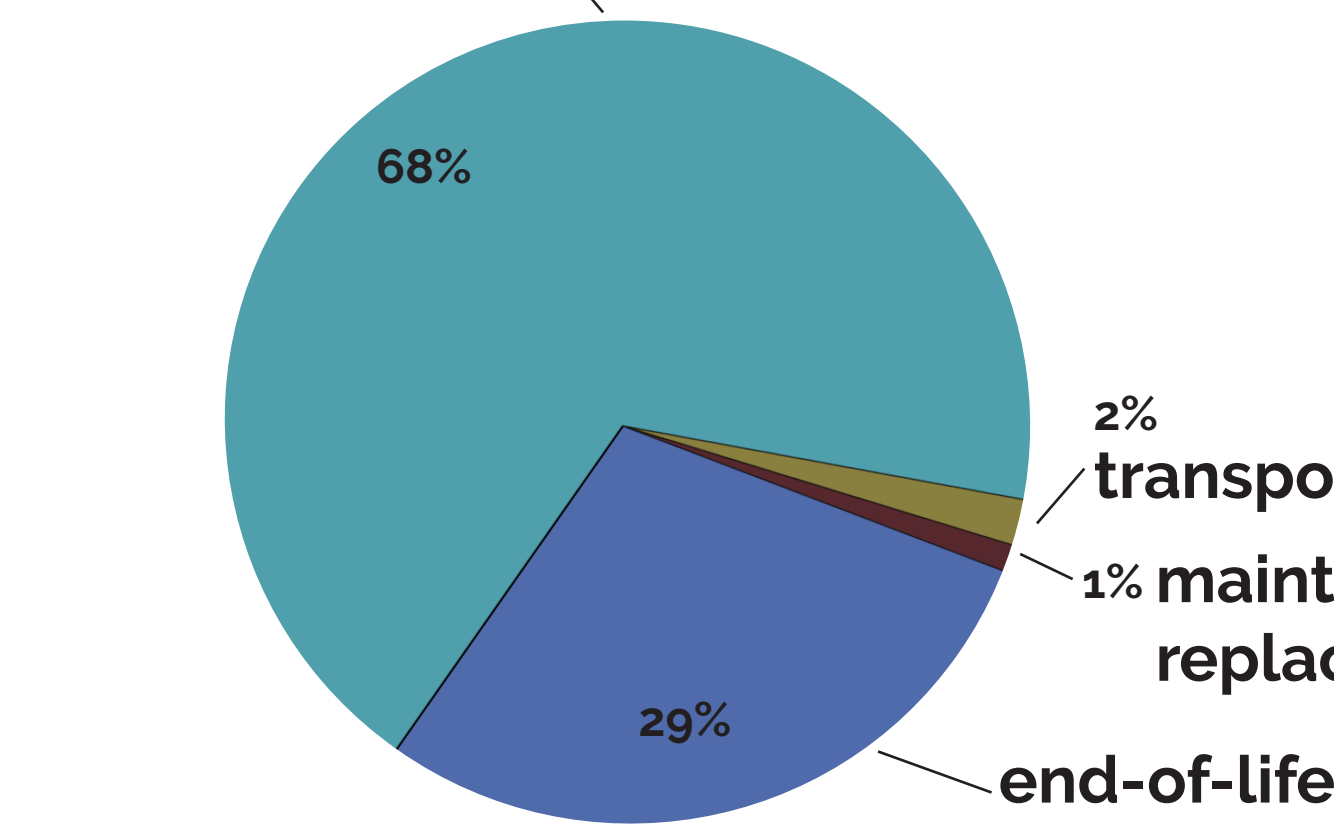


GWP per material

GWP per life stage

A1-A3	379.5 kg/m ²	68%
A4	10.19 kg/m ²	2%
B2-B5	5.95 kg/m ²	1%
C2-C4	16.11 kg/m ²	29%
D	-76.5 kg/m ²	

material extraction and production



GWP per life stage module

including biogenic carbon

Embodied Carbon

building size 137.8 m² (1,483 ft²)

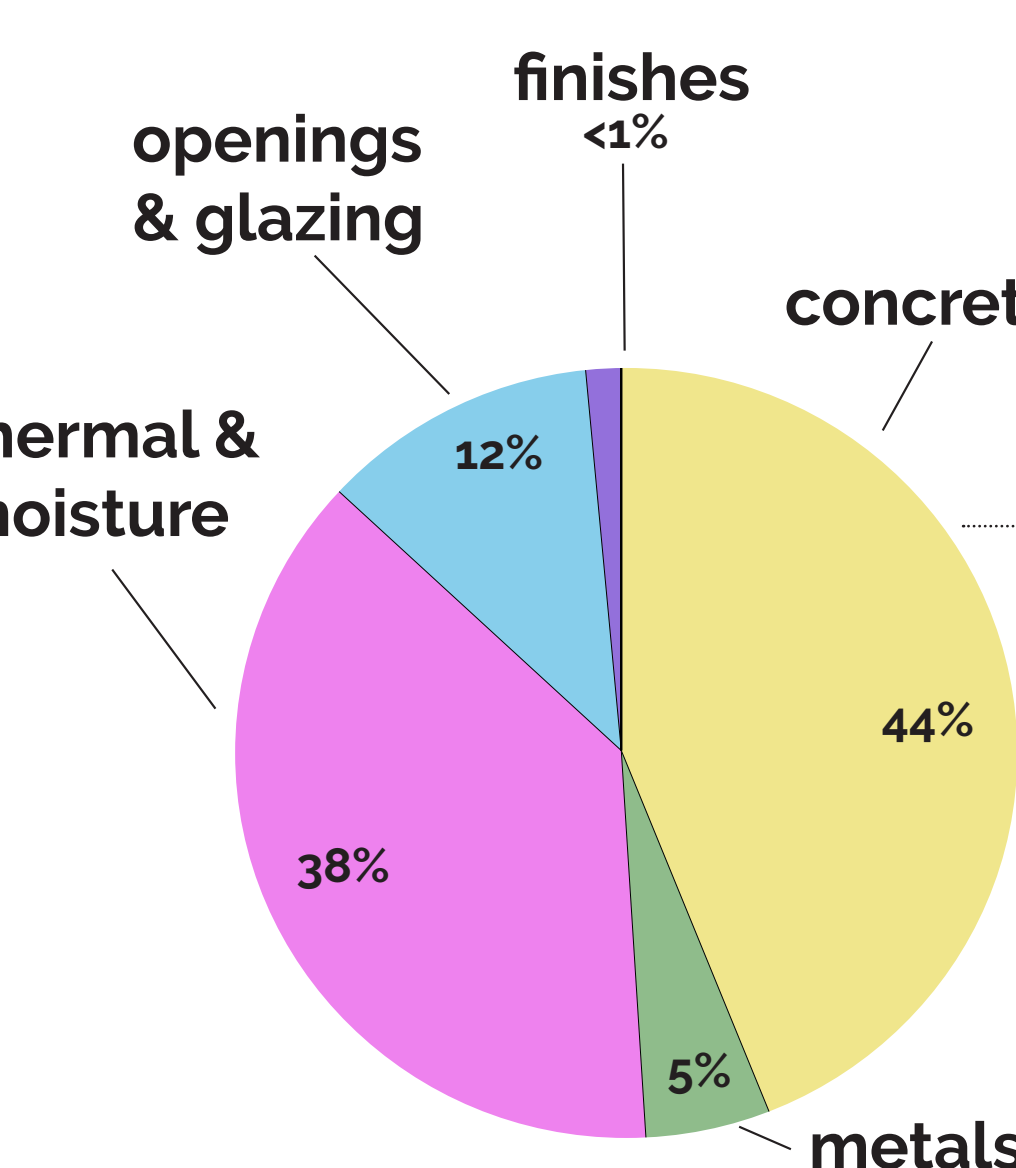
global warming potential kg CO₂eq per m²

initial **GWP** -157

total **GWP** 207

GWP per material

CLT, Glulam, and Wood	-13%
Concrete	44%
Metals	5%
Thermal & Moisture Protection	38%
Openings and Glazing	12%
Finishes	1%

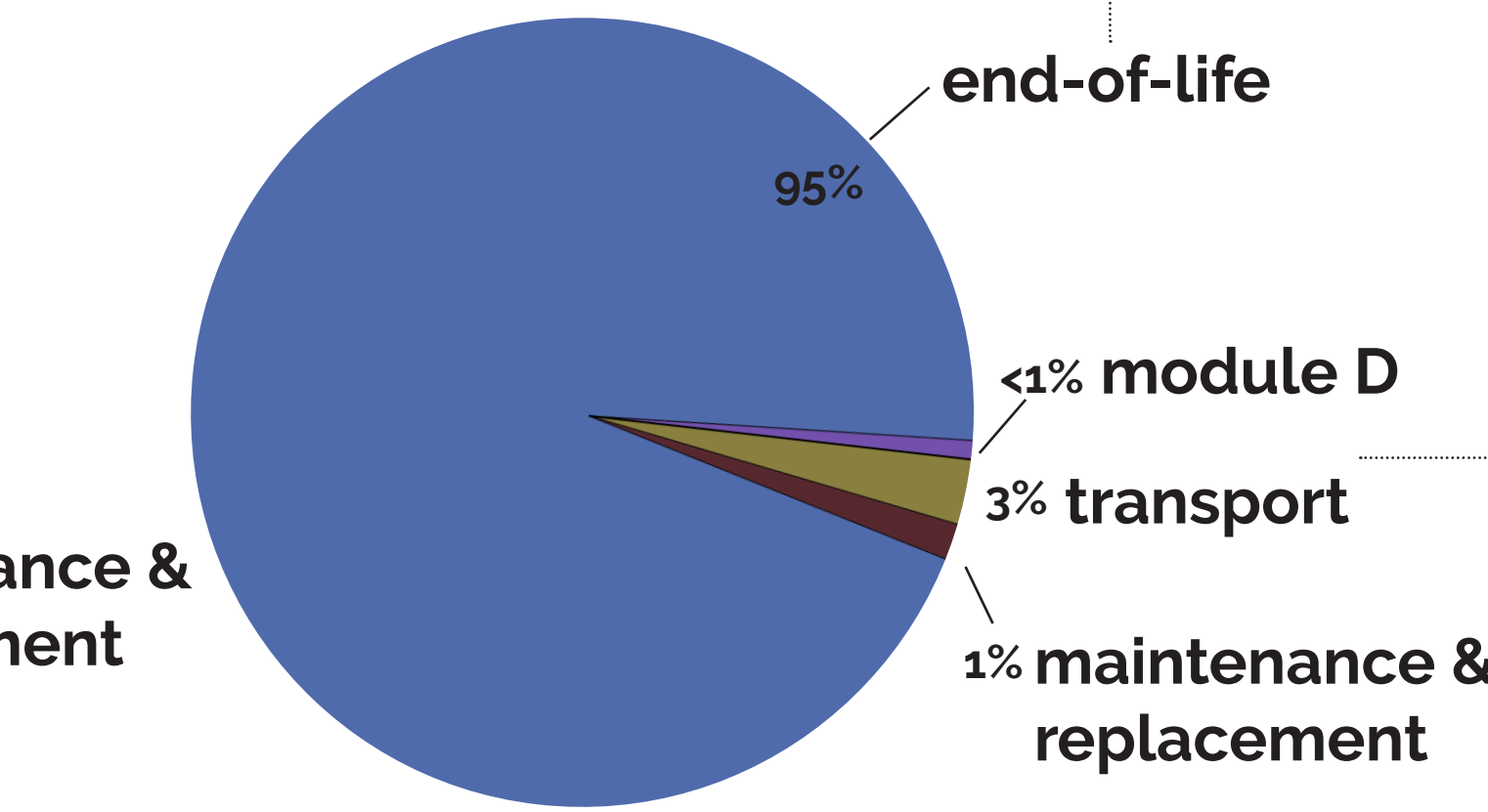


GWP per material

GWP per life stage

A1-A3	-167 kg/m ²	-45%
A4	10.25 kg/m ²	3%
B2-B5	5.71 kg/m ²	2%
C2-C4	354.8 kg/m ²	95%
D	2.944 kg/m ²	<1%

material extraction and production



GWP per life stage module

Tally, a software for WBLCA, can include or exclude biogenic carbon in an assessment. For mass timber buildings, this can have a large impact on the global warming potential. When biogenic carbon is included, the biogenic stored carbon in the wood materials is initially counted as a credit that reduces GWP. At the end-of-life, biogenic carbon leaves the system (expressed as emissions) through incineration, landfill, or recycling. Some biogenic carbon is assumed to be permanently sequestered in a landfill; that amount of carbon remains in the total GWP reduction.

Global warming potential (GWP) is a climate change indicator of the sum of greenhouse gas emissions over a period of time, typically expressed as kg CO₂ eq. Including biogenic carbon results in a lower global warming potential.

Initial GWP is the net CO₂ eq emissions associated with material extraction, material manufacturing, and transport to the construction site.

Total GWP is the net CO₂ eq emissions associated with material extraction, material manufacturing, transport to the construction site, future deconstruction, and disposal of building materials.

When including biogenic carbon, wood and CLT reduce the GWP.

CLT and other wood materials are not shown because they contribute to a net reduction in the GWP when including biogenic carbon.

A1-A3 includes CO₂ eq emissions from extraction of raw materials and manufacturing of building products.

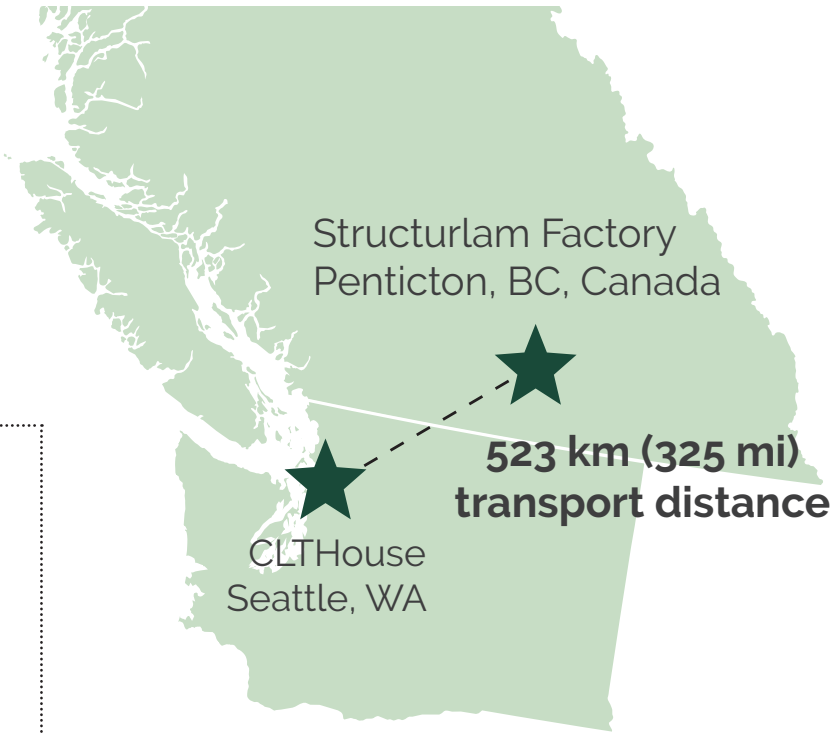
A4 is the CO₂ eq emissions from transport of materials from manufacturing to construction site.

B encompasses the CO₂ eq emissions from maintenance and replacement of materials during the building's use. Module B1 is excluded.

C2 shows the CO₂ eq emissions from transportation to disposal site, C3 shows emissions from waste processing, and C4 shows emissions from final disposal. Tally averages multiple end-of-life scenarios for wood and CLT. In this WBLCA, it is assumed that 14.5% of wood and CLT is recycled, 22% is incinerated with energy recovery, and 63.5% is landfilled.

D indicates benefits beyond the system boundary. For wood, it shows potential credit for utilizing waste products for energy; it is expressed by the equivalent avoided emissions of US average grid electricity. The incinerated energy from wood products (or any landfill gas that is captured for energy) results in avoided production of energy from fossil fuels. Because avoided energy product cannot be directly attributed to the material use, it is expressed as a separate module "D," which is considered beyond the system boundary.

Including biogenic carbon results in the impacts being more heavily weighted towards end-of-life, when the biogenic carbon leaves the system.



Transport distance assumptions
CLT: 523 km
Concrete: 24 km
Steel: 434 km

Global Warming Potential: Case Studies in Tally and Athena

