

Whole Building Life Cycle Assessment of a mass timber office structure

including & excluding biogenic carbon



image courtesy of Hacker

Whole Building Life Cycle Assessment

Several whole building life cycle assessments (WBLCAs) were carried out for the BC Passive House Factory using two different WBLCAs software: 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 is limited to the building's structure and foundations:

- CLT roof structure
- CLT panel cores
- glulam columns and beams
- CLT floors
- concrete foundations & one level of underground parking

Scope excludes:

- building envelope, finishes, mechanical, electrical & lighting, plumbing, connections, fasteners, concrete formwork and sitework

District Office

Location: Portland, OR
 Architect: Hacker Architects
 Structural Engineer: KPFF
 Gross Area: 105,890 ft² (9,838 m²)
 Height: 85 ft (26 m)
 Use: commercial office, retail, and parking
 Reference Service Life for WBLCAs: 75 years

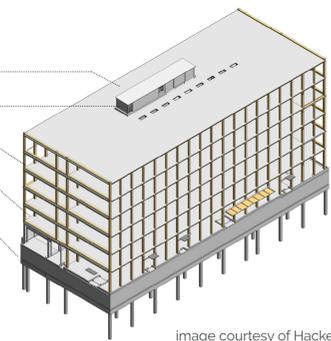


image courtesy of Hacker

excluding biogenic carbon

Embodied Carbon

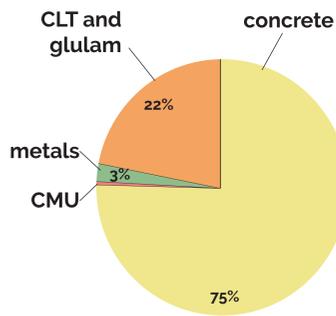
building size 9,837 gsm (105,890 gsf)

global warming potential kg CO₂e/m²

initial GWP	246
total GWP	300

total GWP per material

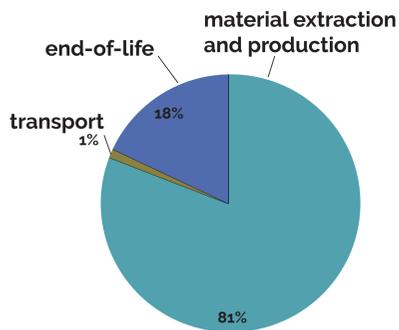
Glulam and CLT	22%
Concrete & CMU	76%
Metals	2%



GWP per material

GWP per life stage

A1-A3	242.4 kg/m ²	81%
A4	3,361 kg/m ²	2%
B		not included
C2-C4	53.98 kg/m ²	18%
D	-37.4 kg/m ²	



GWP per life stage module

including biogenic carbon

Embodied Carbon

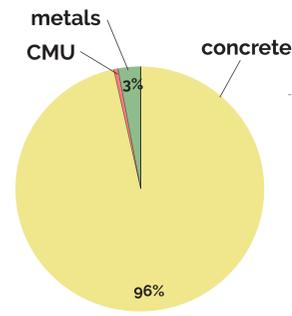
building size 9,837 gsm (105,890 gsf)

global warming potential kg CO₂e/m²

initial GWP	97
total GWP	204

total GWP per material

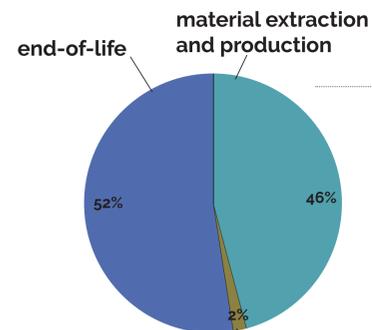
Glulam and CLT	-7%
Concrete & CMU	96%
Metals	3%



GWP per material

GWP per life stage

A1-A3	93.2 kg/m ²	46%
A4	3,38 kg/m ²	2%
B		not included
C2-C4	106.7 kg/m ²	52%
D	-16 kg/m ²	



GWP per life stage module

Tally, a software for WBLCAs, 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 CO₂e. Including biogenic carbon results in a lower global warming potential.

Initial GWP is the net CO₂e emissions associated with material extraction, material manufacturing, and transport to the construction site.

Total GWP is the net CO₂e emissions associated with material extraction, material manufacturing, transport to the construction site, future deconstruction, and disposal of building materials.

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

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

A1-A3 includes CO₂e emissions from extraction of raw materials and manufacturing of building products.

A4 is the CO₂e emissions from transport of materials from manufacturing to construction site.

B encompasses the CO₂e emissions from maintenance and replacement of materials during the building's use. Because this WBLCAs was purely structure, it was assumed that the structure would not be replaced during the building's life.

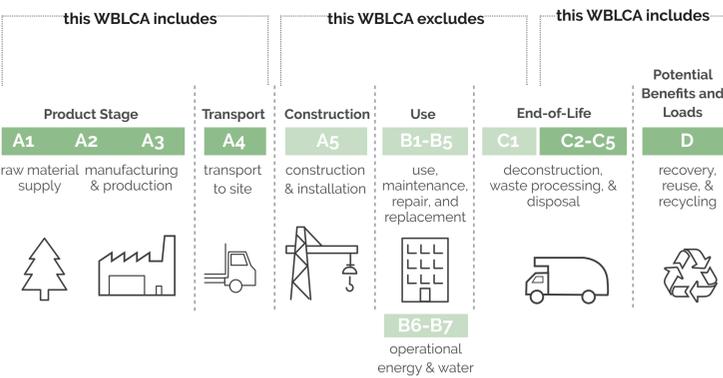
C2 shows the CO₂e emissions from transportation to disposal site, C3 shows emissions from waste processing, and C4 shows emissions from final disposal. Tally averages multiple end-of-life scenarios for glulam and CLT. In this WBLCAs, it is assumed that 14.5% of glulam and CLT is recycled, 22% is incinerated 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.



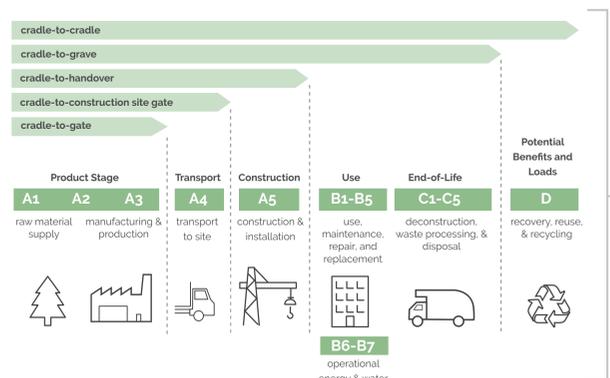
Transport distance assumptions:
 CLT & Glulam: 321 km
 Concrete: 24 km
 Steel: 434 km



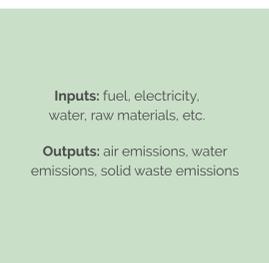
WBLCAs: a Method for Assessing the Environmental Impacts of Buildings

SYSTEM BOUNDARIES

LIFE CYCLE STAGES & MODULES



LIFE CYCLE INVENTORY



IMPACTS



REPORT

