Embodied Carbon Assessment of Wood: From Early-Stage Analysis to WBLCA

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Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
WINDOW TO THE QUAD
GLAZING AND WINTER COMFORT TOOL

This tool displays the impact of glazing geometry and U-value on occupant thermal comfort during winter months. It should be used to evaluate perimeter heat in cases where the U-value is slow and windows are small.

Email the developers, visit our GitHub, and read the license.

We've updated! See the release notes to learn about the tool's improved comfort model and interface upgrades.

OUTDOOR DESIGN CONDITION

Outdoor Temperature (°C)

FAÇADE GEOMETRY

Ceiling Height (m)
Room Length (m)
Room Width (m)
Window Height from Floor (m)
U-value (W/m²K)

FAÇADE PERFORMANCE

Window U-value (W/m²K)

INDOOR CONDITIONS

Indoor Temperature (°C)
Relative Humidity (%)
TIMBER CURTAIN WALL
There is greater urgency to minimize carbon emissions between now & 2030 to stem the impacts of climate change - there is a time value to targeting embodied carbon.
ENVELOPE AND THERMAL COMFORT

ALUMINUM + TRIPLE GLAZING
U = 0.25

TIMBER + TRIPLE GLAZING
U = 0.16

TIMBER + DOUBLE GLAZING
U = 0.22

3'-6" occupant distance from facade
UNIT BASED EMBODIED CARBON SAVINGS

kgCO\textsubscript{2}eq

Global Warming Potential per square inch

Aluminum

Timber
VOLUME BASED EMBODIED CARBON SAVINGS

- Aluminum Curtain Wall
- Timber Curtain Wall

54% Reduction

- Aluminum Extrusion
- Glulam
CURTAIN WALL BASED EMBODIED CARBON SAVINGS

Global Warming Potential

- Aluminum Curtain Wall
- Timber Curtain Wall

26% Reduction

- Triple Glazed

kgCO₂eq

- Glazing System
- Aluminum CW
- Timber CW
PERFORMANCE BASED EMBODIED CARBON SAVINGS

- Aluminum Curtain Wall
- Timber Curtain Wall

47% Reduction

Global Warming Potential

- Triple Glazed
- Double Glazed

kgCO₂eq

Aluminum
Timber

Glazing System
Aluminum CW
Timber CW
Kaleidoscope: Embodied Carbon Design Tool
WHOLE BUILDING LCA

BASELINE VS DESIGN CASE

- SUM OF ACIDIFICATION POTENTIAL TOTAL (KGSO2EQ)
- SUM OF EUTROPHICATION POTENTIAL TOTAL (KGNEQ)
- SUM OF GLOBAL WARMING POTENTIAL TOTAL (CGH2O2EQ)
- SUM OF OZONE DEPLETION POTENTIAL TOTAL (CFC-11EQ)
- SUM OF SMOG FORMATION POTENTIAL TOTAL (KG03EQ)
- SUM OF NON-RENEWABLE ENERGY DEMAND TOTAL (MJ)

Baseline Case:  
Design Case:
WHOLE BUILDING LCA - CHALLENGES

**Glulam as CLT proxy**

- Baseline Case: 100%
- Design Case: 104%

**EPD specific data for CLT**

- Baseline Case: 100%
- Design Case: 101%

BASELINE VS DESIGN CASE

- Baseline Case: 100%
- Design Case: 100%

<table>
<thead>
<tr>
<th>Metric</th>
<th>Baseline (Total)</th>
<th>Design (Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidification Potential</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Eutrophication Potential</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>SMOG Formation Potential</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Non-Renewable Energy Demand</td>
<td>0%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**SUM OF ACIDIFICATION POTENTIAL (KGSO₂EQ)**

- Baseline: 100%
- Design: 104%

**SUM OF EUROTROPHICATION POTENTIAL (KGSNO₃EQ)**

- Baseline: 100%
- Design: 101%

**SUM OF GLOBAL WARMING POTENTIAL (KGCO₂EQ)**

- Baseline: 100%
- Design: 100%

**SUM OF OZONE DEPLETION POTENTIAL (CFC-11 EQ)**

- Baseline: 100%
- Design: 100%

**SUM OF SMOG FORMATION POTENTIAL (KGNO₃EQ)**

- Baseline: 100%
- Design: 100%

**SUM OF NON-RENEWABLE ENERGY DEMAND (MJ)**

- Baseline: 0%
- Design: 20%

**BASELINE VS DESIGN CASE**

- Baseline Case: 100%
- Design Case: 100%
**PROCESS**

*Tools tested (only Module A)*

Replaced with EPD data, calculated for same volume

Step 1: Tally locked CSV

Step 2: Copied and changed in new excel document

*Updated CSV output with product specific EPD*
Wood End-of-Life

Scope:
End of Life waste treatment methods and rates for wood are based on the 2014 Municipal Solid Waste and Construction Demolition Wood Waste Generation and Recovery in the United States report by Dovetail Partners, Inc. It is assumed that 63.5% of wood is sent to landfill, 22% to incineration, and 14.5% to recovery.
WHOLE BUILDING LCA

BASELINE VS DESIGN CASE

- Baseline Case: ▲
- Design Case: ■

- **SUM OF ACIDIFICATION POTENTIAL TOTAL (KGSO2EQ)**
  - Baseline: 100%
  - Design: 10%

- **SUM OF EUTROPHICATION POTENTIAL TOTAL (KGNEQ)**
  - Baseline: 100%
  - Design: 6%

- **SUM OF GLOBAL WARMING POTENTIAL TOTAL (KGCO2EQ)**
  - Baseline: 100%
  - Design: 9%

- **SUM OF OZONE DEPLETION POTENTIAL TOTAL (CF-11EQ)**
  - Baseline: 100%
  - Design: 4%

- **SUM OF SMOG FORMATION POTENTIAL TOTAL (KG03EQ)**
  - Baseline: 100%
  - Design: 4%

- **SUM OF NON-RENEWABLE ENERGY DEMAND TOTAL (MJ)**
  - Baseline: 100%
  - Design: 2%
OTHER LIFE CYCLE IMPACTS

- **non-renewable energy** [ MJ ]
- **eutrophication potential** [ kg N-eq ]
- **smog formation potential** [ kg O_3-eq ]
- **acidification potential** [ kg SO_2-eq ]
- **ozone depletion potential** [ kg CFC 11-eq ]
Option 2: Whole Building Life-Cycle Assessment (1-4 points):

For new construction (buildings or portions of buildings), conduct a cradle-to-grave LCA of the project’s structure and enclosure and follow one of the paths below to earn up to 4 points:

- **Path 1 (1 point):** Conduct LCA of structure and enclosure

- **Path 2 (2 points):** Conduct LCA of structure and enclosure that demonstrates a minimum of 5% reduction, compared with baseline building in at least 3 of the 6 impact categories, one of which must be GWP*

- **Path 3 (3 points):** Conduct LCA of structure and enclosure that demonstrates a minimum of 10% reduction, compared with baseline building in at least 3 of the 6 impact categories, one of which must be GWP*

- **Path 4 (4 points):** Meet requirements of Path 3 and incorporate reuse and/or salvage materials into the project’s structure and enclosure for the proposed design. Demonstrate reductions compared to baseline building of at least 20% reduction for GWP, and at least 10% reduction in 2 additional impact categories*

* no impact category assessed as part of the life-cycle assessment may increase by more than 5% compared with the baseline building

** impact categories: GWP in kg CO2e, depletion of stratospheric ozone layer in kg CFC-11e, acidification in kg SO2e, eutrophication in kg nitrogen eq, formation of tropospheric ozone in kg O3 eq (smog), depletion of nonrenewable energy resources in MJ
END-OF-LIFE - EUTROPHICATION

Metal

Scope:
Metal products are modeled using the avoided burden approach. The recycling rate at end of life is used to determine how much secondary metal can be recovered after having subtracted any scrap input into manufacturing (net scrap). Net scrap results in an environmental credit in Module D for the corresponding share of the primary burden that can be allocated to the subsequent product system using secondary material as an input. If the value in Module D reflects an environmental burden, then the original product (A1-A3) contains more secondary material than is recovered.

LCI Source:
- Brass - GLO: Zinc mix ts (2012)
- Brass - GLO: Copper (99.99% cathode) ICA (2013)
- Brass - EU-28: Brass (CuZn20) ts (2017)
- Copper - DE: Recycling potential copper sheet ts (2016)
- Steel - GLO: Value of scrap worldsteel (2014)
- Zinc - GLO: Special high grade zinc IZA (2012)

End-of-Life Scope:
- 98% Recovered
- 2% Landfilled (inert material)

Wood

Scope:
End of Life waste treatment methods and rates for wood are based on the 2014 Municipal Solid Waste and Construction Demolition Wood Waste Generation and Recovery in the United States report by Dovetail Partners, Inc. It is assumed that 63.5% of wood is sent to landfill, 22% to incineration, and 14.5% to recovery.

LCI Source:
- RNA: Softwood lumber CORRIM (2011)

End-of-Life Scope:
- 14.5% Recovered
- 22% Incinerated with energy recovery
- 63.5% Landfilled (wood product waste)
EUTROPHICATION - TOMORROW’S SOLUTION

**Today**
*Time value of carbon*

**Tomorrow**
*Eutrophication*

**Call to action:**
*Improve mass timber end of life in 60 years*
EMBODIED CARBON REDUCTION AREAS

- **Envelope Assembly**
  - Timber Curtainwall
- **Roof Assembly**
  - XPS to Polyiso
- **Floors**
  - CLT deck
- **Structural System**
  - Low Embodied Carbon Concrete mix
  - Steel beam quantity reduction

### Graph

- **Industry Standard Baseline**
  - 61.4 kg CO eq/sf
- **PSU EDI**
  - 39.8 kg CO eq/sf

<table>
<thead>
<tr>
<th>Component</th>
<th>Industry Standard</th>
<th>PSU EDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations</td>
<td>24%</td>
<td>31%</td>
</tr>
<tr>
<td>Structure</td>
<td>19%</td>
<td>28%</td>
</tr>
<tr>
<td>Floors</td>
<td>16%</td>
<td>7%</td>
</tr>
<tr>
<td>Core</td>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td>Envelope</td>
<td>21%</td>
<td>22%</td>
</tr>
<tr>
<td>Roof</td>
<td>23%</td>
<td>6%</td>
</tr>
</tbody>
</table>

**35% reduction**
WHAT IF ALL TIMBER?

**Industry Standard Baseline**
- 61.4 kg CO eq/sf

**PSU EDI: Timber + Steel**
- 39.8 kg CO eq/sf

**All Timber**
- 30.6 kg CO eq/sf

- **35% reduction**
  - foundations: 24% to 31%
  - structure: 19% to 28%
  - floors: 16% to 7%
  - core: 5% to 7%
  - envelope: 21% to 22%
  - roof: 23% to 6%

- **50% reduction**
  - foundations: 24% to 40%
  - structure: 19% to 9%
  - floors: 16% to 7%
  - core: 5% to 9%
  - envelope: 21% to 28%
  - roof: 23% to 7%
QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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