32 Mill Street Net-Zero Energy Retrofit

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Embodied Environmental Impact Narrative

U.S. Department of Energy
Solar Decathlon 2023 Build Competition

32 Mill Street
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23BC_WH_D8_JURYEMBODIED_2023-03-28

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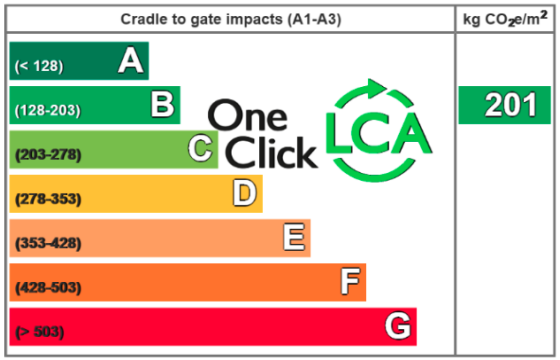
In partnership with the
KW Urban Native Wigwam Project

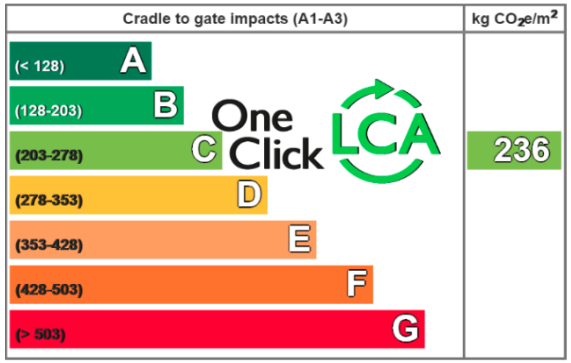
Embodied Environmental Impact Jury

Life Cycle Assessment Results

Embodied environmental impact was heavily considered when deciding to complete a retrofit instead of a new construction project. The life cycle assessment completed for the 32 Mill Street retrofit project resulted in an average of 201 kg CO2e/m2. Had we completed a new construction project, the impact off the project would have been 236 kg CO2e/m2. This is only considering material impact and not the additional energy spent for demolition of the existing house.



Retrofit Option



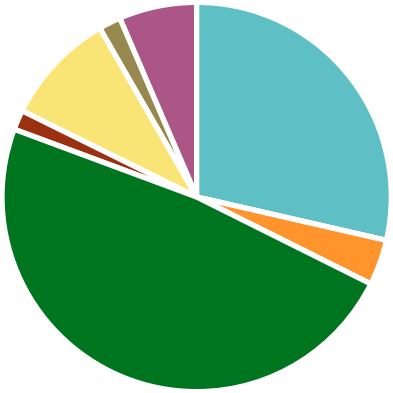
New Construction Option

Low Carbon Design Decisions

As shown in the figure below, transportation made up only 0.1% of the house's total environmental impact. This is because Warrior Home was conscious about partnering with local trades and material manufacturers. For example, all of the lumber used in the retrofit is sourced from the home hardware located just a mile away from the site. Although the project includes a lot of insulation, in order to improve the performance of the home, low global warming potential spray foam insulation was chosen to minimize environmental impacts. Spray foam was chosen as the primary insulation for the house because of the nature of the existing double wythe structural brick. Warrior Home also made sure to minimize the number of spray foam mobilizations to decrease the overall environmental impact of the material.

Global warming t CO_2e - Life cycle stages

- 1 Ready mix concrete (A1-A3) - 28.8%
- 11 Other materials (A1-A3) - 48.2%
- 8 Insulation (A1-A3) - 9.2%
- A4 Transport - 0.1%
- 10 Gypsum (A1-A3) - 3.6%
- 4 Steel (A1-A3) - 1.9 %
- 9 Wood (A1-A3) - 1.9%
- A5 Construction - 6.3 %

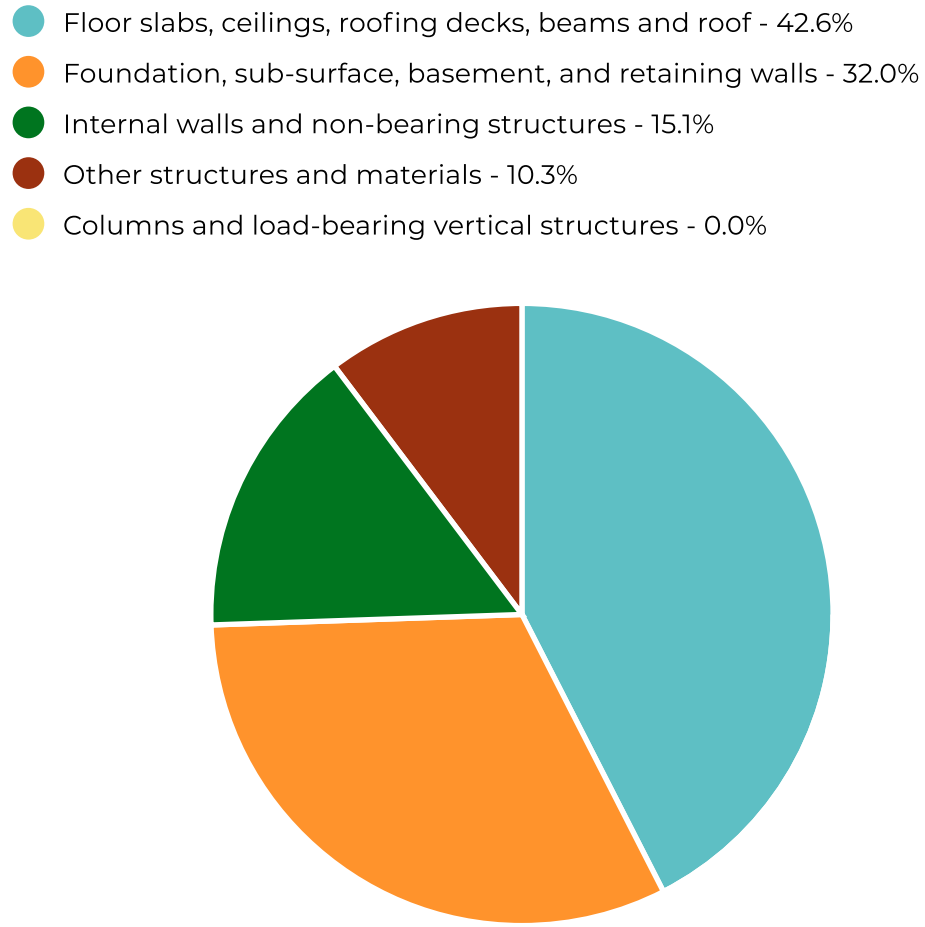


Environmental Impact of Material Choices

As shown in the figure to the right, one of the largest global warming categories was the concrete for the foundations and benching in the basement. The decision to increase the height of the basement resulted in an increased use of concrete. However, this is now a usable space that will be well-used by the family who will be living in the house. The increased basement height was an important decision because it created more usable space to replace the square footage being taken away by the higher performance envelope on the upper floors. If Warrior Home had completed a demo and new construction for this house, the concrete usage would have increased by an order of magnitude, resulting in a much higher overall global warming potential.

Since high quality materials were used for the construction of the retrofit, this century old home hopes to last for another 100 years, being passed on from generation to generation. Since Warrior Home is aware of the lifespan of this building, this embodied environmental impact is quite small compared to the operational carbon savings to be expected from the building due to its high performance.

Global warming t CO_2e - Classifications



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WARRIOR HOME

Embodied Carbon Report

This report is created with One Click LCA Planetary - a free embodied carbon tool. It calculates cradle to gate (A1 - A3) embodied carbon impacts and materials efficiency for the 10 most carbon-intensive material categories. It is built on the world's #1 life-cycle assessment platform, One Click LCA.
Get free access at **oneclicklca.com/planetary**.

Project name	Report date	Building type
Warrior Home 2023BC	**27.03.2023**	**One-dwelling buildings**
Design name	Assessor	Gross floor area
2023BC Design	**Talina**	**112.7843 m2**
Location	Contact details	Organisation
Canada	**tsensmet@uwaterloo.ca**	**-**

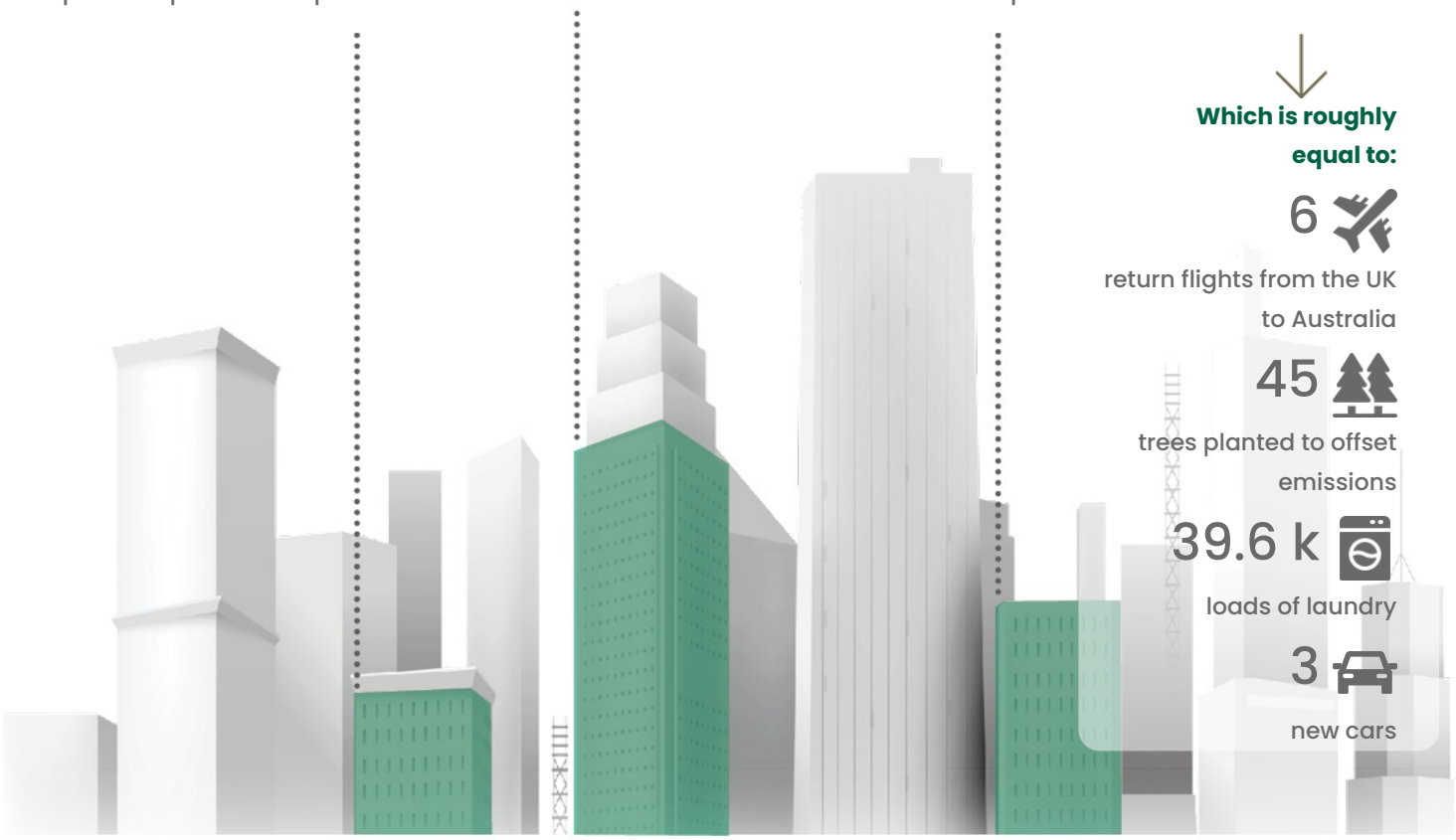
Embodied carbon result summary

Embodied carbon is defined as the carbon emissions from the manufacture, transportation, use and end-of-life of construction materials.

201 kg
CO_2e/m^2
Kilograms of carbon dioxide equivalent per metre squared

1,132 €
social cost of carbon
Social cost set at a rate of 50€/ton

23 t
CO_2e
Total carbon dioxide equivalent emissions in tons



Embodied carbon by material

Cradle to gate (A1-A3) covers impacts of a material or product that is ready to ship to the construction site, including raw materials extraction, transport and manufacturing emissions.

Embodied carbon and materials use by material type

The below table shows information on absolute and relative embodied carbon and materials use efficiency

	Result category	Global warming t CO_2e	Global warming kg CO_2e/m^2	Mass of raw materials t	Mass of raw materials kg/m^2
1	Ready mix concrete (A1-A3)	6.52	57.78	42.86	380.05
4	Steel (A1-A3)	0.42	3.73	0.42	3.77
6	Bricks (A1-A3)	0	0	1.24	11.01
8	Insulation (A1-A3)	2.09	18.54	2.48	21.98
9	Wood (A1-A3)	0.44	3.88	2.41	21.33
10	Gypsum (A1-A3)	0.82	7.24	4.02	35.6
11	Other materials (A1-A3)	10.9	96.65	3.5	31.03
A1-A3	Construction Materials	21.18	187.82	56.93	504.78
A4	Transportation to site	0.02	0.2		
A5	Construction/installation process	1.43	12.7	3.05	27.01

Global warming potential, t CO2e by material type

Most contributing materials

Most contributing materials (Global warming)

No.	Resource	Cradle to gate impacts (A1-A3)	Of cradle to gate (A1-A3)	Sustainable alternatives
1.	Concrete, ready mix, 2501 - 3000 psi (C18/20)	0.01 t CO_2e	62.2 %	Show sustainable alternatives
2.	Vinyl flooring, heterogeneous, 1.1- 5.5 mm, 1.5 - 3.7 kg/m2	0 t CO_2e	12.7 %	Show sustainable alternatives
3.	Rock wool insulation batt, L=0.035 W/mK, R=5.68 (Rsi=1 m2K/W), 1.38 in (35 mm), 0.33 lb/ft2 (1.6 kg/m2), 2.8 lb/ft3 (45 kg/m3)	0 t CO_2e	8.8 %	Show sustainable alternatives
4.	Ceramic tile, US average, 0.287-0.433in, 0.5x0.5in - 24x24in, planks max. 36in, 3.5-7.0 lb/ft2	0 t CO_2e	6.2 %	Show sustainable alternatives
5.	Rock wool insulation panels, unfaced, generic, L = 0.035 W/mK, R = 2.89 m2K/W (16 ft2°Fh/BTU), 50 kg/m3 (3.12 lbs/ft3) (applicable for densities: 25-50 kg/m3 (1.56-3.12 lbs/ft3)), Lambda =0.0346 W/(m.K)	0 t CO_2e	5.5 %	Show sustainable alternatives

Embodied carbon by building part

Choosing low carbon materials while also considering the quantity of materials is key to unlocking carbon reductions. The graphs below provide evidence of both carbon performance and materials efficiency for the design by building element. Identifying and optimizing building elements responsible for the largest emissions, and limiting the material mass can result in both carbon and cost savings

Global warming potential, t CO2e - building part **Mass, kg - building part**

Global warming potential (GWP) by material type and building part

About One Click LCA Planetary

One Click LCA Planetary aims to help decarbonise the construction industry at a planetary scale. It's a free embodied carbon tool that can be used to power embodied carbon and materials efficiency policies as well as individual design, construction and procurement decisions.

Get free access at **oneclicklca.com/planetary**.

About One Click LCA

One Click LCA is the world-leading construction sector life-cycle assessment software that helps you calculate and reduce the environmental impacts of your construction projects, products, and portfolios. As well as decarbonizing building and infrastructure projects, One Click LCA can also help you to generate and manage Environmental Product Declarations (EPD), and real estate portfolio greenhouse gas reports.

If your project requires more advanced features, One Click LCA commercial tools support all impact categories and life-cycle stages, as well as compliance for certifications such as LEED and BREEAM, BIM integrations, all materials categories, and advanced functionality, reporting, support and training.

Learn more at **oneclicklca.com**