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Case Study: Calina Collective Home

The "Calina" is a 3-bedroom, 2-bathroom home designed by Collective Carpentry with the goal of optimizing the marriage of a high-performance building envelope with a prefabricated panelized construction approach. Designed for cold climates in North America, it features a Larsen truss-style two-layer wall assembly and I-joist roof assembly - both insulated with densepack cellulose and sealed with high-quality Pro Clima airtight tapes and membranes – as well as high performing triple-pane windows made in the USA by Alpen. This particular home was built for two teachers based in Bozeman, MT, with the support of local General Contractor, Eesome Builders.

Embodied Carbon

Cradle-to-gate, kg CO_2e/m^2

*Average based on report from 2022.

Reduction Strategies

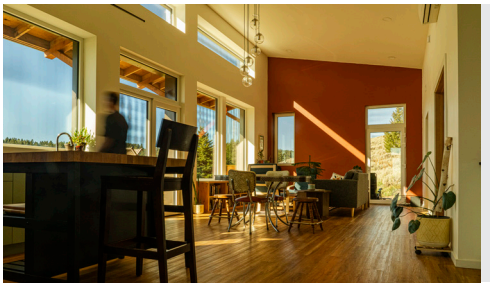
- Cellulose insulation in walls and roof
- Substituted wood structure where possible

Carbon Storage

- Cellullose insulation (walls, roof)
- Wood stud structure

8.8 tons of CO_2 stored


Photo credit: Jason Thompson



> **What we're trying to do with Collective Homes is prove - by showing what's possible with a bit of standardization and the right priorities around the materials and building systems used in building homes – that this style of building is the way of the future and that we CAN combat complacency in the face of a climate and housing emergency.**
>
> **Craig Toohey, Business Development Director**

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Operational Carbon | This home was designed to meet the Passive House Low Energy Building standard, and efforts were made to keep heat demand as low as possible by positioning the house for optimal solar gain, designing panel connection details to limit thermal bridging, designing panel assemblies to include significant amounts of insulation, designing panel fabrication and installation processes to deliver an optimal airtightness result, and employing high performance windows and heat recovery ventilation.

Meets Passive House Low Energy Building Standard

Airtight fabrication and installation

Detailed to limit thermal bridging

Comparing the project's prefabricated approach with a baseline design that is built to code using conventional materials, the embodied carbon savings are staggering. This is accomplished by opting for carbon-storing insulation materials instead of using spray foam in the roof and fiberglass or mineral wool in the walls. The final design resulted in a mere 1 ton CO2e emissions for the prefabricated envelope assembly compared to 10 to 17 tons CO2e estimated for conventional approaches.

As-built prefabricated envelope assembly results.

Net Project Emissions	1,124	kg CO_2e

HIGHEST CARBON MATERIAL APPLICATIONS		
SECTION	kg CO_2e	MATERIAL
Windows	3,642	Window - triple pane / Vinyl frame / BfCA Study [US
Roof	731	Wood I joist / TJI 230/360 / 16" Depth / AWC & CWC
Exterior Walls	545	Mineral wool batt / Rockwool / ComfortBatt R22 (5.5
Roof	514	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA
Exterior Walls	511	Wood I joist / TJI 230/360 / 9-1/2" Depth / AWC & CW
Exterior Walls	475	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA
Exterior Walls	331	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Av

Comparison to code-built equivalent.

Net Project Emissions	10,097	kg CO_2e

HIGHEST CARBON MATERIAL APPLICATIONS		
SECTION	kg CO_2e	MATERIAL
Windows	3,164	Window - double-glazed / Vinyl frame / BfCA Study [
Roof	2,363	Spray polyurethane foam - Closed Cell (HFC gas) / R
Exterior Walls	780	Mineral wool batt / Rockwool / ComfortBatt R22 (5.5
Roof	766	Wood roof truss / Gable Roof, Double Howe, 2x6 Ch
Roof	706	Fiberglass loose fill / Owens Corning / AttiCat, ProC
Exterior Walls	610	Mineral wool board / Rockwool / Comfortboard 80 /
Roof	514	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA

Top: Standard wall to roof connection detail for the Collective Carpentry Building System.

Bottom: Stages of wall panel production starting with structural framing, sheathing, airtight tape along plywood seams, exo joists, cellulose insulation, vapor-open airtight membrane, vertical strapping and insect screens. Window details are applied in the shop before the panel is shipped.

Lessons Learned

1. Airsealing windows with the right materials and methods is critical, as the installation team revisited a few problem areas and improved a blower door test from .7ACH50 to .3ACH50.

2. Designing, fabricating, and installing in-house provides a number of opportunities for optimization, and helps the project stay on the affordable side of high performance construction.

3. The BEAM calculation showed how much the windows and the mineral wool insulation, concrete footings, and finish materials can impact the embodied carbon calculation. We can further optimize in these areas thanks to the feedback from this tool.

Project Information

Project name: Calina Collective Home

Location: Bozeman, MT

Builder: Eesome Builders

Year Built: 2022

Typology: Single-family home

Size: 1,764 SF GFA | 1,514 SF CFA