



Embodied Carbon Analysis **Spray Foam Assemblies**

Prepared For:
Elastochem, Honeywell

Prepared By:
RDH Building Science



Embodied Carbon Elastochem / Honeywell Enclosures



WRAPSULATE
FOAM JACKET

ELASTOCHEM

Design highly efficient building enclosures using vapour-permeable spray foam



INSULTHANE[®]
450 NM

Insulthane[®] 450 NM

TECHNICAL DATA SHEET



INSULTHANE[®]
EXTREME

ELASTOCHEM

Tackle environmental challenges with lasting & sustainable spray foam insulation.

Build greener with
Insulthane[®] Extreme

Closed Cell Spray Foam	LTTR R-6.03 per inch @ 4"	Contains no HFCs	Ultra-low GWP of 1
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1 Introduction

The purpose of this embodied carbon analysis for Elastochem and Honeywell is to present exterior wall assemblies that incorporate various combinations of open cell and closed cell spray foam insulation. These assemblies are intended to illustrate different design options and compare their embodied carbon impacts. The results will contribute to the ongoing expansion of the RDH-TMU Embodied Carbon Resource Guide database (<https://www.rdh.com/blog/embodied-carbon-resources-for-building-enclosures/>). The analysis of these assemblies provides a starting point for whole-building life-cycle assessments that require exterior wall assemblies and other enclosure assemblies to be defined and quantified.

Version History

TABLE 1.1 VERSION HISTORY		
Version Number	Issued Date	Description
0.1	2025-06-30	Draft for client review
0.2	2025-07-25	Revisions based on client feedback received on July 22, 2025
0.3	2025-07-31	Revisions based on client feedback received on July 29, 2025
0.4	2025-08-20	Revisions to CR2, UC3, and UR2 replace mineral wool insulation board with appropriate heavy density mineral wool board in assemblies.

2 Whole-Building Life-Cycle Assessment

A whole-building life-cycle assessment evaluates a building's environmental climate impacts by analyzing the materials and operations at each stage of the building's life, and the associated environmental impacts. The stages in a life-cycle assessment (LCA) for materials start with the extraction and processing of raw materials all the way to the end of life or recycling (see Figure 1). An LCA may assess the outcomes under many different impact categories¹, however, this analysis focuses on the main impact category of Global Warming Potential (GWP) which evaluates greenhouse gas (GHG) emissions or global warming potential in kg CO₂e².

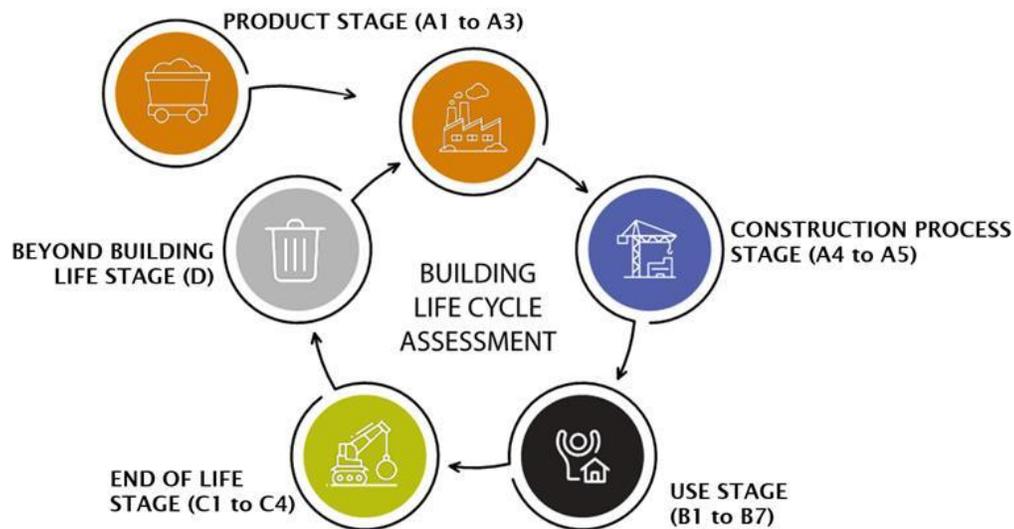


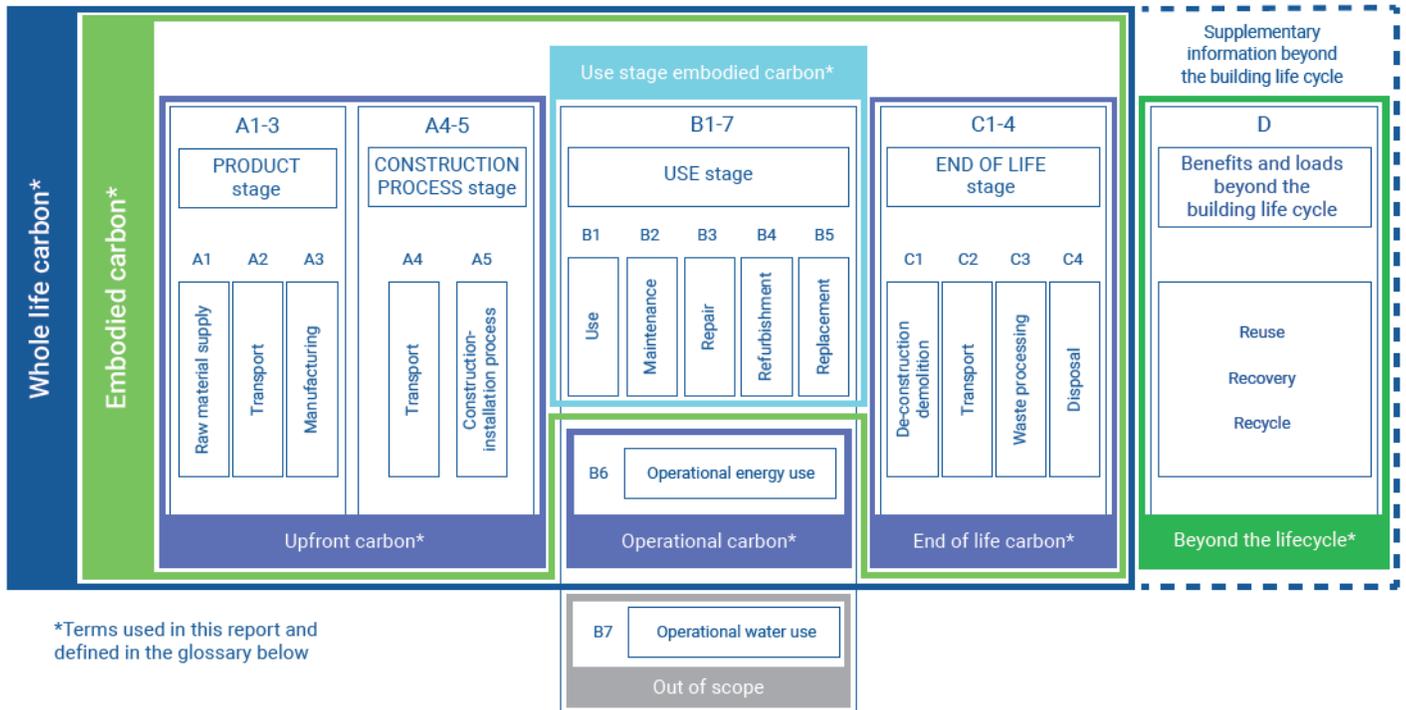
Figure 1 A building life-cycle analysis considers all phases that a building goes through in its lifetime

The stages that the GHG emissions occur in over a building's life can be categorized as shown in Figure 2. The Product Stage (A1 to A3) includes raw material supply (extraction), transport to the manufacturing facility, and manufacturing processes. The Construction and Process Stage (A4 to A5) includes the transportation of material from the manufacturing facility to site, construction equipment energy use, and effects of construction waste. The Use Stage (B1 to B7) includes maintenance, repair, refurbishment, and replacement materials, as well as operational energy and water use. The End-of-Life Stage (C1 to C4) includes demolition equipment energy use, material transport from site to the landfill, waste processing effects, disposal facility equipment energy use and landfill site effects. The Beyond Building Life Stage (D) includes reuse, recycling and energy recovery. Therefore, when Stage D embodied carbon is included, it can reduce the total embodied carbon when compared to the total for

¹ Other impact categories include: Depletion of the stratospheric ozone layer, in kg CFC-11; Acidification of land and water sources, in moles H⁺ or kg SO₂; Eutrophication, in kg nitrogen or kg phosphate; Formation of tropospheric ozone, in kg NO_x or kg ethene; and Depletion of non-renewable energy resources, in MJ.

² kg CO₂e refers to equivalent greenhouse gas emissions represented as CO₂ emissions. This is used interchangeably with kg CO₂ throughout the report.

Stages A-C. Stage D is not typically required by embodied carbon guidelines and has not been included in this analysis.



/ Figure 2 Life-cycle stages excluded from Embodied Carbon Emissions Calculation³

³ Figure based on Figure 1: Terminology used in this report cross-referenced to terms and lifecycle stages defined in EN 15978 from the World Green Building Council's Bringing embodied carbon upfront report (https://worldgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2022/09/22123951/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf)

3 Methodology

This analysis was conducted in accordance with the methodology outlined in the RDH-TMU Embodied Carbon Resource Guide and Udisi et al. Embodied Carbon Impacts of Building Envelope Systems, *World Sustainable Built Environment* (2024). The following is an overview of the methodology used to model the proposed exterior wall assemblies and to report the results.

The assemblies were selected in collaboration with the client and our team's enclosure industry expertise. The intent was to create a variety of assemblies that would include open cell spray foam, closed cell spray foam, and other insulation types that are typically seen combined in commercial and residential (mid-rise to high-rise MURBs) type constructions. The U.S. assemblies focus on including closed cell spray foam and split insulation methods (interior and exterior).

In order to establish reasonable performance targets that both meet current needs of designers as well as meeting future performance requirements of local energy codes such as the Toronto Green Standard Version 4, the "City of Toronto Zero Emissions Building Framework (2017) Appendix C: Parametric modeling results" was used as a reference point to set recommended baseline target effective R-values for the wall assemblies. A thermal performance target of R-25 (RSI-4.4) for the walls. However, the exception was the existing assembly retrofit as this is expected to be limited by interior space available for insulation, which will typically result in a lower R-value. The U.S. assemblies generally followed the same methodology with a focus on Boston, Massachusetts, for their stringent sustainability standards. Some R-values are higher than R-25 based on the assembly make-up. For example, assembly UR2 and UR3 were selected with Passive House as the intended typology, so they result in higher R-values and have the potential for even higher R-values if the insulation layer is increased. The data is presented in a manner that allows user to adjust the quantities of materials to investigate, for example, different thermal resistance levels or material substitutions.

The embodied carbon emissions analysis was carried out by calculating the volume or mass of material in each layer of the assembly and then using emissions data from appropriate Environmental Product Declarations (EPDs). The EPDs were prioritized as follows:

- Generic EPDs where possible. Specific EPDs were used when generic ones were not available.
- Regional prioritization for relevance to the GTHA (Greater Toronto Hamilton Area) for Canadian Assemblies and U.S. (United States) for U.S. defined assemblies (except for concrete which was set to Massachusetts).
- EPDs that are valid and published within the last three to five years and include all stages A1-A5.

The calculations were made for a functional unit of 9 m² of enclosure assembly. This was to account for all assembly components that might be missed in a smaller area, such as studs, insulations pins, and anchorage systems. However, the data is reported both for 9 m² and also normalized for 1 m² carbon intensity (kg CO₂e/m²) to simplify early design stage calculations from enclosure area take-offs. The LCA calculations assumed a building life span of 60 years. If components had a shorter lifespan (as referenced in the NRC's National Whole-Building Life Cycle Assessment Practitioner's Guide Table

5: Average lifespans for Elements and Products), the emissions associated with replacement were included.

The new building materials included are:

- Cladding
- Cladding attachments
- Insulation layers
- Air-Vapour Barriers
- Back-up structure
- Interior finish

One Click LCA was the software used for this analysis. The LCA boundary accounts for cradle-to-grave impacts (A-C) and a lifetime of 60 years. One Click LCA contains global data and over 150,000 data points that feed into the EPDs within their database and it is updated regularly. One Click LCA is compliant with requirements of the following ISO and EN construction LCA standards: EN 15978, ISO 21931-1, ISO 21929, ISO 14040, and EN 15804.

Biogenic carbon, which refers to the carbon that is taken out of the atmosphere and stored in biological materials such as trees or plants through the process of photosynthesis, is also reported where appropriate. Materials that originate from biological sources may sequester carbon while in use as part of the enclosure system. In this respect biogenic carbon stored in timber and other plant-based materials can be viewed as a negative emission. Timber used in construction is considered to lock in the biogenic carbon for the lifetime of the building. When a component using such materials reaches the end of its life it is assumed to be incinerated with the stored carbon released back into the atmosphere. Refer to the guide methodology for the full details of methods used for the analysis.

Life-Cycle Assessment Model

- The life-cycle inventory database used was ISO 14040, 14044, and 21930 compliant
- The Life-Cycle Impact Assessment (LCIA) method used was the One Click LCA tool which employs the data from the US EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI)

Life-Cycle Assessment Reporting

- Life cycle stages A1 to A3 by layer indicating the layers with the highest impact.
- Life stages A4 and A5 are also included although these are a small proportion of the total.
- Total environmental impact showing stages A, B, C are also reported based on various TRACI environmental impact categories with less confidence of their accuracy. The calculated life-cycle impacts including global warming potential (kgCO₂e), ozone depletion potential (CFC-11e), acidification potential (SO₂e), eutrophication potential (N e), formation of tropospheric ozone (NO_x e), and depletion of non-renewables energy resources (MJ).

4 Life-Cycle Assessment Results

4.1 Insulation EPD Comparisons

This comparison is based on cradle-to-building installation embodied carbon values (A1–A5) sourced from Environmental Product Declarations (EPDs). The most recent industry average EPDs were used for the comparison of common insulation types used in exterior wall assemblies. Figure 3 shows the embodied carbon in kgCO_2/m^2 of insulation vs nominal RSI ($\text{m}^2\text{K}/\text{W}$). Heavy density mineral wool board has the highest embodied carbon per RSI value, while fiberglass batt has the lowest embodied carbon per RSI value. Open cell spray foam insulation has one of the lowest embodied carbon intensities per unit of thermal resistance (RSI), ranking just behind fiberglass batt insulation. EPS and closed cell spray foam are the next two lowest embodied carbon per RSI insulation options.

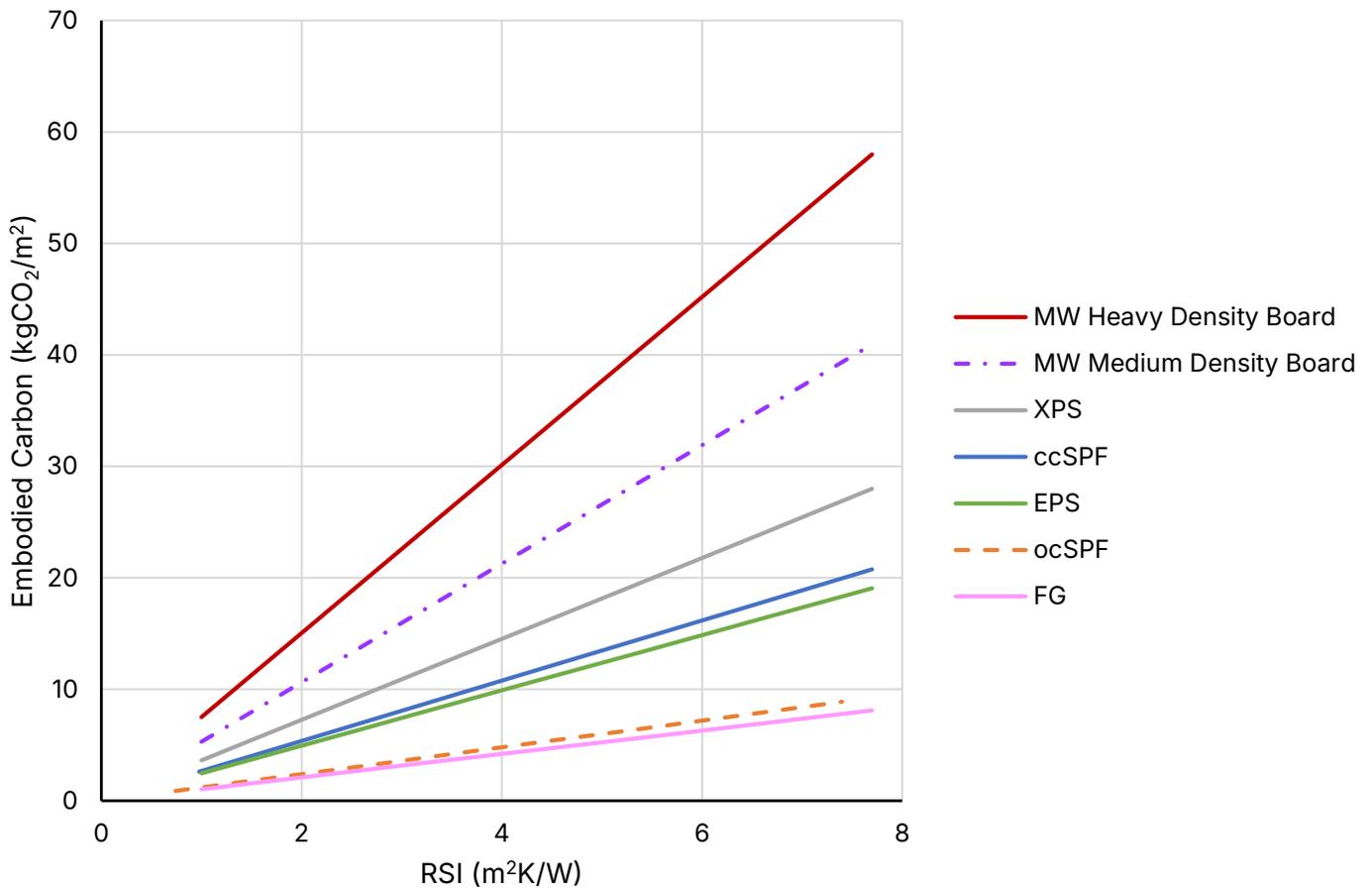


Figure 3 Embodied carbon of common insulation types vs RSI value ($\text{m}^2\text{K}/\text{W}$). Abbreviations: ccSPF = closed cell spray foam, ocSPF = open cell spray foam, XPS = extruded polystyrene, MW = mineral wool, FG = fiberglass batt, EPS = expanded polystyrene.

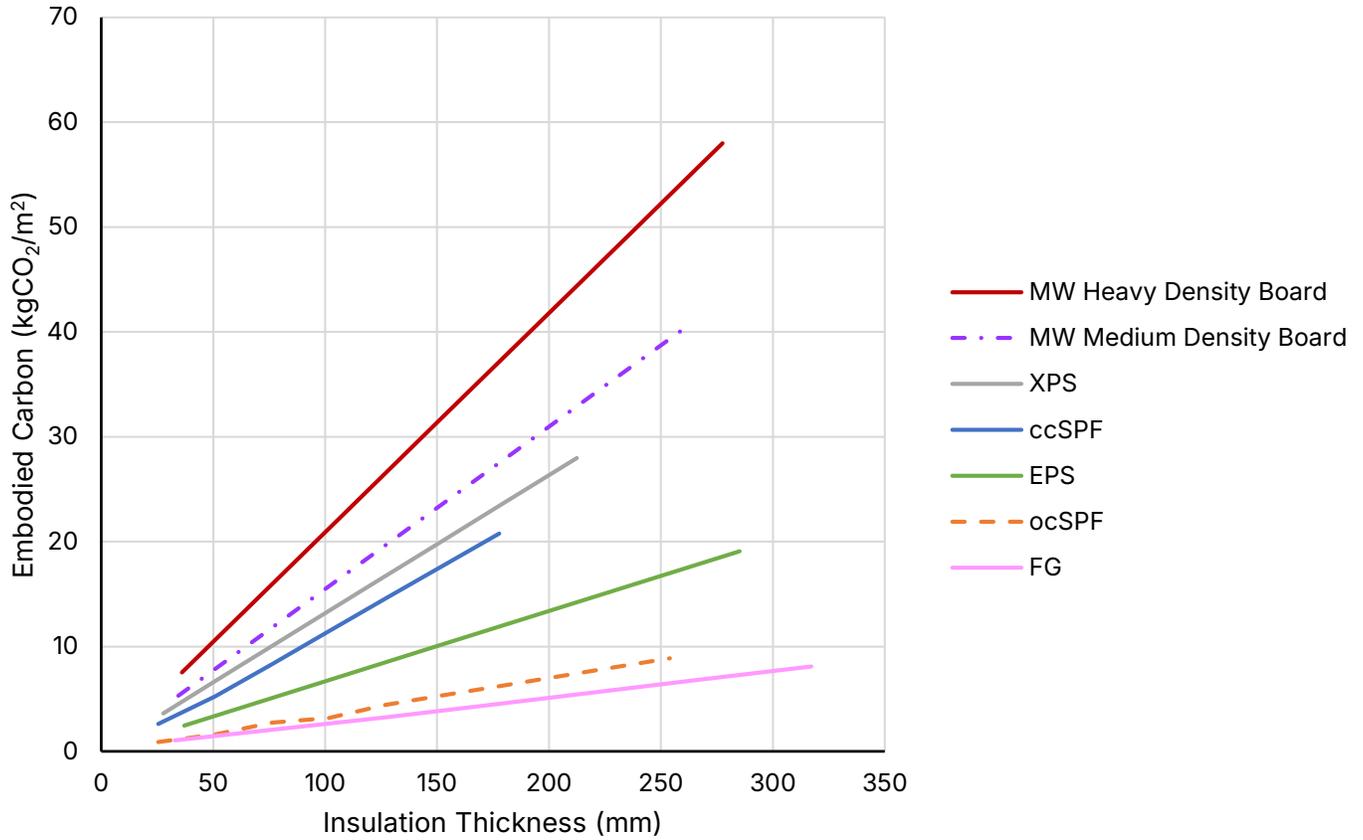
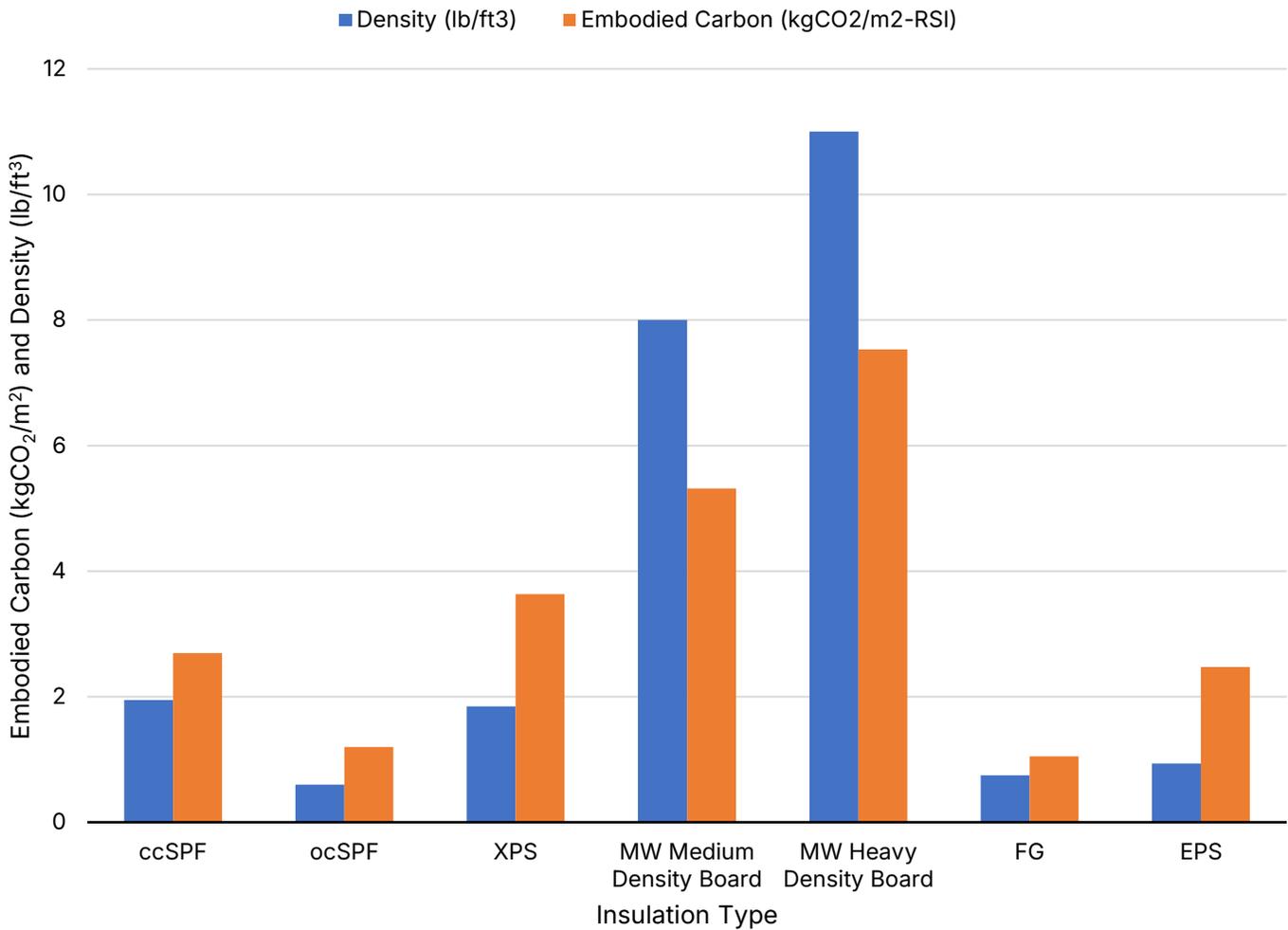


Figure 4 Embodied carbon of common insulation types vs insulation thickness

Figure 4 shows the embodied carbon of common insulation types vs the insulation thickness which is closely correlated to the RSI so the comparison is similar. Heavy density mineral wool board has the highest embodied carbon per thickness of insulation, while open cell spray foam and fiberglass have the lowest embodied carbon per unit of thickness.



/ Figure 5 Embodied carbon and density by common insulation type

Figure 5 shows the embodied carbon and density by common insulation type. The density is shown in blue and embodied carbon is shown in orange on the right. This illustrates that heavy density mineral wool board has a high embodied carbon while having the highest density. Open cell spray foam and fiberglass insulation both have low embodied carbon and the lowest densities. EPS and closed cell spray foam have the next lowest embodied carbon and densities after fiberglass batt and open cell spray foam.

4.2 Comparison of Wall Enclosures

Descriptions of each assembly can be found in section 4.3.1.

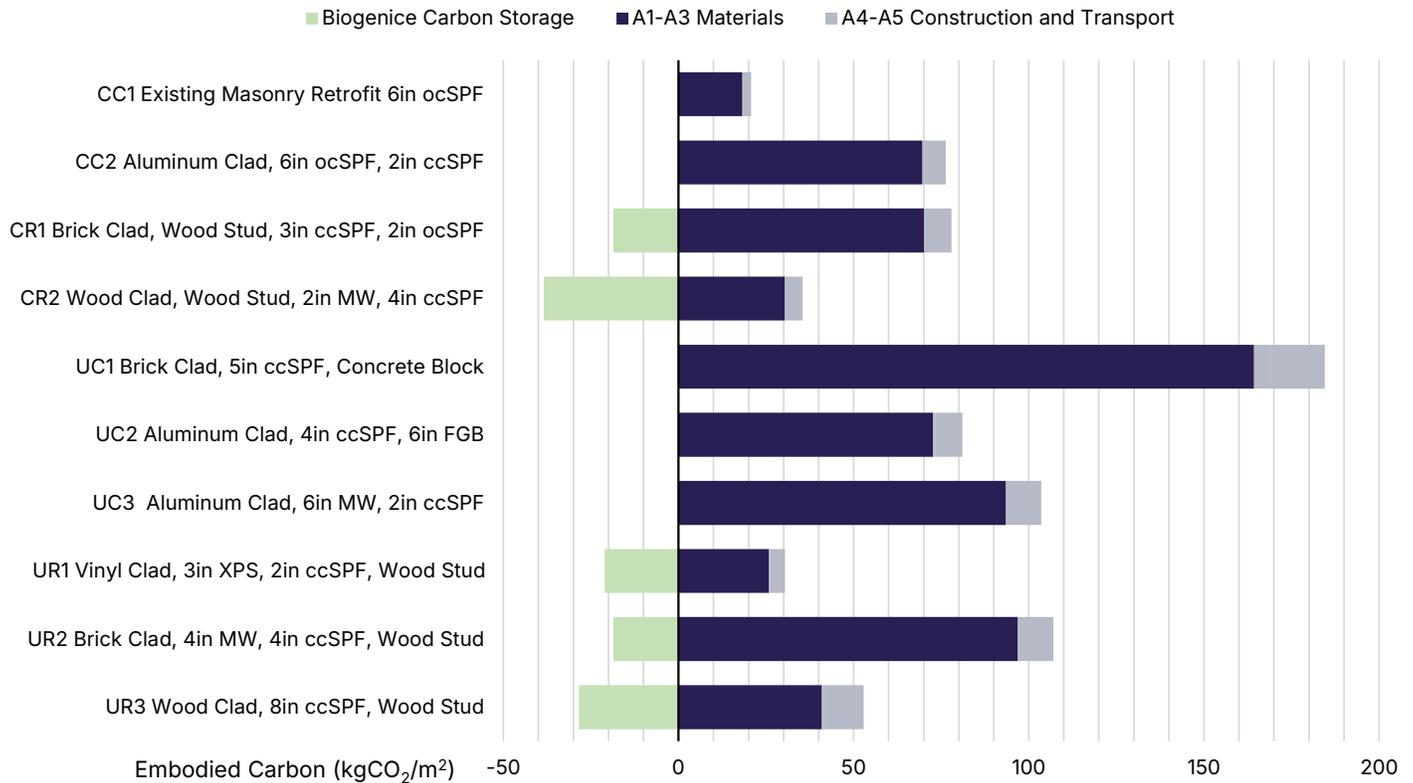


Figure 6 Embodied carbon emissions and biogenic carbon storage by life cycle stages A1-A5 and assembly

Figure 6 shows the embodied carbon emissions and biogenic carbon storage by life cycle stages A1-A5 and assembly. CR2 with wood cladding and wood studs has the highest biogenic carbon storage, and UR3 in the US has a similar makeup with the second highest biogenic carbon storage. UC1 with brick cladding and interior concrete block finish has the highest embodied carbon for stages A1-A5. The lowest embodied carbon assembly is CC1 which is an existing masonry retrofit. The new construction assembly with the lowest embodied carbon is CR2. A close second is the UR1 assembly, which incorporates vinyl cladding, XPS insulation, closed cell spray foam, and wood stud framing.

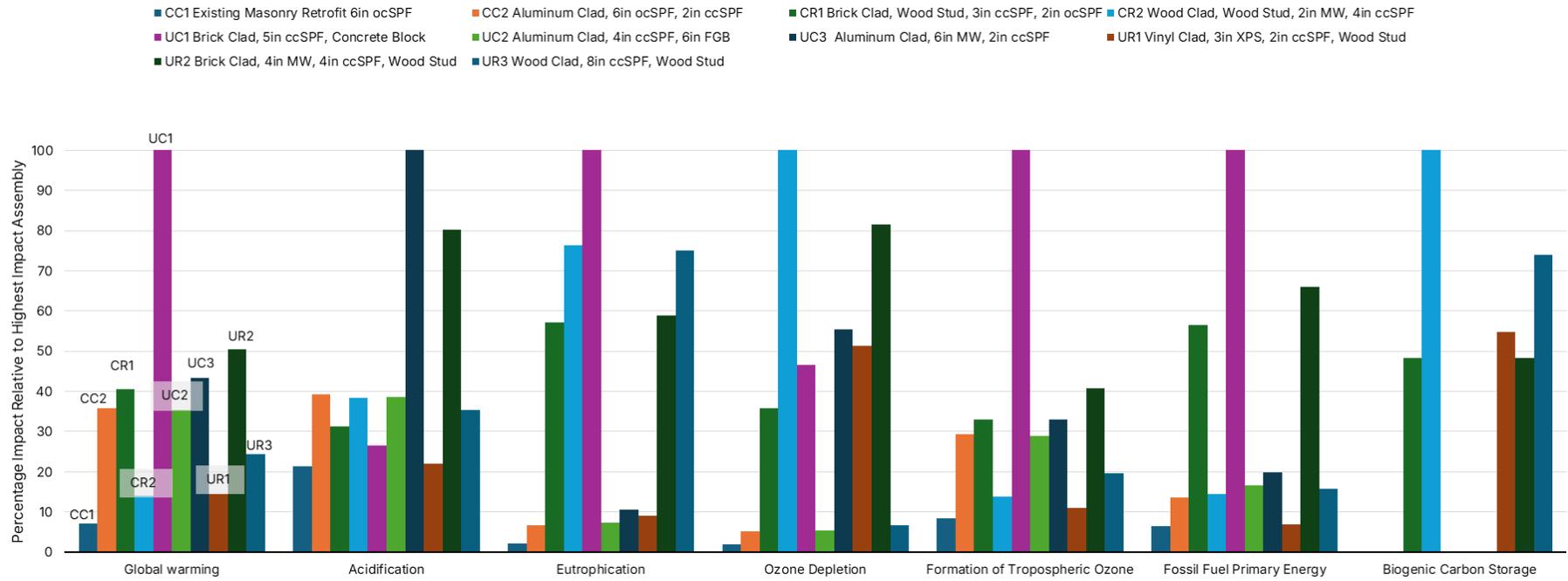


Figure 7 Percentage impact for all environmental indicators for stages A1-C4 by assembly

Figure 7 presents the relative impact of each assembly across all environmental indicators for stages A1-C4. For each indicator, the assembly with the highest impact is normalized to 100%, and the impacts of the remaining assemblies are expressed as a percentage relative to that maximum. As mentioned above, UC1 has the highest global warming impact, while CC1, CR2, and UR1 have the lowest global warming impacts (embodied carbon). UC3 with aluminum cladding, mineral wool, and closed cell spray foam has the highest acidification impact, while CC1 has the lowest acidification impact. UC1 has the highest impact in eutrophication, formation of tropospheric ozone, and fossil fuel primary energy impacts. For eutrophication, CC1, CC2, UC2, and UR1 all have the lowest impact; these assemblies use open cell spray foam, closed cell spray foam, fibreglass batt, and XPS in different combinations and they do not have brick cladding or mineral wool insulation. CR2 has the highest ozone depletion impact. CC1, CC2, UC2, and UR3 have the lowest ozone depletion impact. CC1, CR2, UR1, and UR3 have the lowest formation of tropospheric ozone impacts. CC1 and UR1 have the lowest fossil fuel primary energy impact (<10%), while most other assemblies have a low impact between 10%-20% except for CR1, UC1, and UR2. The only assemblies with biogenic carbon storage are those that contain wood elements which are CR1, CR2, UR1, UR2, and UR3.

4.3 Individual Enclosure Assessments

The assembly R-value calculations were done by our enclosure team using ASHRAE Fundamentals 2017, ASHRAE 90.1 and manufacturer technical data sheets to obtain conductivity (k), and rated R-values. The thickness of insulation was determined using different combinations of interior and exterior insulation (in stud cavity or continuous) to achieve R-values close to an effective R-25 for the whole assembly. The R-value calculations accounted for thermal degradation due to cladding attachments and masonry ties.

4.3.1 Description of Assemblies

CC1 is a Canadian Commercial Assembly 1 that is an existing masonry retrofit using a total of six inches of open cell spray foam (ocSPF). This assembly achieves an effective R-18. This assembly achieves a lower effective R-value because of the practical limitations of including additional insulation thickness (i.e. limited interior space that can be sacrificed for higher thicknesses of insulation).

CC2 is a Canadian Commercial Assembly 2 that is a new construction assembly with aluminum cladding, six inches open cell spray foam, steel studs, and two inches of closed cell spray foam (ccSPF). The effective R-value of the assembly is R-26.

CR1 is a Canadian Residential Assembly 1 that is a new construction with brick cladding, three inches closed cell spray, two inches open cell spray foam in the wood stud cavity. The effective R-value is R-24.

CR2 is a Canadian Residential Assembly 2 that is a new construction with wood cladding, two inches of mineral wool (MW) board and four inches of closed cell spray foam in a wood stud cavity. The effective R-value is R-27.

UC1 is a U.S. Commercial Assembly 1 that is a new construction with brick cladding, five inches of closed cell spray foam, and concrete block interior finish. The effective R-value of the assembly is R-26.

UC2 is a U.S. Commercial Assembly 2 that is a new construction with four inches of closed cell spray foam and six inches of fiberglass batt insulation in the steel stud cavity. The effective R-value is R-27.

UC3 is a U.S. Commercial Assembly 3 that is a new construction with aluminum cladding, six inches of mineral wool and two inches of closed cell spray foam in the steel stud cavity. The effective R-value of the assembly is R-26.

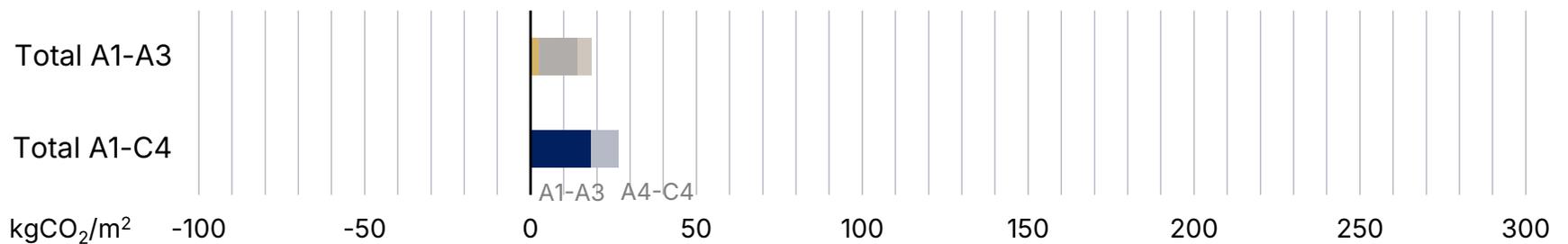
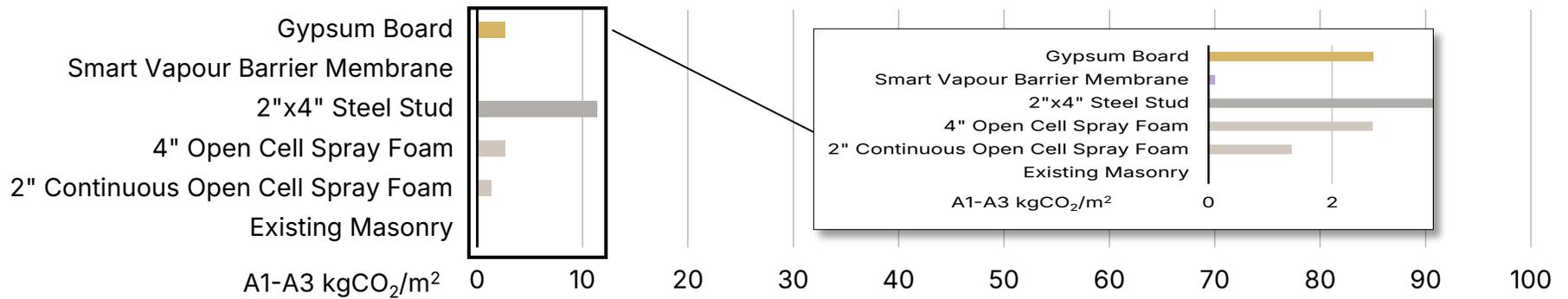
UR1 is a U.S. Residential Assembly 1 that is a new construction with vinyl cladding, three inches of extruded polystyrene (XPS) insulation, and two inches of closed cell spray foam inside the wood stud cavity. The effective R-value of the assembly is R-25.

UR2 is a U.S. Residential Assembly 2 that is a new construction with brick cladding, four inches of mineral wool insulation, and four inches of closed cell spray foam inside the wood stud cavity. The effective R-value of the assembly is R-35.

UR3 is a U.S. Residential Assembly 3 that is a new construction with wood cladding, four inches of closed cell spray foam insulation, and four inches of closed cell spray foam inside the wood stud cavity. The effective R-value of the assembly is R-37.

CC1: Results Summary

Metrics	Results
Description	Masonry Retrofit with Split Open Cell Spray Foam Insulation
Effective R-value	RSI 3.2 m ² K/W R 18 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	18.2 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	0 kgCO ₂ /m ²



CC1: Assembly Effective R-value Calculation

Description	t_{si}	t_p	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
Smart Vapour Barrier Membrane	-	-	-	-	-	-	-
2"x4" Steel Stud offset from masonry with 4" ocSPF,	101.60	4.00	-	-	1.18	6.70	17.20
2" continuous ocSPF	50.80	2.00	0.03	0.66	1.52	8.61	8.61
Existing Masonry	295.40	11.63	0.79	2.67	0.37	2.12	2.12
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	460.50	18.13	-	-	3.22	18.28	28.78

CC1: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂	`
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		24	14.6%
Vapour Control	Smart Vapour Barrier Membrane	Polypropylene vapor barrier membrane, 0.45 mm, 0.134 kg/m ² , fire class E	*		0.97	0.6%
Back-up Structure	2"x4" Steel Stud	Solid sheet steel for studs, industry average US and CN, 1ft 5/8in-14in x1ft 1/4in x 3ft 1/2in x0.0188in-0.1242in		48.45 kg	102.97	62.8%
Interior Insulation	4" Open Cell Spray Foam	Spray polyurethane foam insulation open cell, 1 m ² K/W, 40 mm, 0.29 kg/m ²	100.6		23.9	14.6%
Exterior Insulation	2" Continuous Open Cell Spray Foam	Spray polyurethane foam insulation open cell, 1 m ² K/W, 40 mm, 0.29 kg/m ²	50.8		12.1	7.4%
Existing Structure	Existing Masonry	Existing - Not Included in calculations				
TOTAL					163.9	100.0%

* Thickness determined by EPD default.

¹Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

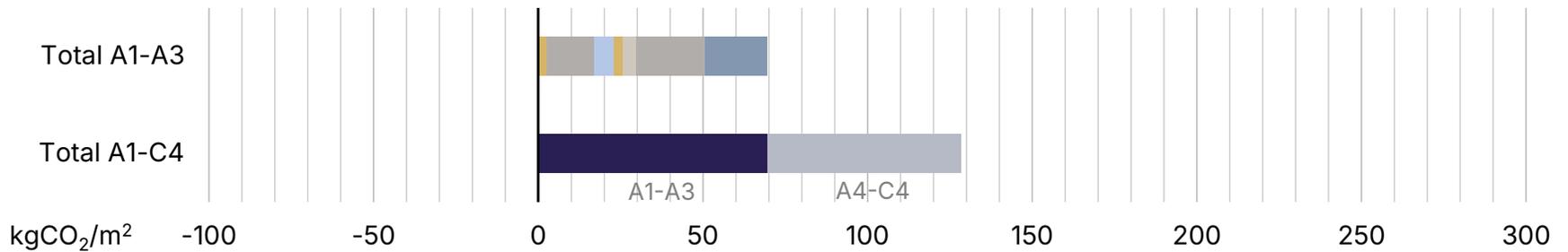
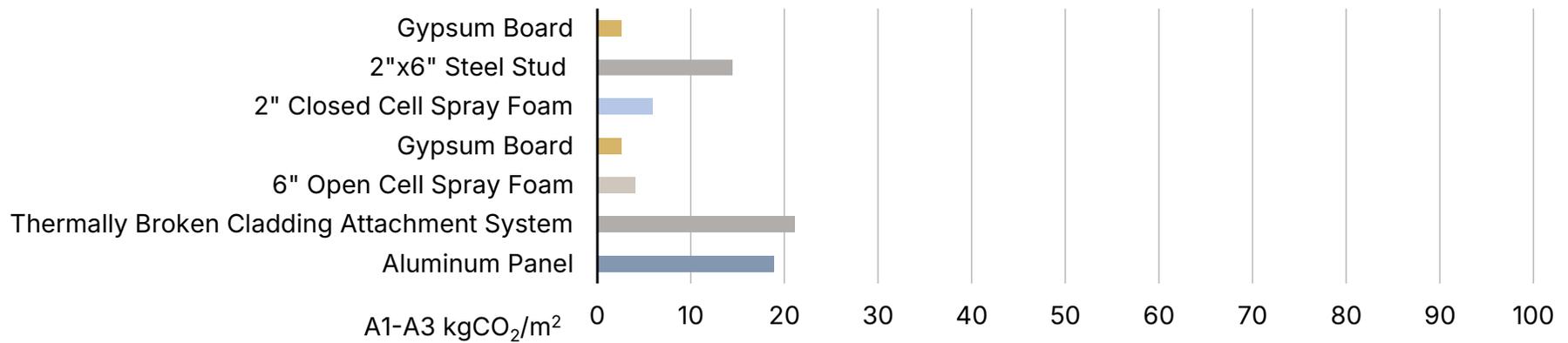
CC1: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	239.2	163.9	22.4	27.16	25.69	69%
Acidification	kg SO	9.4	4.7	0.0	4.36	0.30	50%
Eutrophication	kg Ne	0.062	0.0410	0.0014	0.01	0.01	66%
Ozone Depletion	kg CFC11e	0.0000073	0.00000250	0.00000047	0.00000280	0.00000150	34%
Formation of Tropospheric Ozone	kg O ₃ e	15.5	12.4	0.3	2.67	0.21	80%
Fossil Fuel Primary Energy	MJ	2,377.5	2,240.1	50.7	70.60	16.06	94%
Biogenic Carbon Storage	kg CO ₂ e	0.0	0.0	0.0	0.00	0.00	0%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

CC2: Results Summary

Metrics	Results
Description	Aluminum Clad with Split Closed Cell and Open Cell Spray Foam Insulation
Effective R-value	RSI 4.7 m ² K/W R 26 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	69.6 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	0 kgCO ₂ /m ²



CC2: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
2"x6" Steel Stud with 2" ccSPF	152.40	6.00	-	-	1.00	5.70	11.00
Exterior Gypsum Board	12.70	0.50	0.128	10.10	0.10	0.56	0.56
6" ocSPF with Thermally Broken Cladding Attachment System	152.40	6.00	0.03	0.22	3.41	19.37	25.83
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Aluminum Panel	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	355.60	14.00	-	-	4.66	26.49	38.24

CC2: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		23.5	3.8%
Back-up Structure	2"x6" Steel Stud	Solid sheet steel for studs, industry average US and CN, 1ft 5/8in-14in x1ft 1/4in x 3ft 1/2in x0.0188in-0.1242in	1.4	60.6 kg	130	20.8%
Interior Insulation	2" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	50.3		53	8.5%
Sheathing	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		23.5	3.8%
Exterior Insulation	6" Open Cell Spray Foam	Spray polyurethane foam insulation open cell, 1 m ² K/W, 40 mm, 0.29 kg/m ²	152.4		36	5.8%
Cladding Anchorage	Thermally Broken Cladding Attachment System	Cold-formed steel framing products, 7850 kg/m ³		87.3 kg	190	30.4%
Cladding	Aluminum Panel	Roll formed aluminum cladding, 4.91 kg/m ²	*		170	27.2%
				TOTAL	626.0	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

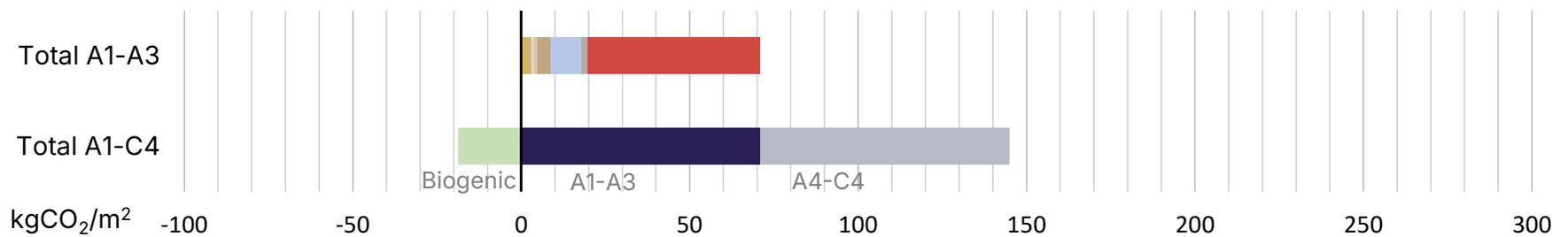
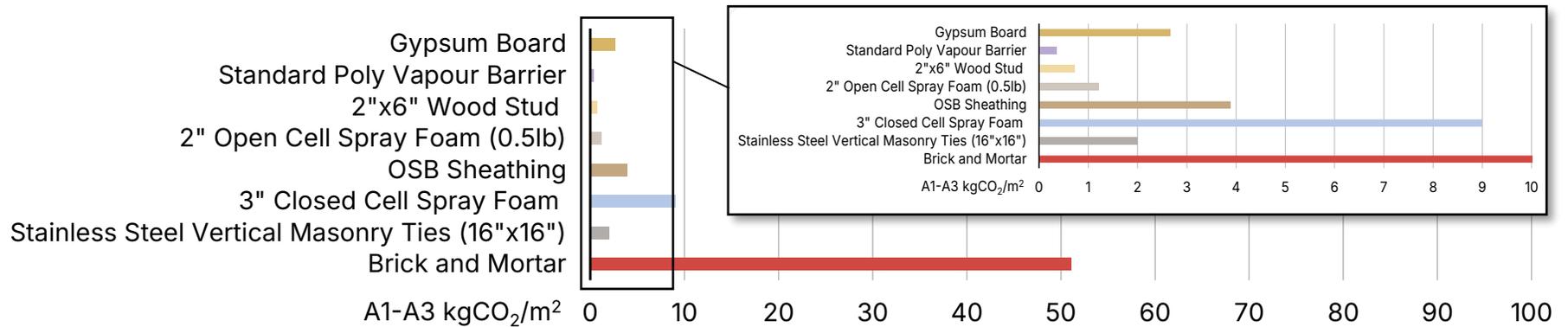
CC2: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	1,155.0	626.6	65.3	399.15	63.94	54%
Acidification	kg SO	17.3	10.4	0.062	5.96	0.87	60%
Eutrophication	kg Ne	0.204	0.110	0.009	0.058	0.027	54%
Ozone Depletion	kg CFC11e	0.0000203	0.0000067	0.0000030	0.0000065	0.0000041	33%
Formation of Tropospheric Ozone	kg O ₃ e	54.9	34.4	1.8	18.28	0.52	63%
Fossil Fuel Primary Energy	MJ	5,074.5	4,176.6	314.4	537.44	45.96	82%
Biogenic Carbon Storage	kg CO ₂ e	0.0	0.0	0.0	0.00	0.00	0%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

CR1: Results Summary

Metrics	Results
Description	Brick Clad with Split Exterior Closed Cell Spray Foam and Open Cell Spray Foam in Wood Stud
Effective R-value	RSI 4.3 m ² K/W R 24 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	70.12 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	-18.57 kgCO ₂ /m ²



CR1: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
Standard Poly Vapour Barrier	-	-	-	-	-	-	-
2"x6" Wood Stud with 2" ocSPF (0.5lb)	139.70	5.50	-	-	1.36	7.70	7.70
OSB Exterior Sheathing	12.70	0.50	0.16	8.30	0.12	0.68	0.68
3" ccSPF with Std. SS Vert. Masonry Ties (16"x16")	76.20	3.00	0.025	0.33	2.66	15.11	17.45
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Brick	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	266.70	10.50	-	-	4.29	24.34	26.68

CR1: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		24	3.8%
Vapour Control	Standard Poly Vapour Barrier	Polyethylene vapour barrier membrane, 0.15 mm, 0.14 kg/m ²	*	60.6 kg	3.2	0.5%
Back-up Structure	2"x6" Wood Stud	Wood framing, Carbon Leadership Forum benchmark, 19 mm, 460 kg/m ³ , 15% moisture content	139.7	0.84 m ²	6.5	1.0%
Interior Insulation	2" Open Cell Spray Foam (0.5lb)	Spray polyurethane foam insulation open cell, 1 m ² K/W, 40 mm, 0.29 kg/m ²	46.0		11	1.7%
Sheathing	OSB Sheathing	Oriented strand board (OSB), 11 mm, 3.58 kg/m ² , 325 kg/m ³	12.7		35	5.5%
Exterior Insulation	3" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	76.2		81	12.7%
Cladding Anchorage	Stainless Steel Vertical Masonry Ties (16"x16")	Cold-formed steel framing products, 7850 kg/m ³		0.001 m ³	18	2.8%
Cladding	Brick and Mortar	Clay brick, 2120 kg/m ³ and Adhesive mortar, silica sand based, latex additive	90.0		460	72.0%
TOTAL					638.7	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

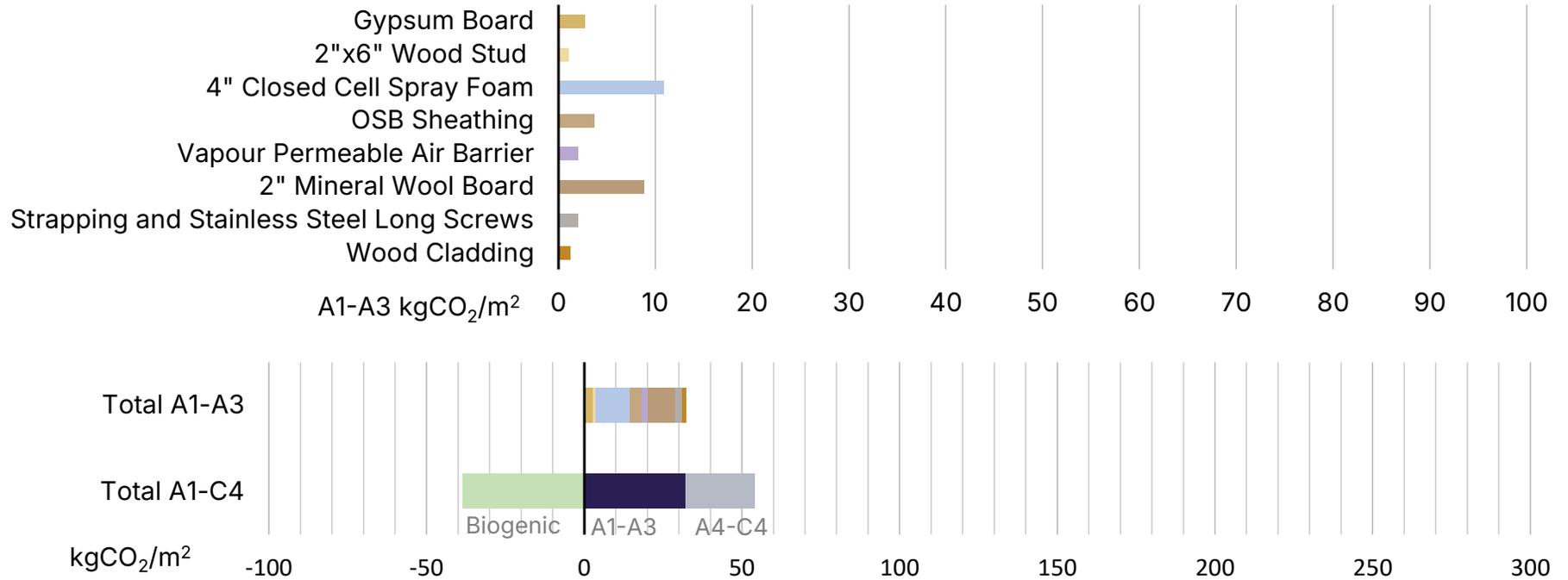
CR1: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	1,295.3	631.1	70.1	527.95	66.09	49%
Acidification	kg SO	13.8	6.4	0.097	6.60	0.68	47%
Eutrophication	kg Ne	1.7	0.830	0.014	0.790	0.058	49%
Ozone Depletion	kg CFC11e	0.000129	0.0000570	0.0000045	0.0000640	0.0000038	44%
Formation of Tropospheric Ozone	kg O ₃ e	60.7	30.7	2.8	26.27	0.98	51%
Fossil Fuel Primary Energy	MJ	20,388.1	10,749.2	485.9	9,121.54	31.42	53%
Biogenic Carbon Storage	kg CO ₂ e	-167.1	167.1	0.0	0.00	0.00	-26%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

CR2: Results Summary

Metrics	Results
Description	Wood Clad with Split Exterior Mineral Wool Insulation and Closed Cell Spray Foam in Wood Stud
Effective R-value	RSI 4.7 m ² K/W R 27 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	30.3 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	-38.5 kgCO ₂ /m ²



CR2: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
2"x6" Wood Stud with 4" ccSPF	139.70	5.50	-	-	3.13	17.80	24.12
OSB Exterior Sheathing	12.70	0.50	0.16	8.30	0.12	0.68	0.68
Vapour Permeable Air Barrier	-	-	-	-	-	-	-
2" MW Board with Strapping and SS Long Screws	50.80	2.00	0.034	0.68	1.33	7.57	8.41
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Wood Cladding	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	241.30	9.50	-	-	4.74	26.90	34.06

CR2: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		24	8.3%
Back-up Structure	2"x6" Wood Stud	Softwood lumber, kiln-dried and planed, 19 mm, 460 kg/m ³ , 15% moisture content	139.7	0.84 m ²	9.1	3.1%
Interior Insulation	4" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	92.1		98	33.9%
Sheathing	OSB Sheathing	Oriented strand board (OSB), 11 mm, 3.58 kg/m ² , 325 kg/m ³	12.7		33	11.4%
Exterior Membrane	Vapour Permeable Air Barrier	Self-adhesive air/vapour barrier membrane, tri-laminated polyethylene faced, 40 mil (1 mm), 0.2 lb/ft ² (0.975 kg/m ²)			18	6.2%
Exterior Insulation	2" Mineral Wool Board	Stone wool insulation board and batt, RSI= 1 m ² K/W, 89 mm, 1.2 kg/m ² , input factored up by 5.1 for heavy density board and factored up to match RSI calculation	50.8		79	27.3%
Cladding Anchorage	Strapping and Stainless Steel Long Screws	Softwood lumber, kiln-dried and planed, 19 mm, 460 kg/m ³ , 15% moisture content; Cold formed steel framing and accessories, thickness 0.381 mm - 2.4638 mm, 7850 kg/m ³	19.0	1.41 m ²	17.6	6.1%
Cladding	Wood Cladding	Treated wooden cladding, generic, 15-40 mm (0.59-1.57 in), 9.75 kg/m ² (1.99 lbs/ft ²) (for 15 mm/0.59 in), 525 kg/m ³ (32.8 lbs/ft ³), min. G4-1; Softwood lumber, kiln-dried and planed, 2x6in, 2x4in, 433.57 kg/m ³	*		10.63	3.7%
TOTAL					289.3	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

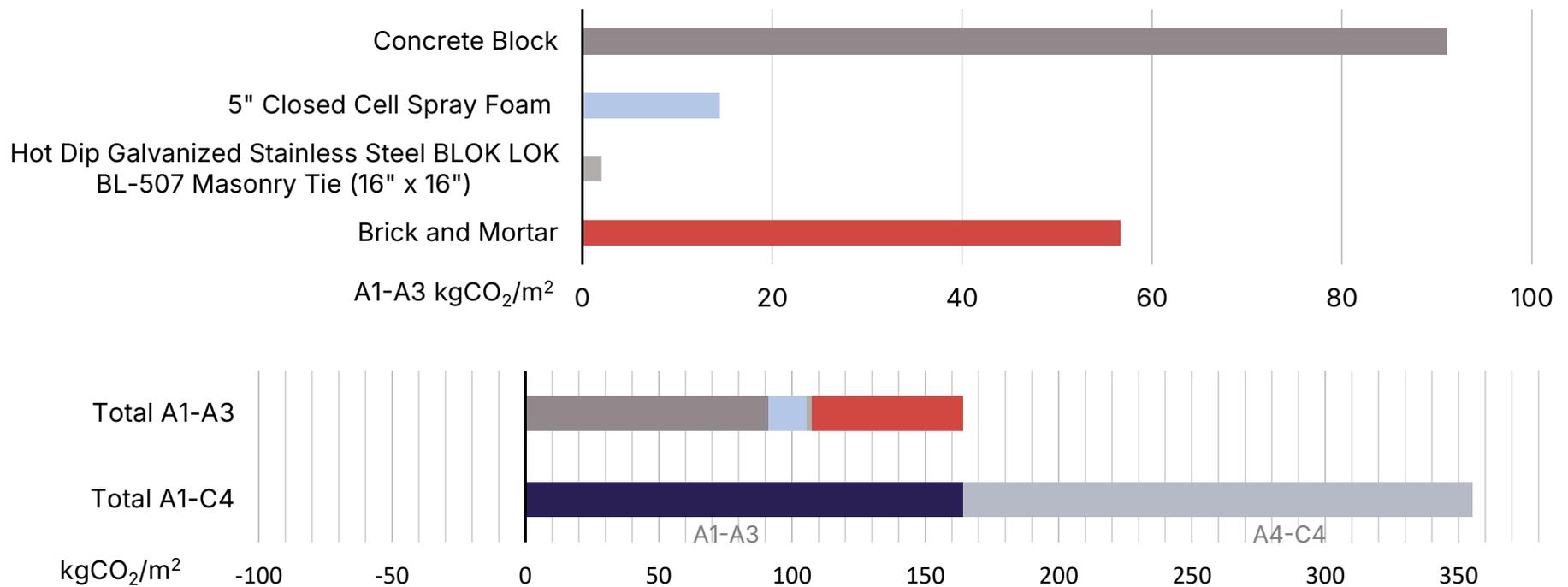
CR2: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	470.8	272.9	46.2	71.57	80.09	58%
Acidification	kg SO	16.90	15.72	0.0320000	0.830000	0.320000	93%
Eutrophication	kg Ne	2.3	0.8	0.005	1.38	0.09	35%
Ozone Depletion	kg CFC11e	0.0004	0.0002	0.0000015	0.00018	0.0000035	49%
Formation of Tropospheric Ozone	kg O ₃ e	25.5	15.7	0.9	7.25	1.71	61%
Fossil Fuel Primary Energy	MJ	5,192.2	4,080.5	161.1	926.75	23.90	79%
Biogenic Carbon Storage	kg CO ₂ e	-346.3	346.3	0.0	0.00	0.00	-127%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

UC1: Results Summary

Metrics	Results
Description	Brick Clad with Closed Cell Spray Foam and Interior Concrete Block
Effective R-value	RSI 4.6 m ² K/W R 26 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	164.3 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	0 kgCO ₂ /m ²



UC1: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Concrete Block	203.20	8.00	2.50	12.30	0.08	0.46	0.46
5" ccSPF with SS BLOK LOK BL-507 Masonry Tie (16" x 16")	127.00	5.00	0.024	0.19	4.32	24.53	30.17
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Brick	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	355.60	14.00	-	-	4.55	25.84	31.48

UC1: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish / Structure	Concrete Block	Concrete masonry unit (CMU), 22 MPa; Preblended cement mortar with dried sand, 800 psi	203.2		820	55.5%
Interior Insulation	5" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	127.0		130	8.8%
Cladding Anchorage	Hot Dip Galvanized Stainless Steel BLOK LOK BL-507 Masonry Tie (16" x 16")	Cold-formed steel framing products, 7850 kg/m ³		0.001 m ³	18	1.2%
Cladding	Brick and Mortar	Clay brick, 2120 kg/m ³ ; Mortar Type N	90.0		510	34.5%
				TOTAL	1478.0	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

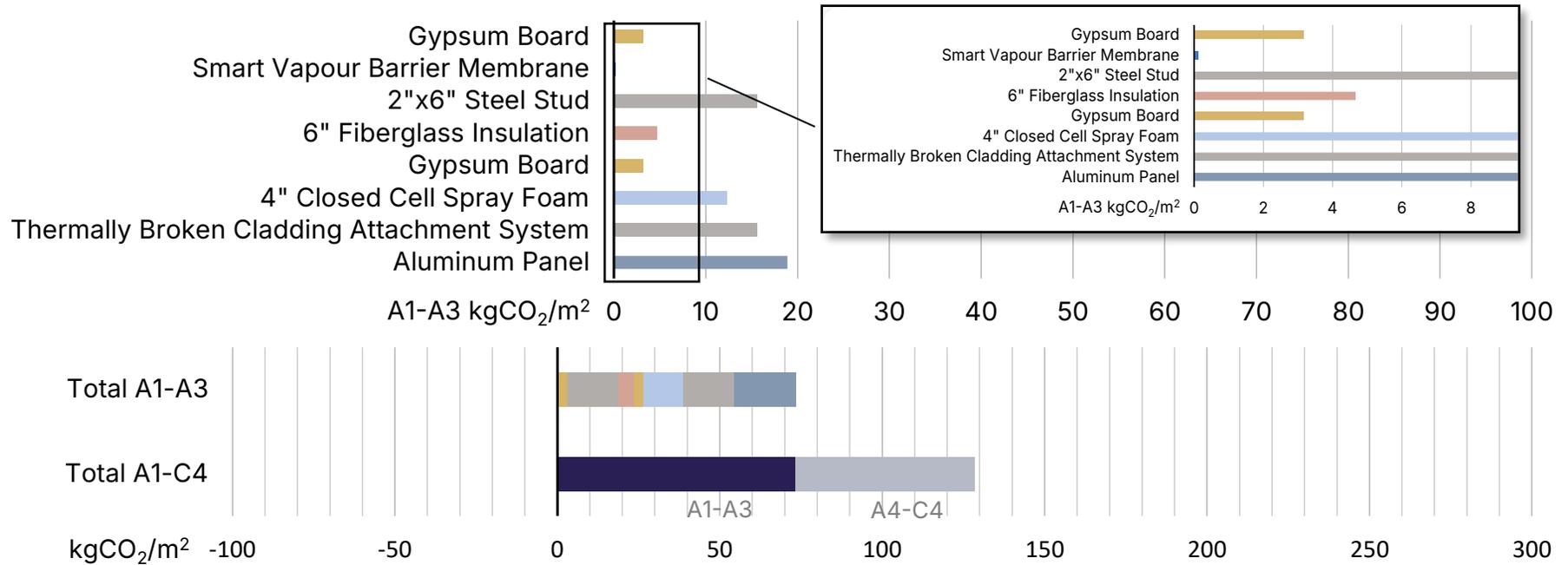
UC1: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	3,195.5	1,478.6	182.0	1,436.19	98.65	46%
Acidification	kg SO	11.7	4.3	0.25	5.78	1.39	37%
Eutrophication	kg Ne	2.9	1.4	0.0350	1.46	0.05	47%
Ozone Depletion	kg CFC11e	0.000169	0.000064	0.000012	0.000086	0.000007	38%
Formation of Tropospheric Ozone	kg O ₃ e	183.6	84.4	7.1	91.25	0.82	46%
Fossil Fuel Primary Energy	MJ	36,126.5	17,912.4	1,257.6	16,902.15	54.36	50%
Biogenic Carbon Storage	kg CO ₂ e	0.0	0.0	0.0	0.00	0.00	0%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

UC2: Results Summary

Metrics	Results
Description	Aluminum Clad with Split Exterior Closed Cell Spray Foam Insulation and Interior Fiberglass Batt Insulation
Effective R-value	RSI 4.7 m ² K/W R 27 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	72.7 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	0 kgCO ₂ /m ²



UC2: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
Smart Vapour Barrier Membrane	-	-	-	-	-	-	-
2"x6" Steel Stud with 6" Fiberglass	152.40	6.00	-	-	1.30	7.40	21.00
Exterior Gypsum Board	12.70	0.50	0.128	10.10	0.10	0.56	0.56
4" ccSPF with Thermally Broken Cladding Attachment System	101.60	4.00	0.024	0.24	3.19	18.10	24.14
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Aluminum Panel	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	304.80	12.00	-	-	4.74	26.92	46.55

UC2: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		28.5	4.3%
Vapour Control	Smart Vapour Barrier Membrane	Polypropylene vapor barrier membrane, 0.45 mm, 0.134 kg/m ² , fire class E	*		1.1	0.2%
Back-up Structure	2"x6" Steel Stud	Solid sheet steel for studs, industry average US and CN, 1ft 5/8in-14in x1ft 1/4in x 3ft 1/2in x0.0188in-0.1242in		60.56 kg	140	21.2%
Interior Insulation	6" Fiberglass Insulation	Fiberglass batt insulation, unfaced, 1 m ² K/W, 33 mm, 12.01 kg/m ³ , 0.396 kg/m ²	150.9		42	6.4%
Sheathing	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		28.5	4.3%
Exterior Insulation	4" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	101.6		110	16.7%
Cladding Anchorage	Thermally Broken Cladding Attachment System	Cold-formed steel framing products, 7850 kg/m ³		59.7 kg	140	21.2%
Cladding	Aluminum Panel	Roll formed aluminum cladding, 4.91 kg/m ²	*		170	25.8%
TOTAL					660.1	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

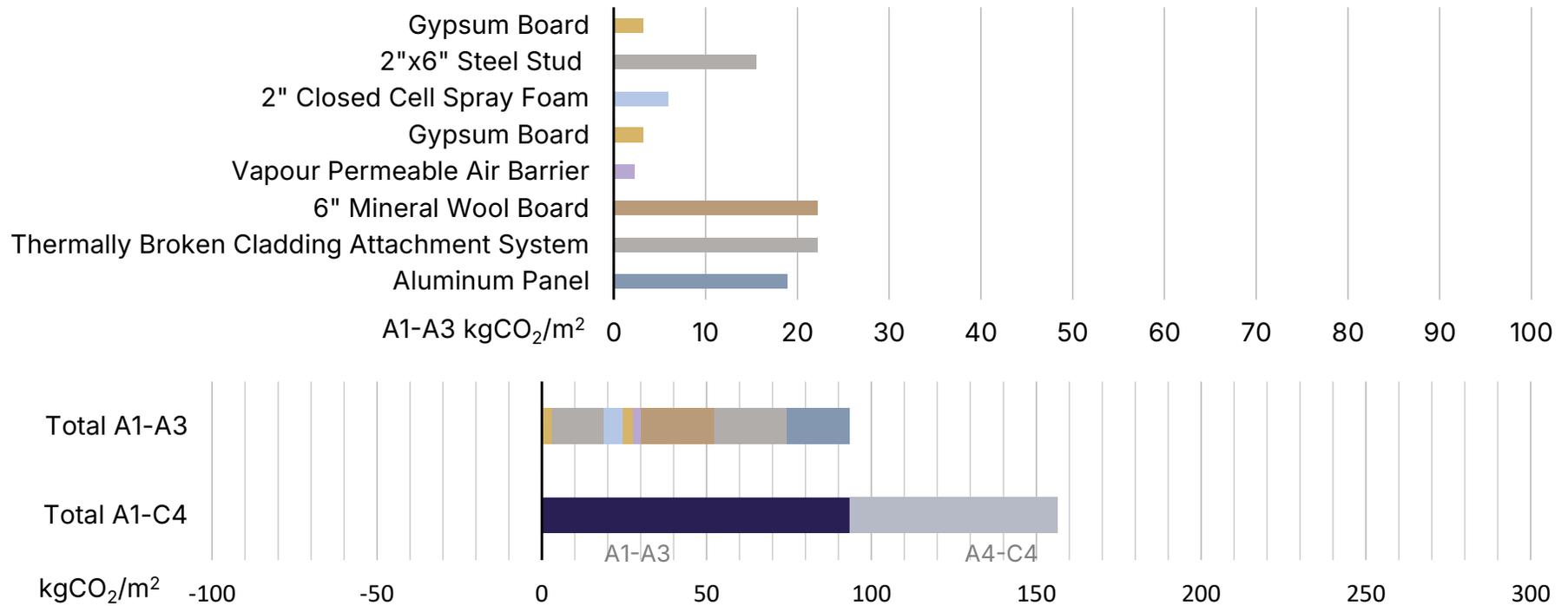
UC2: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	1,150.2	654.3	74.8	346.94	74.14	57%
Acidification	kg SO	17.1	10.4	0.0	5.78	0.81	61%
Eutrophication	kg Ne	0.2	0.1	0.0	0.05	0.03	60%
Ozone Depletion	kg CFC11e	0.0	0.0	0.0	0.00	0.00	39%
Formation of Tropospheric Ozone	kg O ₃ e	53.2	35.1	0.8	16.61	0.63	66%
Fossil Fuel Primary Energy	MJ	6,016.2	5,335.7	146.5	489.61	44.43	89%
Biogenic Carbon Storage	kg CO ₂ e	0.0	0.0	0.0	0.00	0.00	0%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

UC3: Results Summary

Metrics	Results
Description	Aluminum Clad with Split Exterior Mineral Wool Insulation and Interior Closed Cell Spray Foam Insulation
Effective R-value	RSI 4.6 m ² K/W R 26 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	93.5 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	0 kgCO ₂ /m ²



UC3: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
2"x6" Steel Stud with 2" ccSPF	152.40	6.00	-	-	1.00	5.70	11.00
Exterior Gypsum Board	12.70	0.50	0.128	10.10	0.10	0.56	0.56
Vapour Permeable Air Barrier	-	-	-	-	-	-	-
6" MW Board with Thermally Broken Cladding Attachment System	152.40	6.00	0.034	0.22	3.36	19.09	25.45
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Aluminum Panel	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	355.60	14.00	-	-	4.61	26.20	37.86

UC3: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		28.5	3.4%
Back-up Structure	2"x6" Steel Stud	Solid sheet steel for studs, industry average US and CN, 1ft 5/8in-14in x1ft 1/4in x 3ft 1/2in x0.0188in-0.1242in		60.56 kg	140	16.7%
Interior Insulation	2" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	50.3		53	6.3%
Sheathing	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		28.5	3.4%
Exterior Membrane	Vapour Permeable Air Barrier	Self-adhesive air/vapour barrier membrane, tri-laminated polyethylene faced, 40 mil (1 mm), 0.2 lb/ft ² (0.975 kg/m ²)	*		20	2.4%
Exterior Insulation	6" Mineral Wool Board	Stone wool insulation board and batt, RSI= 1 m ² K/W, 89 mm, 1.2 kg/m ² , input factored up by 5.1 for heavy density board, and factored up to match RSI calculation	152.4		200	23.8%
Cladding Anchorage	Thermally Broken Cladding Attachment System	Cold-formed steel framing products, 7850 kg/m ³		87.3 kg	200	23.8%
Cladding	Aluminum Panel	Roll formed aluminum cladding, 4.91 kg/m ²	*		170	20.2%
TOTAL					840.0	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

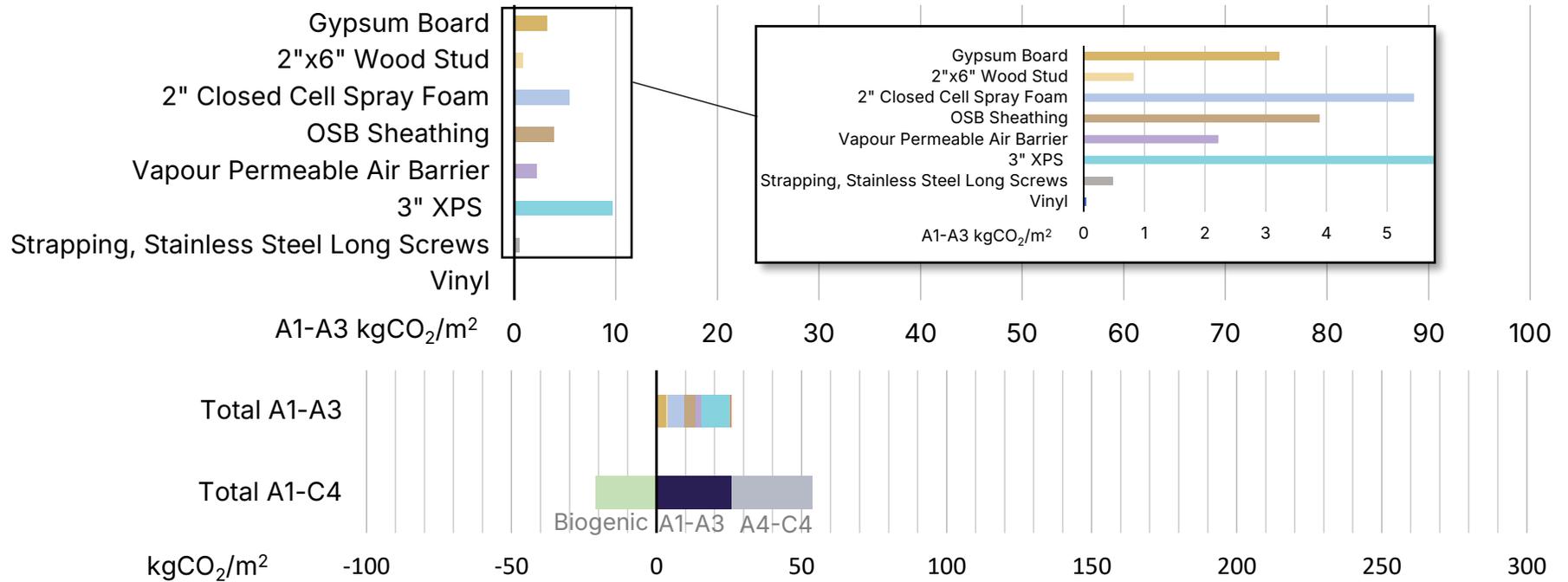
UC3: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	1,408.1	841.1	90.9	413.50	62.57	60%
Acidification	kg SO	44.1	37.2	0.039	5.99	0.91	84%
Eutrophication	kg Ne	0.312	0.220	0.005	0.060	0.027	70%
Ozone Depletion	kg CFC11e	0.00020	0.00019	0.00000	0.00001	0.00000	94%
Formation of Tropospheric Ozone	kg O ₃ e	60.5	39.7	1.10	19.02	0.63	66%
Fossil Fuel Primary Energy	MJ	7,191.5	6,379.8	193.3	570.71	47.69	89%
Biogenic Carbon Storage	kg CO ₂ e	0.0	0.0	0.0	0.00	0.00	0%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

UR1: Results Summary

Metrics	Results
Description	Vinyl Clad with Split Exterior XPS Insulation and Interior Closed Cell Spray Foam Insulation in Wood Stud
Effective R-value	RSI 4.5 m ² K/W R 25 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	25.9 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	-21.1 kgCO ₂ /m ²



UR1: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
2"x6" Wood Stud with 2" ccSPF	139.70	5.50	-	-	1.81	10.30	11.00
OSB Exterior Sheathing	12.70	0.50	0.16	8.30	0.12	0.68	0.68
Vapour Permeable Air Barrier	-	-	-	-	-	-	-
3" XPS with Strapping and SS Long Screws	76.20	3.00	0.029	0.38	2.36	13.43	14.92
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Vinyl	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	266.70	10.50	-	-	4.45	25.26	27.45

UR1: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		29	12.5%
Back-up Structure	2"x6" Wood Stud	Softwood lumber, kiln-dried and planed, 19 mm, 460 kg/m ³ , 15% moisture content	139.7	0.84 m ²	7.41	3.2%
Interior Insulation	2" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	46.0		49	21.1%
Sheathing	OSB Sheathing	Oriented strand board (OSB), 11 mm, 3.58 kg/m ² , 325 kg/m ³	12.7		35	15.1%
Exterior Membrane	Vapour Permeable Air Barrier	Self-adhesive air/vapour barrier membrane, tri-laminated polyethylene faced, 40 mil (1 mm), 0.2 lb/ft ² (0.975 kg/m ²)	*		20	8.6%
Exterior Insulation	3" XPS	XPS insulation, L=0.0276 W/mK, R=1 m ² K/W, 27.6 mm 0.744 kg/m ² , 26.9 kg/m ³ , Lambda=0.0267 W/(m ² K)	76.2		87	37.5%
Cladding Anchorage	Strapping, Stainless Steel Long Screws	Cold formed steel framing and accessories, thickness 0.381 mm - 2.4638 mm, 7850 kg/m ³	19.0	1.41 m ²	4.4	1.9%
Cladding	Vinyl	Horizontal vinyl siding, T: 0.04 inches, L: 12 ft, W: 0.75 ft, 89.27 lbs/ft ³	*		0.42	0.2%
TOTAL					232.2	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness

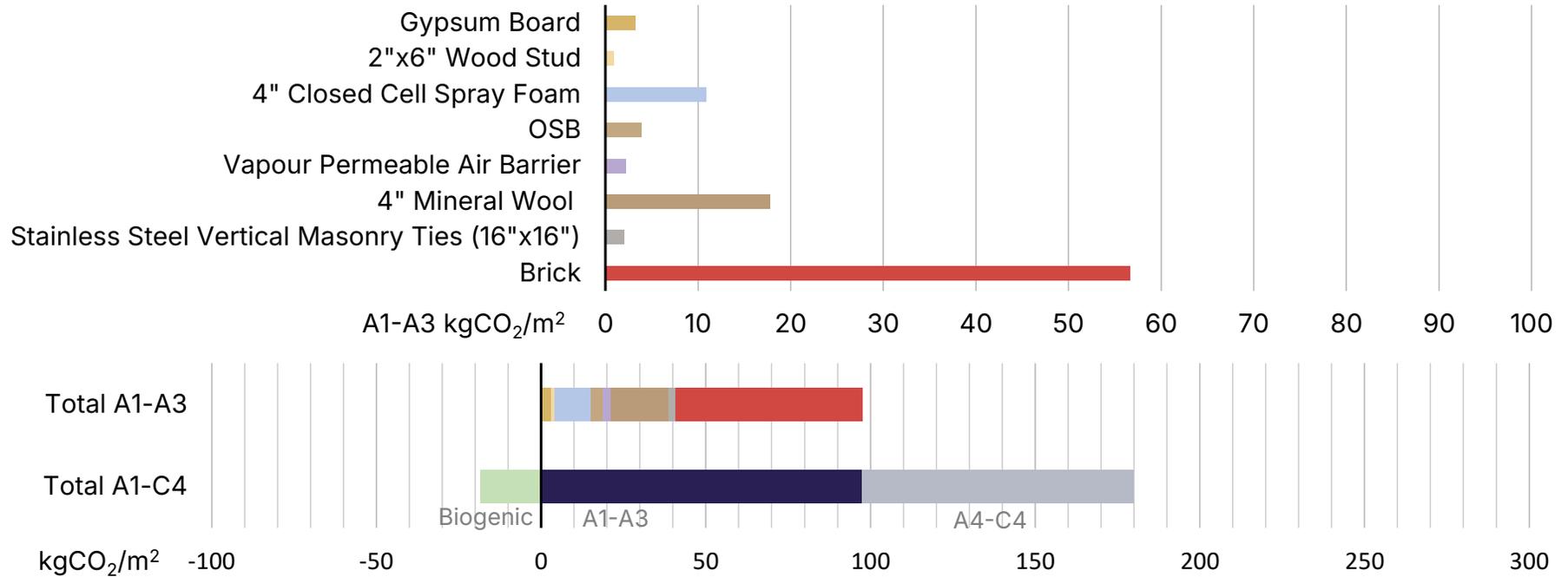
UR1: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	481.9	232.7	40.8	93.07	115.37	48%
Acidification	kg SO	9.7	4.9	0.019	4.46	0.29	51%
Eutrophication	kg Ne	0.261	0.120	0.0027	0.059	0.079	46%
Ozone Depletion	kg CFC11e	0.000181	0.000170	0.000001	0.000006	0.000005	94%
Formation of Tropospheric Ozone	kg O ₃ e	20.2	14.2	0.54	3.92	1.54	70%
Fossil Fuel Primary Energy	MJ	2,477.0	2,244.8	95.7	109.30	27.17	91%
Biogenic Carbon Storage	kg CO ₂ e	-189.7	189.7	0.0	0.00	0.00	-82%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

UR2: Results Summary

Metrics	Results
Description	Brick Clad with Split Exterior Mineral Wool Insulation and Interior Closed Cell Spray Foam Insulation in Wood Stud
Effective R-value	RSI 6.1 m ² K/W R 35 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	96.9 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	-18.6 kgCO ₂ /m ²



UR2: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
2"x6" Wood Stud with 4" ccSPF	139.70	5.50	-	-	3.13	17.80	24.00
OSB	12.70	0.50	0.16	8.30	0.12	0.68	0.68
Vapour Permeable Air Barrier	-	-	-	-	-	-	-
4" MW with Std. SS Vert. Masonry Ties (16"x16")	101.60	4.00	0.034	0.33	2.71	15.39	16.97
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Brick	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	292.10	11.50	-	-	6.12	34.72	42.50

UR2: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		29	3.3%
Back-up Structure	2"x6" Wood Stud	Softwood lumber, kiln-dried and planed, 19 mm, 460 kg/m ³ , 15% moisture content	139.7	0.84 m ²	7.4	0.8%
Interior Insulation	4" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	92.1		98	11.2%
Sheathing	OSB	Oriented strand board (OSB), 11 mm, 3.58 kg/m ² , 325 kg/m ³	12.7		35	4.0%
Exterior Membrane	Vapour Permeable Air Barrier	Self-adhesive air/vapour barrier membrane, tri-laminated polyethylene faced, 40 mil (1 mm), 0.2 lb/ft ² (0.975 kg/m ²)	*		20	2.3%
Exterior Insulation	4" Mineral Wool	Stone wool insulation board and batt, RSI= 1 m ² K/W, 89 mm, 1.2 kg/m ² , input factored up by 5.1 for heavy density board, and factored up to match RSI calculation	101.6		160	18.2%
Cladding Anchorage	Stainless Steel Vertical Masonry Ties (16"x16")	Cold-formed steel framing products, 7850 kg/m ³		0.001 m ³	18	2.1%
Cladding	Brick	Clay brick, 2120 kg/m ³ ; Mortar Type N	90.0		510	58.1%
TOTAL					877.4	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

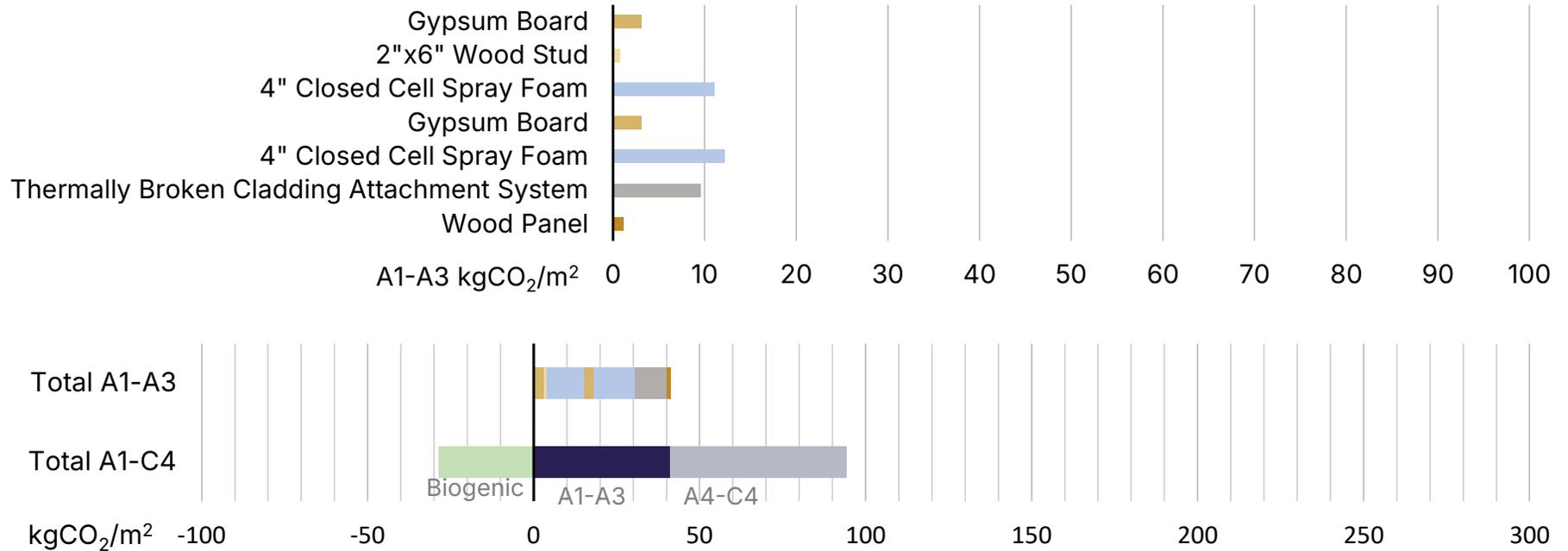
UR2: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	1,615.0	872.3	91.2	565.63	85.88	54%
Acidification	kg SO	35.3	28.0	0.00	6.52	0.73	79%
Eutrophication	kg Ne	1.7	0.9	0.000	0.76	0.07	52%
Ozone Depletion	kg CFC11e	0.00029	0.00023	0.00000	0.00006	0.00000	79%
Formation of Tropospheric Ozone	kg O ₃ e	71.7	40.2	0.0	30.25	1.27	56%
Fossil Fuel Primary Energy	MJ	23,327.0	13,790.0	0.0	9,500.69	36.35	59%
Biogenic Carbon Storage	kg CO ₂ e	-167.6	167.6	0.0	0.00	0.00	-19%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

UR3: Results Summary

Metrics	Results
Description	Wood Clad with Split Exterior Closed Cell Spray Foam Insulation and Interior Closed Cell Spray Foam Insulation in Wood Stud
Effective R-value	RSI 6.6 m ² K/W R 37 ft ² ·°F·h/BTU
Embodied Carbon per m ² of Enclosure (A1-A3)	40.9 kgCO ₂ /m ²
Biogenic Carbon per m ² of Enclosure	-28.5 kgCO ₂ /m ²



UR3: Assembly Effective R-value Calculation

Description	t_{SI}	t_P	k	C (USI)	$RSI_{effective}$	$R_{effective}$	$R_{nominal}$
Units	mm	in	W/mK	W/m ² K	m ² K/W	ft ² ·°F·h/BTU	ft ² ·°F·h/BTU
Interior Film	-	-	-	8.30	0.12	0.68	0.68
Interior Gypsum Board	12.70	0.50	-	-	-	-	-
2"x6" Wood Stud with 4" ccSPF	139.70	5.50	-	-	3.13	17.80	24.00
Exterior Gypsum Board	12.70	0.50	0.128	10.10	0.10	0.56	0.56
4" ccSPF with Thermally Broken Cladding Attachment System	76.20	3.00	0.025	0.33	3.19	18.10	24.14
Ventilated Air Space	25.40	1.00	-	-	-	-	-
Wood Panel	-	-	-	-	-	-	-
Exterior Film	-	-	-	34	0.03	0.17	0.17
TOTALS	266.70	10.50	-	-	6.57	37.32	49.55

UR3: Embodied Carbon Emissions (A1-A3 Life Stages) for 9 m² Assembly Area

Category	Material	Description from EPD	Thickness	Other Quantity ¹	Carbon Emissions (A1-A3)	% of total
Units			mm		kgCO ₂ e	%
Finish	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		28.5	7.7%
Back-up Structure	2"x6" Wood Stud	Softwood lumber, kiln-dried and planed, 19 mm, 460 kg/m ³ , 15% moisture content	139.7	0.84 m ²	7.4	2.0%
Interior Insulation	4" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	92.1		99.8	26.9%
Sheathing	Gypsum Board	Gypsum plaster board, regular, generic, 6.5-25 mm (0.25-0.98 in), 10.725 kg/m ² (2.20 lbs/ft ²) (for 12.5 mm/0.49 in), 858 kg/m ³ (53.6 lbs/ft ³), 0% recycled gypsum	12.7		28.5	7.7%
Exterior Insulation	4" Closed Cell Spray Foam	Spray polyurethane foam insulation closed cell with HFO blowing agent, 1 m ² K/W, 20 mm, 0.65 kg/m ²	101.6		110.2	29.7%
Cladding Anchorage	Thermally Broken Cladding Attachment System	Cold-formed steel framing products, 7850 kg/m ³		36.74 kg	86	23.2%
Cladding	Wood Panel	Treated wooden cladding, generic, 15-40 mm (0.59-1.57 in), 9.75 kg/m ² (1.99 lbs/ft ²) (for 15 mm/0.59 in), 525 kg/m ³ (32.8 lbs/ft ³), min. G4-1; Softwood lumber, kiln-dried and planed, 2x6in, 2x4in, 433.57 kg/m ³	21.0	0.001 m ³	10.63	2.9%
TOTAL					371.0	100.0%

* Thickness determined by EPD default.

¹ Volume/mass/area only shown if calculated differently than 9 m² area and thickness.

UR3: Environmental Emissions (A1 to C4 Life Stages) for 9 m²

Lifecycle Stage		A1 to C4	A1-A3	A4-A5*	B1-B5	C1-C4	A1-A3 Contribution to total
Category	Units	Total	Construction Materials	Transport to Site & Construction	Material Replacement & Refurbishment	Deconstruction	%
Global Warming	kg CO ₂ e	846.1	368.5	107.2	244.36	126.05	44%
Acidification	kg SO	15.6	9.4	0.0	5.69	0.57	60%
Eutrophication	kg Ne	2.2	0.7	0.0	1.38	0.10	33%
Ozone Depletion	kg CFC11e	0.0	0.0	0.0	0.00	0.00	32%
Formation of Tropospheric Ozone	kg O ₃ e	36.0	18.7	1.0	14.48	1.85	52%
Fossil Fuel Primary Energy	MJ	5,680.2	4,936.4	166.5	537.18	40.11	87%
Biogenic Carbon Storage	kg CO ₂ e	-256.1	256.1	0.0	0.00	0.00	-69%

*The software does not provide estimates for stage A5 environmental impacts except for GWP, so these results only show stage A4.

5 Closure

We trust this report adequately summarizes the results of the Embodied Carbon Analysis for Elastochem and Honeywell. Please contact the undersigned should you require further information.

Yours Truly,

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