Environmental Product Declaration

Program Operator: Smart EPD®
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IN ACCORDANCE WITH ISO 14025:2006 AND ISO 21930:2017



SmartEPD-2026-158-1124-01

H Window Timber Curtain Wall +

Date of Issue	Expiration Date	Last Updated
Oct 27, 2026	**Oct 27, 2031**	**Oct 27, 2026**

Refer to the EPD Library at **www.smartepd.com** for the latest EPD listing information

General Information



The H Window Company

401 17th Ave W Ashland, WI 54806

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hwindow.com

Product Name:	H Window Timber Curtain Wall +
Declared Unit:	1 m2 of fenestration assembly, including frame and glazing
Declaration Number:	SmartEPD-2026-158-1124-01
Date of Issue:	October 27, 2026
Expiration:	October 27, 2031
Last updated:	October 27, 2026
EPD Scope:	Cradle to gate A1 - A3
Market(s) of Applicability:	North America

General Organization Information

H Window manufactures windows, doors, and timber curtain walls for architects, builders, and owners, with a focus on appearance, quality, and energy performance. H Window's design team works collaboratively with project teams to deliver each project's design intent.

The H Window Timber Curtain Wall + is a fully engineered curtain wall system employing engineered wood as the framing component for large glass wall installations. Timber curtain wall is a featured architectural element in residential, commercial, and institutional projects, often specified for its natural wood appearance, thermal performance, and ability to accommodate complex designs. The H Window Timber Curtain Wall + is fabricated at the company's Ashland, Wisconsin facility.

Further information can be found at: https://www.hwindow.com

Limitations, Liability and Ownership

The EPD owner has sole ownership, liability, and responsibility for the EPD.

Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance of products using EPD information shall be based on the product's use and impacts at the building or construction works level, and therefore EPDs may not be used for comparability purposes when not considering the whole building life cycle. EPD comparability is only possible when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences in results upstream or downstream of the life cycle stages declared.

The environmental impact results of products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted.

A manufacturer shall not make claims based on an industry-average EPD which leads the market to believe the industry-average is representative of manufacturer-specific or product-specific results.

This EPD reports cradle-to-gate results (A1-A3) for a declared unit. Modules A4-A5, B1-B7, C1-C4 and D are not declared, so the results do not represent installation, use, maintenance, replacement, end-of-life treatment, or loads and benefits beyond the system boundary.

EPDs are only comparable if they conform with ISO 21930, this sub-category PCR, include all relevant information modules and are based on equivalent scenarios with respect to the construction works context.

Reference Standards

Standard(s):	ISO 14025:2006 and ISO 21930:2017
Core PCR:	NSF PCR for Fenestration Assemblies v2 Date of issue: December 31, 2023 Valid until: December 31, 2028
Sub-category PCR review panel:	Contact Smart EPD for more information.
General Program Instructions:	Smart EPD General Program Instructions v.2.0, March 2025

Verification Information

LCA Author/Creator:	Alexander Crease and Pablo Paster CarbonGraph Inc. support@carbongraph.io
EPD Program Operator:	Smart EPD info@smartepd.com www.smartepd.com 585 Grove St., Ste. 145, Herndon, VA 20170, USA
Verification:	Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071: External Sevda Alanya Rosenbaum | sevda@eco-track.net Independent external verification of EPD, according to ISO 14025 and reference PCR(s): External Sevda Alanya Rosenbaum | sevda@eco-track.net

Product Information

Declared Unit:	1 m2 of fenestration assembly, including frame and glazing
Mass:	48.05 kg
Product Specificity:	✗ Product Average ✓ Product Specific

Product specifications

Property	Value	Standard
Total unit U-factor	0.26 Btu/(hr·ft2·°F)	NFRC 100
Solar heat gain coefficient, total unit	0.20	NFRC 200
Visible light transmittance	39%	NFRC 400
Condensation resistance factor	78-81	NFRC 500
Performance class and grade	Engineered to specifications	AAMA
Water penetration resistance	15 psf	ASTM E331, ASTM E547, AAMA 501.1-05
Air infiltration	<0.06 cfm/ft2 at 6.24 psf	ASTM E283
Uniform load deflection	70 psf	ASTM E330, L/175
Uniform load structural	105 psf	ASTM E330, L/175

Thermal values are for a 2-pane IGU with 6 mm glass lites. Air, water and structural values are from laboratory testing; field testing may require AAMA reduction factors. These values describe the product and were not used to calculate the LCA results.

Product Description

The H Window Timber Curtain Wall + is a stick-built timber, aluminum and glass curtain wall system for exterior building envelopes. It consists of timber mullions, extruded aluminum profiles, insulated glazing units (IGUs), gaskets, sealants, fasteners, hardware and installation and anchoring components that support and retain the glazing.

Results are declared for a reference configuration of 1.965 m x 1.980 m (3.891 m2) with three vertical mullions and four horizontal mullion segments, 56 mm x 160 mm softwood glulam mullions finished with varnish (no stain), aluminum profiles with 40% recycled content and a Kynar coating, and a 25.4 mm double-pane IGU with two 6 mm tempered glass lites and a 90% argon-filled cavity. This glazing configuration is used on 67% of H Window Timber Curtain Wall + projects. Results for other dimensions, mullion layouts, mullion sizes and mullion materials can be estimated with the scaling equation in this EPD; glazing results are declared separately so that a different insulated glazing unit can be substituted.

The product carries a 10-year limited warranty.

Product Specifications

Product Classification Codes: Masterformat - 08 44 00

EC3 - Openings -> CurtainWalls

Product Type: curtain wall/window wall/storefront/sloped glazing/ribbon window

Form Factor: Openings >> CurtainWalls

Product Composition Diagram

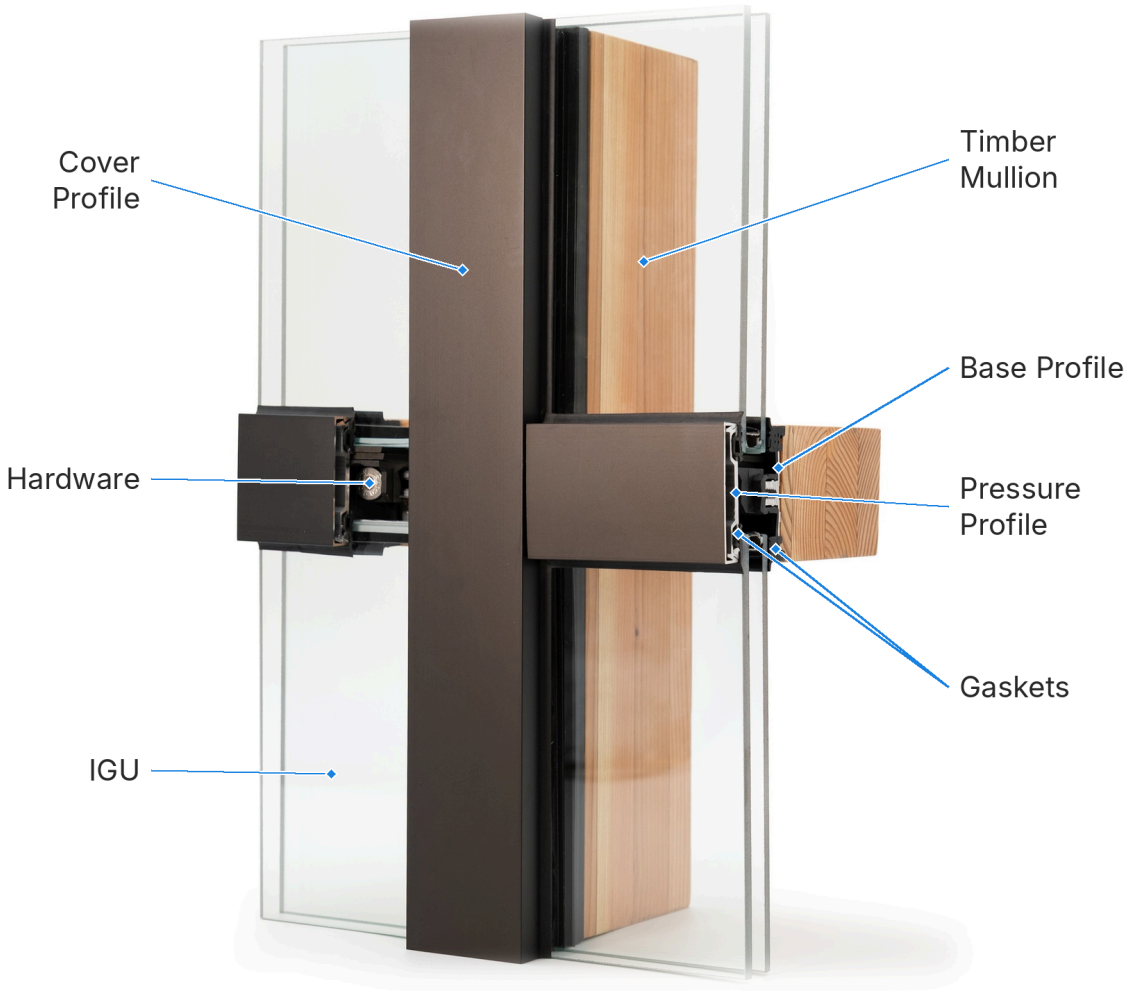


Table 1. Material Composition

Material/Component Category	Origin	% Mass
Glazing assembly (IGU)	USA	57.65
Softwood glulam mullions	USA	25.00
Aluminum profiles (40% recycled content)	USA, Germany, Bosnia and Herzegovina	6.62
Installation and anchoring components	USA	5.98

Material/Component Category	Origin	% Mass
Gaskets	Germany	3.07
Hardware, coatings and other minor components	Germany, China, Indonesia, Taiwan, Vietnam, USA	1.68

Packaging Material	Origin	kg Mass
Oriented strand board	None	3.344
Softwood lumber (2x4 skid members)	None	2.93
Softwood lumber (1x4 skid members)	None	1.953
Extruded polystyrene foam	None	0.4813
Steel skid nails	None	0.07032
LDPE stretch wrap	None	0.03635
Steel screws	None	0.01542

Biogenic Carbon Content	kg C per m2
Biogenic carbon content in product	5.84
Biogenic carbon content in accompanying packaging	3.93

Hazardous Materials
No regulated hazardous or dangerous substances are included in this product.

EPD Data Specificity

Primary Data Year: 2025-2026

Manufacturing Specificity:

- ✗ Industry Average
- ✗ Manufacturer Average
- ✓ Facility Specific

Averaging:

Averaging was not conducted for this EPD. Results represent one reference configuration manufactured at one facility. Variation with dimensions, mullion layout, mullion size and mullion material is addressed with the scaling equation in this EPD rather than by averaging.

Table 2. System Boundary

Production	A1	Raw material supply	✓
	A2	Transport	✓
	A3	Manufacturing	✓
Construction	A4	Transport to site	ND
	A5	Assembly / Install	ND
Use	B1	Use	ND
	B2	Maintenance	ND
	B3	Repair	ND
	B4	Replacement	ND
	B5	Refurbishment	ND
	B6	Operational Energy Use	ND
	B7	Operational Water Use	ND
End of Life	C1	Deconstruction	ND
	C2	Transport	ND
	C3	Waste Processing	ND
	C4	Disposal	ND
Benefits & Loads Beyond System Boundary	D	Recycling, Reuse Recovery Potential	ND

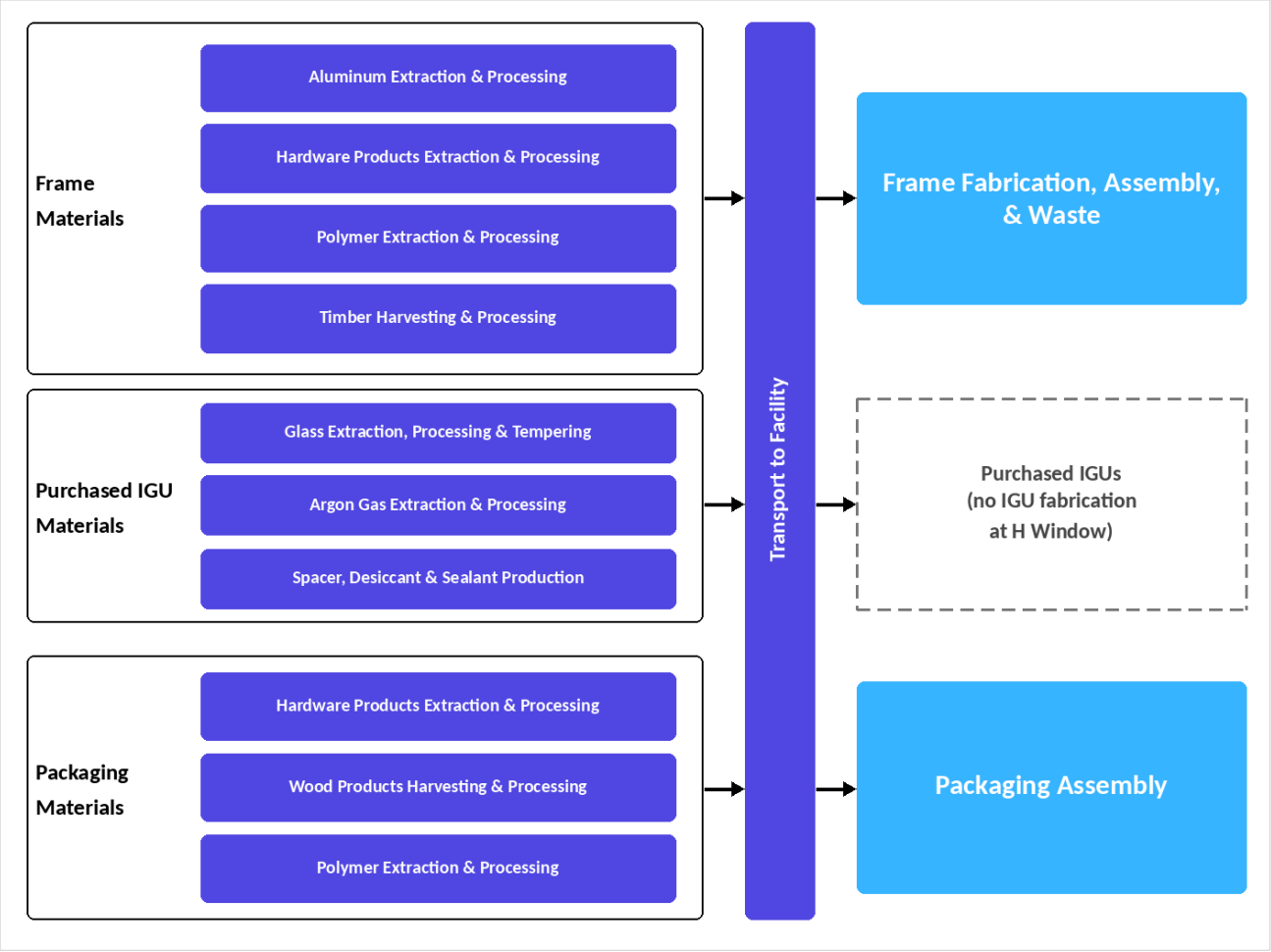
Note:

ND = Module not declared

Plants

The H Window Company, Ashland facility 800 Sum Road, Ashland, WI, USA

Product Flow Diagram



Raw materials and purchased components (timber, aluminum, glass and IGU materials, gaskets, sealants, fasteners, hardware, installation components and packaging) are produced upstream (A1) and transported to the Ashland, Wisconsin facility by truck, ship and rail (A2). At the facility (A3), timber mullions are cut, machined and trimmed, and aluminum cover, base and pressure profiles are fabricated, with offcuts and processing scrap generated at 4% for timber and 5% for the fabricated aluminum profiles. Components are assembled with gaskets, hardware and fasteners and packaged on wood skids with OSB, polystyrene foam and stretch wrap. Facility electricity is modeled as wood-chip cogeneration, representing the facility's supply from a local biomass power plant, and space and process heat as natural gas. Aluminum scrap is sent for recycling and timber scrap to landfill.

Software And Database

LCA Software:	CarbonGraph v. 2025.11.11.p02
LCI Foreground Database(s):	Ecoinvent v. 3.11 | RoW, GLO, RER, US and CN datasets as applicable
	Allocation, cut-off, EN 15804

LCI Background Database(s):	Ecoinvent v. 3.11 | RoW, GLO, RER, US and CN datasets as applicable Allocation, cut-off, EN 15804 Industry-average EPDs: Aluminum Association primary and secondary aluminum ingot; American Wood Council U.S. glued laminated timber, U.S. northern softwood lumber, U.S. oriented strand board v. Aluminum Association 4790545973.102.1 and 4790545973.101.1 (2022); AWC EPD 1054, EPD 1038, EPD 976 (2025) North America (aluminum); US (wood products) | As published in each EPD

A foreground LCI database is the database used to model the primary, site-specific data collected for this EPD. A background LCI database is the database used to model generic or non-specific data.

Data Quality

Primary data. Product geometry, bill of materials, component masses, glazing configuration, aluminum recycled content, scrap rates, packaging quantities and facility electricity and natural gas use were collected from the manufacturer and its supplier documentation and checked against the model. Facility electricity, natural gas and production volume cover January to December 2025; product, bill of materials and packaging data were collected in 2026. Flat glass and argon quantities were calculated from the IGU geometry; non-glass IGU components were estimated from the IGU perimeter. The IGU and float glass suppliers vary by project and are not known, so facility-specific data, the float glass plant's EPA GHGRP carbon intensity and its ENERGY STAR score cannot be disclosed; flat glass is modeled with a generic ecoinvent RoW dataset.

Background data. Secondary data are from ecoinvent 3.11 (Allocation, cut-off, EN 15804 system model). North American industry-average EPDs were used for primary and secondary aluminum ingot and for glulam, softwood lumber and OSB where they were more representative than database processes. The aluminum EPDs report GWP with IPCC AR5 factors, which were used without adjustment as proxies for IPCC AR6 values; their TRACI v2.1 AP, ODP and POCP values were used as proxies for TRACI v2.2, and their eutrophication result was split into marine and freshwater indicators per Smart EPD Errata v6. The glulam, softwood lumber and OSB EPDs report GWP with TRACI 2.1 v1.08, which applies IPCC AR4 factors; because they were not recalculated with AR6 factors, the default +10% adjustment of Smart EPD Errata v6 was applied to their GWP values in the IPCC AR6 (EF v3.1) GWP-total and GWP-fossil results. TRACI v2.1 results are not adjusted.

Temporal representativeness: good; foreground data reflect current production and background datasets are recent.
Geographic representativeness: fair; final assembly and several sources are U.S. or North American, but some upstream materials use RoW, GLO or RER datasets.
Technological representativeness: good; core technologies are represented, with proxies for some minor coatings, sealants and polymers.
Completeness: good; all major material, energy, transport, scrap and packaging flows are included.
Accuracy and precision: key foreground quantities are measured or calculated from product documentation; the main uncertainties are estimated non-glass IGU components, proxy datasets for selected materials, route-based transport estimates and facility energy allocated by production volume. A ±40% change in the estimated IGU components changes total-system GWP by about 0.4%.
Overall data quality rating: Good (study mean score 2.4 on a 1 to 5 scale, where 1 is highest).

Life Cycle Module Description

A1 Raw material supply. Extraction and upstream production of all frame and glazing materials and purchased components: timber, primary and secondary aluminum and its extrusion, flat glass and tempering, IGU materials, gaskets, sealants, coatings, fasteners, hardware, installation and anchoring components, and packaging materials. Supplier-side fabrication of purchased parts, such as the steel anchor points, is included in A1.

A2 Transport to the factory. Inbound transport of materials and components to the Ashland facility by truck, container ship and rail, using supplier routes where known and NSF 1102-23 default distances otherwise. Because the ecoinvent truck datasets include empty return trips, truck distances are entered one-way (half the PCR round-trip default) to avoid counting the backhaul twice.

A3 Manufacturing. Cutting, machining and assembly at the facility, including allocated facility electricity and natural gas, packaging of the finished assembly, and transport (32 km one-way, the PCR default) and treatment of manufacturing scrap: 0.501 kg of timber scrap to landfill and 0.153 kg of aluminum scrap to recycling per declared unit.

LCA Discussion

Allocation Procedure

Allocation was avoided where possible by modeling product-specific material inputs, component masses, transport routes and manufacturing flows directly. Facility electricity and natural gas are shared across product lines and were allocated to the curtain wall by its share of facility production measured in linear feet of mullion, the production measure the facility tracks for this product. No co-products are produced and economic allocation was not applied. Background data follow the ecoinvent 3.11 Allocation, cut-off, EN 15804 system model: recycled aluminum enters the product system with the burdens of secondary production only, and waste producers carry treatment burdens up to the end-of-waste point. Allocation within the input EPDs was accepted as published.

Cut-off Procedure

All material and energy flows contributing more than 1% of total mass or primary energy were included, and excluded flows total less than 5% of mass, energy and each impact category, per ISO 21930:2017 and NSF 1102-23. Excluded: capital goods, personnel and supporting services, research and development, secondary packaging, and minor ancillary materials such as labels and printing inks. All non-optional components of the fenestration assembly and any intentionally added regulated hazardous substances were included regardless of mass.

Renewable Electricity

Energy Attribute Certificates (EACs) such as Renewable Energy Certificates (RECs) or Power Purchase Agreements (PPAs) are included in the baseline reported results:	✕ No

Results

Table 3. Environmental Impact Assessment Results

TRACI 2.1, EF 3.1, TRACI 2.2

per 1 m2 of product of fenestration assembly, including frame and glazing.

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Frame and glazing (total system)

Impact Category	Unit	Method	A1	A2	A3	A1 - A3
GWP-total	kg CO2 eq	TRACI 2.1	7.76e+1	4.80e+0	6.09e+0	8.85e+1
ODP	kg CFC 11 eq	TRACI 2.1	6.33e-5	7.48e-8	1.38e-7	6.35e-5
EP	kg N eq	TRACI 2.1	2.24e-1	7.05e-3	2.64e-2	2.58e-1
AP	kg SO2 eq	TRACI 2.1	4.64e-1	2.97e-2	3.11e-2	5.25e-1
POCP	kg O3 eq	TRACI 2.1	6.07e+0	7.17e-1	6.66e-1	7.45e+0
GWP-total	kg CO2 eq	EF 3.1	7.87e+1	4.87e+0	6.38e+0	8.99e+1
GWP-fossil	kg CO2 eq	EF 3.1	7.83e+1	4.87e+0	6.33e+0	8.95e+1
GWP-biogenic	kg CO2 eq	EF 3.1	3.29e-1	1.08e-3	4.18e-2	3.71e-1
GWP-luluc	kg CO2 eq	EF 3.1	4.68e-2	2.21e-3	3.59e-3	5.26e-2
ODP	kg CFC 11 eq	TRACI 2.2	6.33e-5	7.48e-8	1.38e-7	6.35e-5
AP	kg SO2 eq	TRACI 2.2	4.64e-1	2.97e-2	3.11e-2	5.25e-1
EP-freshwater	kg P eq	TRACI 2.2	1.39e-2	4.51e-4	1.21e-3	1.55e-2
EP-marine	kg N eq	TRACI 2.2	1.92e-1	2.80e-2	1.62e-2	2.36e-1
POCP	kg O3 eq	TRACI 2.2	6.07e+0	7.17e-1	6.66e-1	7.45e+0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

GWP = Global Warming Potential, 100 years (may also be denoted as GWP-total, GWP-fossil (fossil fuels), GWP-biogenic (biogenic sources), GWP-luluc (land use and land use change)), ODP = Ozone Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, SFP = Smog Formation Potential, POCP = Photochemical oxidant creation potential, ADP-Fossil = Abiotic depletion potential for fossil resources, ADP-Minerals&Metals = Abiotic depletion potential for non-fossil resources, WDP = Water deprivation potential, PM = Particular Matter Emissions, IRP = Ionizing radiation, human health, ETP-fw = Eco-toxicity (freshwater), HTP-c = Human toxicity (cancer), HTP-nc = Human toxicity (non-cancer), SQP = Soil quality index.

This EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers or programs, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the construction works level per ISO 21930:2017 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Results are reported for the total system and separately for the frame and the glazing, as NSF 1102-23 requires. Glazing results cover the IGU materials; parts that retain, support, seal or install the IGU are included in the frame. Glazing A3 is zero because no IGU fabrication was modeled at the facility.

TRACI v2.1 results are the NSF 1102-23 result set; TRACI v2.1 GWP 100 uses IPCC AR4 100-year factors. TRACI v2.2 and EF v3.1 (IPCC AR6, 100-year) results are reported for Smart EPD Part A. For aluminum and glulam inputs taken from industry-average EPDs, TRACI v2.1 AP, ODP and POCP values and the EPDs' own GWP values were used as proxies for TRACI v2.2 and IPCC AR6 indicators; the AR4-based wood EPD GWP values carry the +10% adjustment of Smart EPD Errata v6 in the AR6 results.

GWP-biogenic is characterized from the background datasets and does not include the CO2 taken up by the timber mullions and wood packaging, because the glulam, softwood lumber and OSB inputs carry the source EPDs' GWP results forward as proxies. Biogenic CO2 removals and emissions for the product and packaging are reported separately in the additional carbon table.

Frame only

Impact Category	Unit	Method	A1	A2	A3	A1 - A3
GWP-total	kg CO2 eq	TRACI 2.1	4.05e+1	3.35e+0	6.09e+0	4.99e+1
ODP	kg CFC 11 eq	TRACI 2.1	5.28e-5	5.41e-8	1.38e-7	5.30e-5
EP	kg N eq	TRACI 2.1	1.50e-1	4.77e-3	2.64e-2	1.81e-1
AP	kg SO2 eq	TRACI 2.1	1.76e-1	2.35e-2	3.11e-2	2.30e-1
POCP	kg O3 eq	TRACI 2.1	2.43e+0	5.51e-1	6.66e-1	3.65e+0
GWP-total	kg CO2 eq	EF 3.1	4.12e+1	3.39e+0	6.38e+0	5.09e+1
GWP-fossil	kg CO2 eq	EF 3.1	4.11e+1	3.39e+0	6.33e+0	5.08e+1
GWP-biogenic	kg CO2 eq	EF 3.1	7.03e-2	7.36e-4	4.18e-2	1.13e-1
GWP-luluc	kg CO2 eq	EF 3.1	3.03e-2	1.53e-3	3.59e-3	3.54e-2
ODP	kg CFC 11 eq	TRACI 2.2	5.28e-5	5.41e-8	1.38e-7	5.30e-5
AP	kg SO2 eq	TRACI 2.2	1.76e-1	2.35e-2	3.11e-2	2.30e-1
EP-freshwater	kg P eq	TRACI 2.2	9.01e-3	2.96e-4	1.21e-3	1.05e-2
EP-marine	kg N eq	TRACI 2.2	4.16e-2	2.16e-2	1.62e-2	7.95e-2
POCP	kg O3 eq	TRACI 2.2	2.43e+0	5.51e-1	6.66e-1	3.65e+0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

GWP = Global Warming Potential, 100 years (may also be denoted as GWP-total, GWP-fossil (fossil fuels), GWP-biogenic (biogenic sources), GWP-luluc (land use and land use change)), ODP = Ozone Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, SFP = Smog Formation Potential, POCP = Photochemical oxidant creation potential, ADP-Fossil = Abiotic depletion potential for fossil resources, ADP-Minerals&Metals = Abiotic depletion potential for non-fossil resources, WDP = Water deprivation potential, PM = Particular Matter Emissions, IRP = Ionizing radiation, human health, ETP-fw = Eco-toxicity (freshwater), HTP-c = Human toxicity (cancer), HTP-nc = Human toxicity (non-cancer), SQP = Soil quality index.

Frame-only results per 1 m2 of fenestration assembly. The notes under the total-system table apply.

Glazing only

Impact Category	Unit	Method	A1	A2	A3	A1 - A3
GWP-total	kg CO2 eq	TRACI 2.1	3.71e+1	1.46e+0	0	3.86e+1
ODP	kg CFC 11 eq	TRACI 2.1	1.05e-5	2.07e-8	0	1.05e-5
EP	kg N eq	TRACI 2.1	7.46e-2	2.28e-3	0	7.69e-2
AP	kg SO2 eq	TRACI 2.1	2.88e-1	6.16e-3	0	2.95e-1
POCP	kg O3 eq	TRACI 2.1	3.63e+0	1.66e-1	0	3.80e+0
GWP-total	kg CO2 eq	EF 3.1	3.75e+1	1.48e+0	0	3.90e+1
GWP-fossil	kg CO2 eq	EF 3.1	3.73e+1	1.48e+0	0	3.87e+1
GWP-biogenic	kg CO2 eq	EF 3.1	2.58e-1	3.48e-4	0	2.59e-1
GWP-luluc	kg CO2 eq	EF 3.1	1.66e-2	6.83e-4	0	1.72e-2
ODP	kg CFC 11 eq	TRACI 2.2	1.05e-5	2.07e-8	0	1.05e-5
AP	kg SO2 eq	TRACI 2.2	2.88e-1	6.16e-3	0	2.95e-1
EP-freshwater	kg P eq	TRACI 2.2	4.86e-3	1.54e-4	0	5.02e-3
EP-marine	kg N eq	TRACI 2.2	1.50e-1	6.41e-3	0	1.56e-1
POCP	kg O3 eq	TRACI 2.2	3.63e+0	1.66e-1	0	3.80e+0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

GWP = Global Warming Potential, 100 years (may also be denoted as GWP-total, GWP-fossil (fossil fuels), GWP-biogenic (biogenic sources), GWP-luluc (land use and land use change)), ODP = Ozone Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, SFP = Smog Formation Potential, POCP = Photochemical oxidant creation potential, ADP-Fossil = Abiotic depletion potential for fossil resources, ADP-Minerals&Metals = Abiotic depletion potential for non-fossil resources, WDP = Water deprivation potential, PM = Particular Matter Emissions, IRP = Ionizing radiation, human health, ETP-fw = Eco-toxicity (freshwater), HTP-c = Human toxicity (cancer), HTP-nc = Human toxicity (non-cancer), SQP = Soil quality index.

Glazing-only results per 1 m2 of fenestration assembly, for the declared double-pane IGU. The notes under the total-system table apply.

Table 4. Resource Use Indicator

per 1 m2 of product of fenestration assembly, including frame and glazing.

Frame and glazing (total system)

Indicator	Unit	A1	A2	A3	A1 - A3
RPRE	MJ	2.39e+2	9.58e-1	1.34e+2	3.74e+2
RPRM	MJ	2.53e+2	0	2.25e+2	4.78e+2
RPRT	MJ	4.91e+2	9.58e-1	3.60e+2	8.52e+2
NRPRE	MJ	9.02e+2	6.79e+1	8.95e+1	1.06e+3
NRPRM	MJ	8.54e+1	0	2.46e+1	1.10e+2
NRPRT	MJ	9.88e+2	6.79e+1	1.14e+2	1.17e+3
SM	kg	1.33e+0	0	0	1.33e+0
RSF	MJ	0	0	0	0
NRSF	MJ	0	0	0	0
RE	MJ	0	0	0	0
ADPF	MJ	9.48e+2	6.79e+1	1.05e+2	1.12e+3
FW	m3	8.76e-1	9.04e-3	4.62e-2	9.31e-1

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

RPRE or PERE = Renewable primary resources used as energy carrier (fuel), RPRM or PERM = Renewable primary resources with energy content used as material, RPRT or PERT = Total use of renewable primary resources with energy content, NRPRE or PENRE = Non-renewable primary resources used as an energy carrier (fuel), NRPRM or PENRM = Non-renewable primary resources with energy content used as material, NRPRT or PENRT = Total non-renewable primary resources with energy content, SM = Secondary materials, RSF = Renewable secondary fuels, NRSF = Non-renewable secondary fuels, RE = Recovered energy, ADPF = Abiotic depletion potential, FW = Use of net freshwater resources, VOCs = Volatile Organic Compounds.

RPRM and NRPRM come from input EPDs where they report them and otherwise from material mass times net calorific value; only primary material content is counted. SM is the documented 40% secondary aluminum content (1.33 kg per declared unit).

Frame only

Indicator	Unit	A1	A2	A3	A1 - A3
RPRE	MJ	2.17e+2	6.60e-1	1.34e+2	3.52e+2
RPRM	MJ	2.53e+2	0	2.25e+2	4.78e+2
RPRT	MJ	4.70e+2	6.60e-1	3.60e+2	8.30e+2
NRPRE	MJ	4.97e+2	4.71e+1	8.95e+1	6.34e+2
NRPRM	MJ	7.94e+1	0	2.46e+1	1.04e+2
NRPRT	MJ	5.77e+2	4.71e+1	1.14e+2	7.38e+2
SM	kg	1.33e+0	0	0	1.33e+0
RSF	MJ	0	0	0	0
NRSF	MJ	0	0	0	0
RE	MJ	0	0	0	0
ADPF	MJ	5.39e+2	4.71e+1	1.05e+2	6.91e+2
FW	m3	6.55e-1	6.11e-3	4.62e-2	7.08e-1

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

RPRE or PERE = Renewable primary resources used as energy carrier (fuel), RPRM or PERM = Renewable primary resources with energy content used as material, RPRT or PERT = Total use of renewable primary resources with energy content, NRPRE or PENRE = Non-renewable primary resources used as an energy carrier (fuel), NRPRM or PENRM = Non-renewable primary resources with energy content used as material, NRPRT or PENRT = Total non-renewable primary resources with energy content, SM = Secondary materials, RSF = Renewable secondary fuels, NRSF = Non-renewable secondary fuels, RE = Recovered energy, ADPF = Abiotic depletion potential, FW = Use of net freshwater resources, VOCs = Volatile Organic Compounds.

Frame-only results per 1 m2 of fenestration assembly. The notes under the total-system table apply.

Glazing only

Indicator	Unit	A1	A2	A3	A1 - A3
RPRE	MJ	2.13e+1	2.98e-1	0	2.16e+1
RPRM	MJ	0	0	0	0
RPRT	MJ	2.13e+1	2.98e-1	0	2.16e+1
NRPRE	MJ	4.05e+2	2.08e+1	0	4.26e+2
NRPRM	MJ	6.08e+0	0	0	6.08e+0
NRPRT	MJ	4.11e+2	2.08e+1	0	4.32e+2
SM	kg	0	0	0	0
RSF	MJ	0	0	0	0
NRSF	MJ	0	0	0	0
RE	MJ	0	0	0	0
ADPF	MJ	4.09e+2	2.08e+1	0	4.29e+2
FW	m3	2.20e-1	2.93e-3	0	2.23e-1

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

RPRE or PERE = Renewable primary resources used as energy carrier (fuel), RPRM or PERM = Renewable primary resources with energy content used as material, RPRT or PERT = Total use of renewable primary resources with energy content, NRPRE or PENRE = Non-renewable primary resources used as an energy carrier (fuel), NRPRM or PENRM = Non-renewable primary resources with energy content used as material, NRPRT or PENRT = Total non-renewable primary resources with energy content, SM = Secondary materials, RSF = Renewable secondary fuels, NRSF = Non-renewable secondary fuels, RE = Recovered energy, ADPF = Abiotic depletion potential, FW = Use of net freshwater resources, VOCs = Volatile Organic Compounds.

Glazing-only results per 1 m2 of fenestration assembly, for the declared double-pane IGU. The notes under the total-system table apply.

Table 5. Waste and Output Flow Indicators

per 1 m2 of product of fenestration assembly, including frame and glazing.

Frame and glazing (total system)

Indicator	Unit	A1	A2	A3	A1 - A3
HWD	kg	0	0	0	0
NHWD	kg	0	0	5.01e-1	5.01e-1
HLRW	kg	1.71e-4	4.10e-6	5.85e-6	1.81e-4
ILLRW	kg	5.00e-4	1.03e-5	1.59e-5	5.27e-4
CRU	kg	0	0	0	0
MFR	kg	0	0	1.53e-1	1.53e-1
MER	kg	0	0	0	0
EE	MJ	0	0	0	0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed, HLRW = High-level radioactive waste, ILLRW = Intermediate- and low-level radioactive waste, CRU = Components for re-use, MFR or MR = Materials for recycling, MER = Materials for energy recovery, MNER = Materials for incineration, no energy recovery, EE or EEE = Recovered energy exported from the product system, EET = Exported thermal energy.

Significant data limitations currently exist within the LCI data used to generate waste metrics for Life Cycle Assessments and Environmental Product Declarations. The waste metrics were calculated in a way conformant with the requirements of ISO 21930:2017, but these values represent rough estimates and are for informational purposes only. As such, no decisions regarding actual cradle-gate waste performance between products should be derived from these reported values.

HWD and NHWD are based on explicitly modeled foreground waste disposal flows. NHWD is 0.501 kg of timber manufacturing scrap sent to landfill; no foreground hazardous waste disposal flow was identified, so HWD is zero. MFR is 0.153 kg of aluminum scrap sent for recycling. HLRW and ILLRW come from background datasets and input EPDs.

Frame only

Indicator	Unit	A1	A2	A3	A1 - A3
HWD	kg	0	0	0	0
NHWD	kg	0	0	5.01e-1	5.01e-1
HLRW	kg	1.18e-4	2.84e-6	5.85e-6	1.27e-4
ILLRW	kg	3.82e-4	7.30e-6	1.59e-5	4.05e-4
CRU	kg	0	0	0	0
MFR	kg	0	0	1.53e-1	1.53e-1
MER	kg	0	0	0	0
EE	MJ	0	0	0	0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed, HLRW = High-level radioactive waste, ILLRW = Intermediate- and low-level radioactive waste, CRU = Components for re-use, MFR or MR = Materials for recycling, MER = Materials for energy recovery, MNER = Materials for incineration, no energy recovery, EE or EEE = Recovered energy exported from the product system, EET = Exported thermal energy.

Frame-only results per 1 m2 of fenestration assembly. The notes under the total-system table apply.

Glazing only

Indicator	Unit	A1	A2	A3	A1 - A3
HWD	kg	0	0	0	0
NHWD	kg	0	0	0	0
HLRW	kg	5.30e-5	1.26e-6	0	5.43e-5
ILLRW	kg	1.18e-4	3.04e-6	0	1.21e-4
CRU	kg	0	0	0	0
MFR	kg	0	0	0	0
MER	kg	0	0	0	0
EE	MJ	0	0	0	0

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed, HLRW = High-level radioactive waste, ILLRW = Intermediate- and low-level radioactive waste, CRU = Components for re-use, MFR or MR = Materials for recycling, MER = Materials for energy recovery, MNER = Materials for incineration, no energy recovery, EE or EEE = Recovered energy exported from the product system, EET = Exported thermal energy.

Glazing-only results per 1 m2 of fenestration assembly, for the declared double-pane IGU. The notes under the total-system table apply.

Table 6. Carbon Emissions and Removals

per 1 m2 of product of fenestration assembly, including frame and glazing.

Frame and glazing (total system)

Indicator	Unit	A1	A2	A3	A1 - A3	A5	C4
BCCPR	kg C	ND	ND	ND	5.84e+0	ND	5.84e+0
BCCPA	kg C	ND	ND	ND	3.93e+0	3.93e+0	ND
BCRP	kg CO2	-2.23e+1	0	0	-2.23e+1	ND	ND
BCEP	kg CO2	0	0	8.93e-1	8.93e-1	ND	2.14e+1
BCRK	kg CO2	0	0	-1.44e+1	-1.44e+1	ND	ND
BCEK	kg CO2	0	0	0	0	1.44e+1	ND
BCEW	kg CO2	0	0	0	0	ND	ND
CCE	kg CO2	0	0	0	0	ND	ND
CCR	kg CO2	0	0	0	0	ND	ND
CWNR	kg CO2	0	0	0	0	ND	ND

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

BCRP = Biogenic Carbon Removal from Product, BCEP = Biogenic Carbon Emission from Product, BCRK = Biogenic Carbon Removal from Packaging, BCEK = Biogenic Carbon Emission from Packaging, BCEW = Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes, CCE = Calcination Carbon Emissions, CCR = Carbonation Carbon Removals, CWNR = Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes, GWP-luc = Carbon Emissions from Land-use Change.

Negative values are uptake of atmospheric CO2 into biobased material. BCCPR and BCCPA are the biogenic carbon content of the product and packaging at the factory gate. The A3 product emission (0.893 kg CO2) is the carbon in timber manufacturing scrap (0.243 kg C) leaving the product system; landfill-gas emissions from that scrap are already in the landfill dataset and are not counted again. Per ISO 21930:2017, 7.2.7, the biogenic carbon in the packaging is shown leaving the product system in A5 and the carbon in the finished timber product leaving at end of life in C4, which closes the biogenic carbon balance. These A5 and C4 values are technical information only; environmental impacts for modules A5 and C4 are not declared.

Frame only

Indicator	Unit	A1	A2	A3	A1 - A3	A5	C4
BCCPR	kg C	ND	ND	ND	5.84e+0	ND	5.84e+0
BCCPA	kg C	ND	ND	ND	3.93e+0	3.93e+0	ND
BCRP	kg CO2	-2.23e+1	0	0	-2.23e+1	ND	ND
BCEP	kg CO2	0	0	8.93e-1	8.93e-1	ND	2.14e+1
BCRK	kg CO2	0	0	-1.44e+1	-1.44e+1	ND	ND
BCEK	kg CO2	0	0	0	0	1.44e+1	ND
BCEW	kg CO2	0	0	0	0	ND	ND
CCE	kg CO2	0	0	0	0	ND	ND
CCR	kg CO2	0	0	0	0	ND	ND
CWNR	kg CO2	0	0	0	0	ND	ND

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

BCRP = Biogenic Carbon Removal from Product, BCEP = Biogenic Carbon Emission from Product, BCRK = Biogenic Carbon Removal from Packaging, BCEK = Biogenic Carbon Emission from Packaging, BCEW = Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes, CCE = Calcination Carbon Emissions, CCR = Carbonation Carbon Removals, CWNR = Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes, GWP-luc = Carbon Emissions from Land-use Change.

All biogenic carbon in the product and packaging is in the frame and packaging, so frame-only values equal the total-system values. The notes under the total-system table apply.

Glazing only

Indicator	Unit	A1	A2	A3	A1 - A3	A5	C4
BCCPR	kg C	0	0	0	0	ND	0
BCCPA	kg C	0	0	0	0	0	ND
BCRP	kg CO2	0	0	0	0	ND	ND
BCEP	kg CO2	0	0	0	0	ND	0
BCRK	kg CO2	0	0	0	0	ND	ND
BCEK	kg CO2	0	0	0	0	0	ND
BCEW	kg CO2	0	0	0	0	ND	ND
CCE	kg CO2	0	0	0	0	ND	ND
CCR	kg CO2	0	0	0	0	ND	ND
CWNR	kg CO2	0	0	0	0	ND	ND

Note:

Not all abbreviated indicators listed below may be present in the results above. The inclusion of indicators varies based on PCR requirements.

Abbreviations:

BCRP = Biogenic Carbon Removal from Product, BCEP = Biogenic Carbon Emission from Product, BCRK = Biogenic Carbon Removal from Packaging, BCEK = Biogenic Carbon Emission from Packaging, BCEW = Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes, CCE = Calcination Carbon Emissions, CCR = Carbonation Carbon Removals, CWNR = Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes, GWP-luc = Carbon Emissions from Land-use Change.

The IGU contains no biogenic carbon.

Scaling Factors

Results in this EPD are for the reference configuration. Frame-only A1-A3 GWP (TRACI v2.1 GWP 100, kg CO2 eq per m2) for other configurations can be estimated with:

GWPf = (Cm x Vm + 0.7286 x Sm + 14.07 x Lm + 1.800 x Nm + 12.19) / A

where A is the curtain wall area (m2); Vm the total timber mullion volume (m3); Sm the total timber mullion surface area (m2); Lm = Lv + Lh, the total mullion length (m), with Lv the number of vertical mullions times the height and Lh the number of horizontal mullion segments times the span between vertical mullions; Nm = Nh + 6(Nv - 1), with Nv vertical mullions and Nh discrete horizontal segments; and Cm the mullion material coefficient: 193.7 kg CO2 eq/m3 for glulam and 1789 kg CO2 eq/m3 for Lamboo laminated bamboo. Cm is an empirical fitting coefficient, not an emission factor for timber.

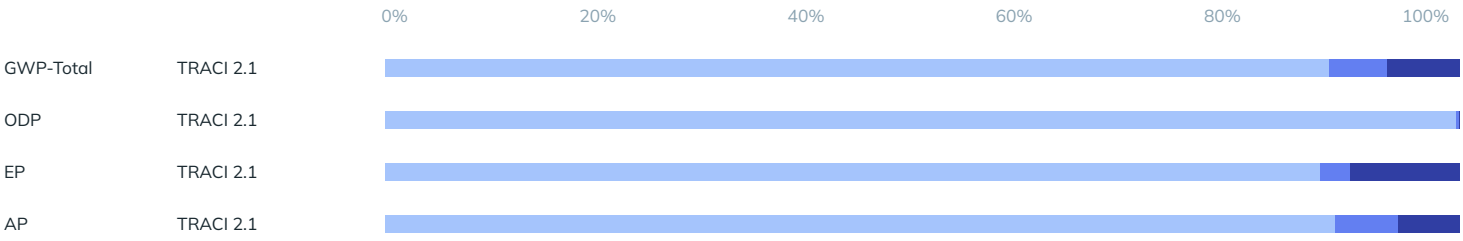
The total-system result is GWPtotal = GWPf + GWPg, where GWPg is the glazing GWP per m2 for the selected glazing (3.86E+01 kg CO2 eq for the declared double-pane IGU).

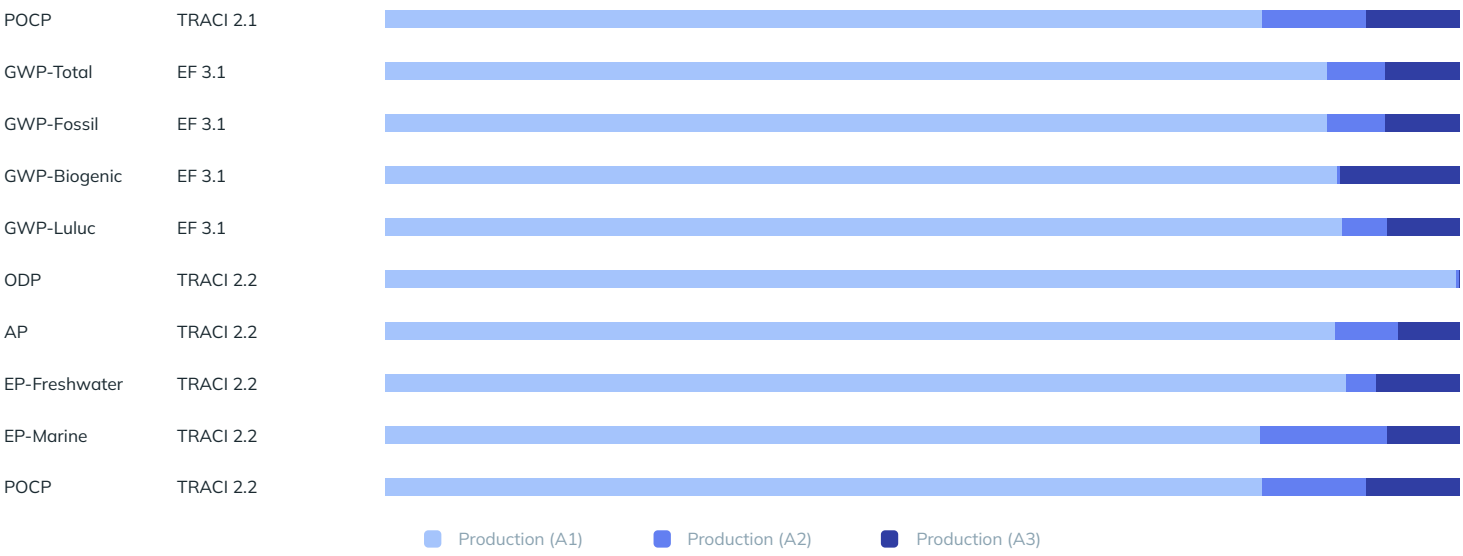
The equation was fitted to 48 modeled frame configurations and checked against 28 configurations not used in fitting (mean absolute difference 0.24%, maximum 1.43%). It applies only to curtain wall widths of 1,000-12,000 mm, heights of 1,000-6,000 mm, mullion widths of 56 mm or 76 mm, mullion depths of 100-240 mm, 3-9 vertical and 4-48 horizontal mullions, the declared aluminum recycled content and facility electricity supply, and glulam or laminated bamboo mullions. Aluminum finish and timber stain options change frame GWP by 2.0% or less and are not part of the equation.

Interpretation

For the total system, A1 raw material supply accounts for 88% of TRACI v2.1 GWP 100 (7.76E+01 of 8.85E+01 kg CO2 eq), A2 transport for 5% and A3 manufacturing for 7%. A1 also dominates the other indicators: 82% of POCP, 87% of EP, 88% of AP and over 99% of ODP. The frame contributes 56% of GWP 100 (4.99E+01 kg CO2 eq) and the glazing 44% (3.86E+01 kg CO2 eq). The main contributors are flat glass production for the IGU, aluminum profile production and the timber mullions, followed by gaskets, sealants, hardware and installation components.

Results depend on configuration choices and on a few modeled inputs. A triple-pane IGU raises total-system GWP 100 by 21.3%. Aluminum recycled content was tested as a robustness check: 0% recycled content raises frame GWP by 21.3% and 100% lowers it by 32.0%, against the documented 40%. Laminated bamboo mullions raise frame GWP by 70.1% relative to glulam. Mullion width and depth, the hardwood glulam proxy, anodized aluminum and replacing the biomass electricity with the regional grid each change frame GWP by 2.0% to 4.3%. Powder coating, timber stain and a ±40% change in the estimated IGU components change results by 1.2% or less.





Additional Environmental Information

Regulated substances. A screening of the bill of materials, safety data sheets and supplier documentation found no regulated hazardous substances intentionally present in the finished product at concentrations requiring disclosure, and none above typical reporting thresholds for substances in articles, such as 0.1% by weight. Some raw or uncured materials are classified as hazardous as supplied, including the wood varnish and the curing agent of the structural silicone glazing sealant (DOWSIL 983). The screening is limited by the availability of supplier declarations for the cured state of coatings, sealants, gaskets, wood finishes, polymer components and IGU edge materials, and does not replace supplier compliance declarations or chemical testing.

GWP-luluc. GWP from land use and land-use change (EF v3.1 / IPCC AR6) is 5.26E-02 kg CO2 eq per declared unit for A1-A3, about 0.06% of GWP-total.

Warranty. The product carries a 10-year limited warranty. No reference service life is declared because use-stage modules are not declared.

Electricity. The facility's electricity supply was identified as the Bay Front biomass power plant in Ashland, Wisconsin, based on its utility supply and not on renewable energy certificates, power purchase agreements or other energy attribute certificates. It is modeled with an ecoinvent wood-chip cogeneration dataset as a proxy. Modeling the regional grid instead raises frame GWP by 4.3%.

Explanatory material. CAS numbers and descriptions of hazardous substances, intended use and product codes may be obtained from The H Window Company, sales@hwindow.com, www.hwindow.com.

Further Information

References

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