BENDHEIM

Glass Marker Boards: Magnetic and Non-Magnetic

Private Office, New York, NY

Bendheim LLC

ENVIRONMENTAL PRODUCT DECLARATION

ISO 14025:2006 and ISO 21930:2017

ASTM INTERNATIONAL

Bendheim LLC is pleased to present this Environmental Product Declaration (EPD) for their Glass Marker Board products. This EPD was developed in compliance with ISO 14025 and ISO 21930 and has been verified by Lindita Bushi, Ph.D., Athena Sustainable Materials Institute.

The LCA and EPD were prepared by Vertima Inc. The EPD includes cradle-to-grave life cycle assessment (LCA) results.

For more information about Bendheim LLC, visit www.bendheim.com.

For any explanatory material regarding this EPD, please contact the program operator.

1. GENERAL INFORMATION

PCR GENERAL INFORMATION			
Reference PCR	BIFMA PCR for Office Furniture Workspace Products: UNCPC 3814 NSF International Validity period extended to July 31, 2025		
The PCR review was conducted by:	*Thomas P. Gloria, Ph.D.* *Industrial Ecology Consultants* *t.gloria@industrial-ecology.com*	*Jack Geibig, P.E.* *Ecoform* *jgeibig@ecoform.com*	*Dr. Michael Overcash* *Environmental Clarity* *mrovercash@earthlink.net*

EPD GENERAL INFORMATION		
Program Operator	ASTM International 100 Barr Harbor Drive West Conshohocken, PA 19428 USA www.astm.org	
Declared Products	Magnetic Glass Marker Boards Non-Magnetic Glass Marker Boards	
EPD Registration Number EPD# 848	**EPD Date of Issue** December 20, 2024	**EPD Period of Validity** December 20, 2024 to December 19, 2029
EPD Recipient Organization	Bendheim LLC 82 Totowa Road Wayne, NJ 07470 USA	BENDHEIM

EPD Type/Scope and Functional Unit			**Year of Reported Manufacturer Primary Data**
Product-specific cradle-to-grave EPD with functional unit of 1 m^2 of worksurface area in use for 10 years			2023
Geographical Scope North America	**LCA Software** OpenLCA v.2.0.3	**LCI Databases** Ecoinvent 3.9.1 and US LCI	**LCIA Methodology** TRACI 2.1 CML 4.8 (ADP_{fossil}) and CED, LHV, v1.0

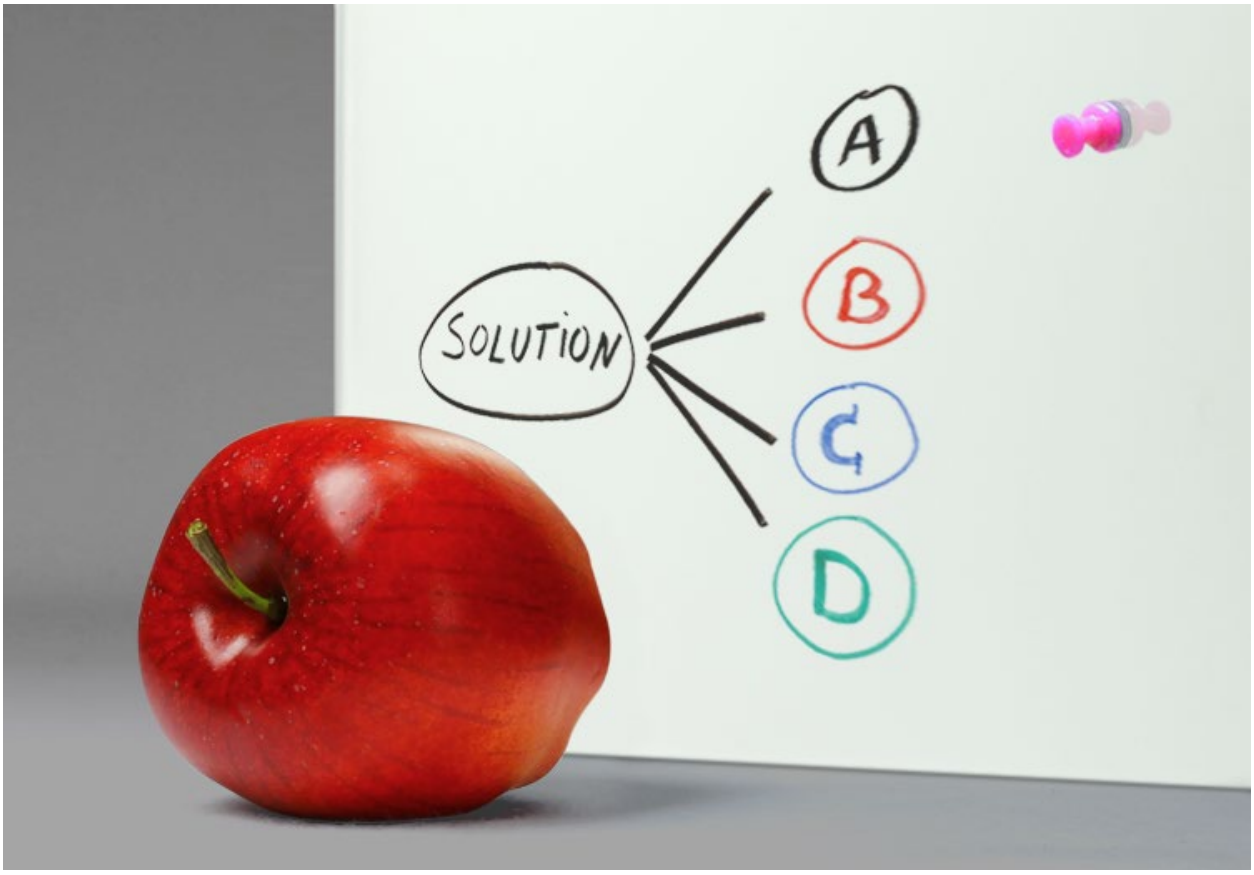
This LCA and EPD were prepared by:	Chantal Lavigne, M.A.Sc. Vertima Inc. www.vertima.ca
This EPD and LCA were independently verified in accordance with ISO 14025:2006, ISO 14040:2006, ISO 14044:2006 and ISO 21930:2017, as well as the NSF International "BIFMA PCR for Office Furniture Workspace Products: UNCPC 3814." ☐ Internal ☒ External	Lindita Bushi Lindita Bushi, Ph.D. Athena Sustainable Materials Institute

LIMITATIONS

Environmental declarations within the same product category but from different programs may not be comparable. [1]

EPDs are comparable only if they comply with the ISO 21930:2017 standard, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.[2]

The PCR this EPD is based on was written to determine the potential environmental impacts of a furniture workspace product from cradle to grave. It was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the variability in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study and the software tool used to conduct the study.[3]



Magnetic glass marker board [Picture courtesy of Bendheim LLC].

2. PRODUCT SYSTEM DESCRIPTION

Bendheim LLC is one of the world's foremost resources for specialty architectural glass. Founded in New York City in 1927, the third-generation, family-owned company offers a virtually unlimited range of in-stock and custom architectural glass varieties. Bendheim develops, fabricates, and distributes its products worldwide. The company maintains production facilities in New Jersey and offices in New York City.

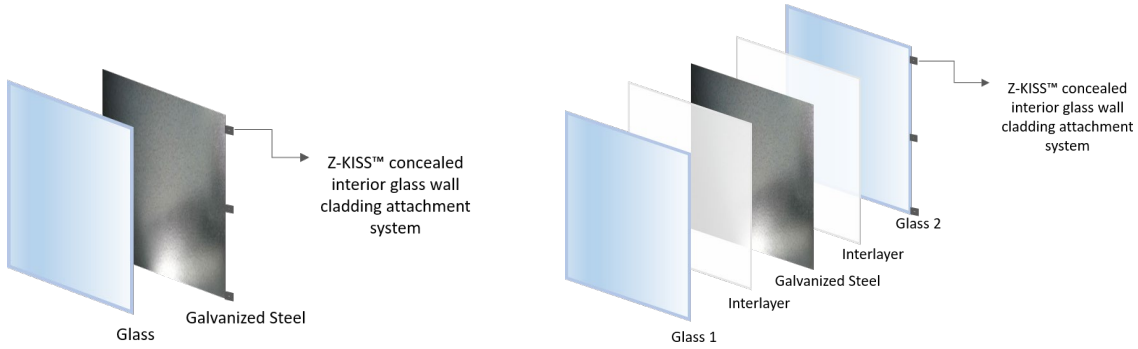
2.1. PRODUCT DESCRIPTION

Glass marker boards[1] may be magnetic or non-magnetic and assembled with back-painted monolithic glass or back-painted laminated glass to glass. The magnetic glass marker board has an additional steel sheet.

Monolithic glass is glass in its most basic form; it is simply a single sheet of rolled or float glass. The glass is either annealed, heat-strengthened or tempered. Annealed glass is glass in its basic form that breaks into jagged pieces, while tempered glass is approximately four times stronger and breaks into small, dice-sized pieces. Furthermore, the glass may be regular, low iron, or tinted float glass and may be etched.

Laminated glass to glass is a safety glass that contains two or more glass panes permanently bonded with an interlayer (PVB or EVA). A safety glass, if broken, remains in place, held together by the interlayer at its core. The glass is either annealed, heat-strengthened or tempered.

Bendheim's Glass Marker Boards may include the Z-KISS™ Concealed Glass Wall Cladding System to facilitate the installation of the board.



Monolithic glass magnetic marker board [left] and laminated glass to glass magnetic marker board [right] with Z-KISS™ Concealed Glass Wall Cladding system.

2.2. PRODUCT APPLICATION

Bendheim products may be used in interior applications for residential or commercial projects.

[1] Glass Marker Boards are classified under the United Nations Standard Products and Services Code (UNSPSC) 3711 and the Construction Specification Institute (CSA) MasterFormat code 08 81 00.

2.3. PLACING ON THE MARKET

Bendheim products meet or exceed the following standards per product type:

a) Glass
- ASTM C1036-21 - Standard Specification for Flat Glass [6]

b) Tempered glass
- ASTM-C1048-18 - Standard Specification for Heat-Strengthened and Fully Tempered Glass [7]

c) Laminated glass
- ASTM C1172-19 - Laminated Architectural Flat Glass [8]

2.4. PROPERTIES OF DECLARED PRODUCT AS DELIVERED

Bendheim's Glass Marker Boards consist of regular, low-iron, and tinted glass. Low-iron glass is produced with a minimal amount of iron, reducing the greenish tint and improving light transmission. Tinted glass, also called colored glass, is made by adding mineral oxides during the float glass process to create different colors. Glass is available as standard annealed, heat-strengthened or safety tempered. Total glass thicknesses range from 4 mm to 12 mm. Glass Marker Boards may be magnetic or non-magnetic. Magnetic Glass Marker Boards have an additional sheet of steel.

2.5. MATERIAL COMPOSITION

The raw materials input for glass marker boards are detailed in the tables below. As for details on material content, refer to the health product declaration (HPD) that can be found at http://www.hpd-collaborative.org/hpd-public-repository/ [9].

Glass Marker Board products material composition

Materials	Monolithic Glass Marker Board	Laminated Glass to Glass Marker Board	Monolithic Glass Magnetic Marker Board	Laminated Glass to Glass Magnetic Marker Board
Glass	92.2%	85.8%	67.5%	63.2%
Mirror	0.0%	0.0%	0.0%	0.0%
Paint (Back-paint colorant)	1.0%	0.9%	0.7%	0.7%
Ceramic inks (Digital printing)	0.0%	0.0%	0.0%	0.0%
Interlayer	0.0%	7.0%	0.0%	6.4%
Specialty interlayer	0.0%	0.0%	0.0%	0.0%
Magnetic backing parts	0.0%	0.0%	26.8%	25.1%
Z-KISS™ system	6.8%	6.3%	5.0%	4.6%
Total Mass (kg/m²)	**1.69E+01**	**1.81E+01**	**2.30E+01**	**2.46E+01**

2.6. MANUFACTURING

Processed glass manufacturing is a multi-step process. First, the glass or mirror is cut, seamed or polished, and washed. The product is then digitally printed (optional) before being heat-strengthened or tempered. The glass may then be back-painted. Laminated products are laminated with EVA or PVB. The product is heated and then cooled to allow the lamination layer to adhere to the glass. The products are then packaged and ready for shipment. Magnetic glass marker boards made from monolithic glass are glued to a sheet of galvanized steel prior to being packaged. The galvanized steel sheet is inserted in the lamination layer for magnetic glass marker boards made from laminated glass to glass.

2.7. PACKAGING

Bendheim products are either shipped on rack trucks, which do not require packaging, or packed in crates. The crates are made of wood lined with polystyrene foam. Cardboard is used to fill any gaps and protect glass panels from touching each other.

Amount of packaging materials per kg of glass and/or mirrors.

Packaging materials	kg/kg glass
Wood	1.55E-1
Cardboard	2.27E-02
Polystyrene foam	9.74E-2

2.8. PRODUCT INSTALLATION

Products should be processed and installed according to industry standards and according to applicable building codes.

2.9. USE CONDITIONS

As specified by the architect, contractor, or owner.

2.10. PRODUCT REFERENCE SERVICE LIFE

According to the BIFMA PCR for Office Furniture Workspace Products, if the product does not show compliance with ANSI/BIFMA X5.5 and 5.6 or equivalent, and the warranty period is five years or more, the maximum service life shall be five years. The warranty for Bendheim's Glass Marker Board is five years; hence, the product service life is set at five years.

2.11. RE-USE PHASE

Products can be reused if still in good condition.

2.12. DISPOSAL

According to the Glass Association of North America (GANA), a wide variety of architectural glass products can be recycled.[7] Annealed, tempered and low-e glass can be recycled with virtually no restrictions, with the exception of the need to separate contaminants. Recycled glass can enter the composition of numerous products such as fiberglass, glass containers, roadways, highway paint, terrazzo flooring and polishing materials, as well as in landscaping.

In sum, glass can be recycled where facilities exist. Otherwise, it is landfilled as an inert and non-hazardous waste.

3. LCA CALCULATION RULES

3.1. DECLARED UNIT

The selected functional unit (FU) is **1 m² of glass marker board work surface area in use for 10 years**.

Glass Marker Board products declared unit and reference flow

Materials	Monolithic Glass Marker Board	Laminated Glass to Glass Marker Board	Monolithic Glass Magnetic Marker Board	Laminated Glass to Glass Magnetic Marker Board
Work surface area (m^2)	1	1	1	1
Physical floor space area (m^2)	1.39E-02	1.39E-02	1.47E-02	1.47E-02
Mass per 1 m^2 of workspace area	1.69E+01	1.81E+01	2.30E+01	2.46E+01
Total mass of product for 10 years	3.37E+01	3.63E+01	4.61E+01	4.92E+01
Number of replacements	1	1	1	1

3.2. PRODUCTION AVERAGE

Bendheim has one facility located in Wayne, New Jersey, and the production data is from their 2023 production year.

Glass marker board products are not averaged. They do include multiple back-paint colorants; however, the impact of colorants is less than 10% and can be presented in the same results.

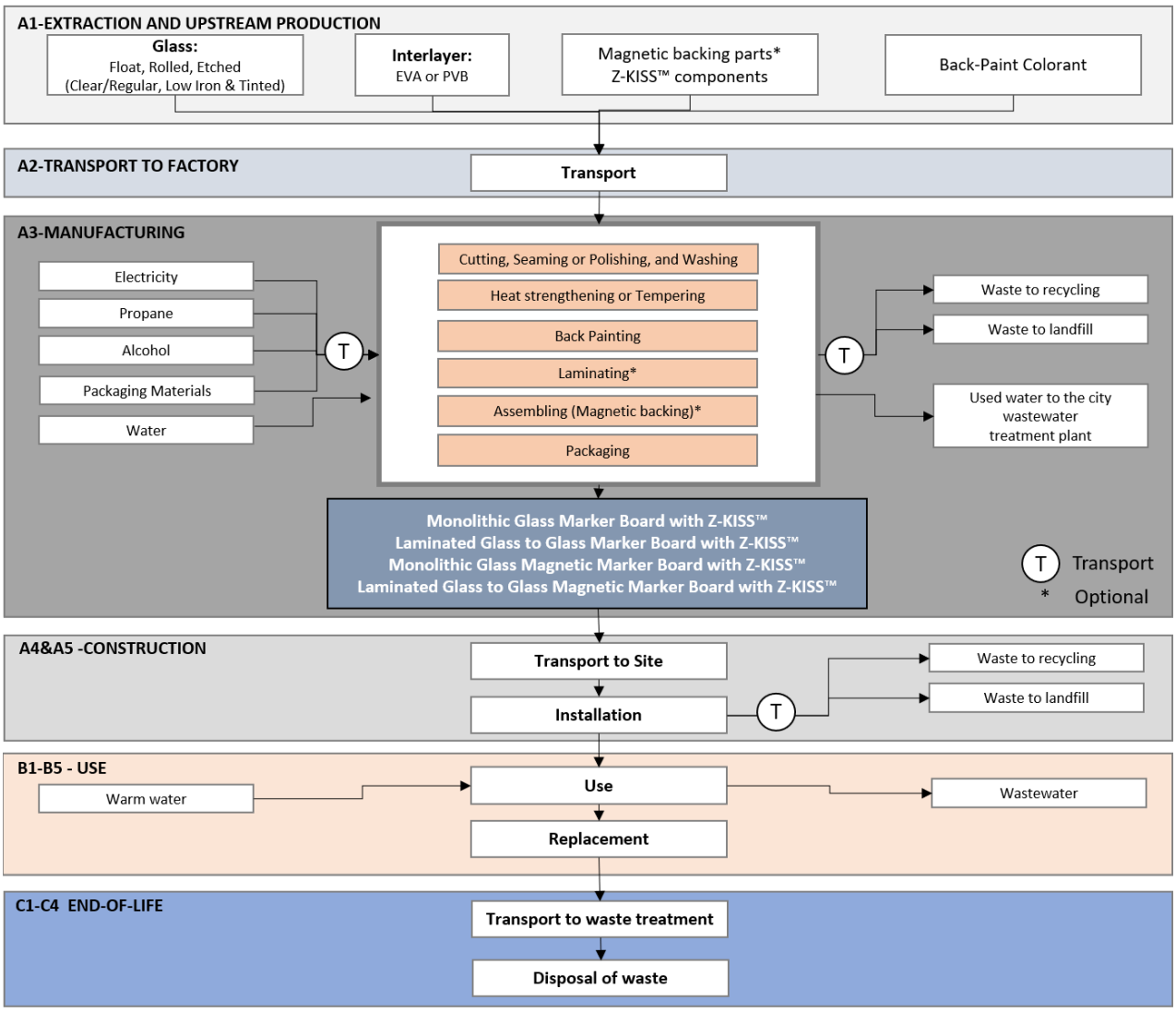
3.3. SYSTEM BOUNDARIES

The system boundaries are **cradle-to-grave**, as illustrated in the table below. Within the production life cycle stage, three (3) modules are considered, namely A-1) Extraction and Upstream Production, A-2) Transport to Factory and A-3) Manufacturing. Construction (A-4; A-5), Use (B-1 to B-7) and End-of-life (C-1 to C-4) stages are included in this study. The figure below presents the process flow diagram. No CO_2 credits are used in the framework of this project. An attributional LCA approach is used.

Description of the system boundary life cycle stages and related information modules

PRODUCTION STAGE			CONSTRUC-TION PROCESS STAGE		USE STAGE							END-OF-LIFE STAGE			
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
Extraction and Upstream Production	Transport to Factory	Manufacturing	Transport to Site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction / Demolition	Transport to Waste Processing or Disposal	Waste Processing	Disposal of Waste
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Key: X = included; MND = module not declared (excluded)



Cradle-to-grave LCA system boundaries of Bendheim's Glass Marker Board Products.

PRODUCTION STAGE: Includes modules A1 to A3.

Extraction and upstream production (A1): This module includes the extraction and transformation of raw materials needed to produce Bendheim's products, such as glass, paint, interlayer (EVA or PVB), magnetic parts and Z-KISS™ components.

Transport to factory (A2): This module includes the transportation of raw materials from Bendheim's suppliers to the Wayne, New Jersey facility.

Manufacturing (A3): This module includes water and energy (electricity, propane) consumption during the manufacturing process. Alcohol used to clean the glass has been considered here, as well as its transport to the plant.

Production losses have been determined by weight and are considered as waste sent either to a recycling center or landfill depending on the component.

Finally, packaging materials, to make products ready for shipment, as well as their transport to Bendheim's manufacturing plant, are covered in this stage.

CONSTRUCTION STAGE: Includes modules A4 to A5 and is part of the Glass Marker Board system only.

Transport to site (A4): This module includes the transport of the glass marker boards to the installation site. Transport distance represents a weighted average of Bendheim's 2023 production year.

Installation (A5): This module includes the products packaging waste transport to the waste treatment facility and the waste treatment itself. Bendheim's Z-KISS™ installation system has been included with the product (modules A1-A4).

USE STAGE: Includes modules B1 to B7 and is part of the Glass Marker Board system only. Only modules B2 and B4 are described here as the other modules are null.

Maintenance (B2): This module includes the cleaning of the Glass Marker Board with warm water for a period of 10 years.

Replacement (B4): This module includes one replacement of the whole product as the PCR requires.

END-OF-LIFE STAGE: Includes modules C2 to C4 and is part of the Glass Marker Board system only. Only modules C2 and C4 are described here as the other modules are null.

Transport to waste processing or disposal (C2): This module includes the transport of the product at its end-of-life to the waste treatment facility.

Disposal of waste (C4): The product is considered sent to landfill at its end of life.

3.4. CUT-OFF CRITERIA

Cut-off rules shall not be applied in order to hide data.[2]

In this study, no known mass nor energy flows were excluded from the system boundaries.

For this study, no data on the construction, maintenance or dismantling of the capital assets, daily transport of the employees, office work, business trips and other activities from Bendheim were included in the model. The model only takes into account the processes associated with infrastructure that are already included in the ecoinvent unit processes.

3.5. ALLOCATION

The ISO 14040 allocation procedure states that whenever possible, allocation should be avoided by collecting data related to the process under study or by expanding the product system.

According to ISO 14040, step 2 consists of partitioning the inputs and outputs between the different products in a way that reflects the physical relationship between them.

When allocation was unavoidable, mass allocation was used.

Waste processing of the material flows undergoing recycling processes are included up to the system boundary of the end-of-waste state.[2] In other words, a cut-off approach was used as further processing of the recycled material is part of raw material preparation of another product system (open-loop recycling). No burdens are allocated across the system boundary with secondary material, secondary fuel or recovered energy flows arising from waste.

3.6. DATA SOURCES AND QUALITY REQUIREMENTS

Data Quality Parameter	Data Quality Discussion
Source of manufacturing data	Manufacturing data was collected from the Bendheim LLC manufacturing plant located in Wayne, New Jersey, for the 2023 production year. This data included: total annual mass of products produced at the manufacturing plant; specific product composition; raw materials and fuels entering the product production process; transport distance of materials; electricity consumption; water consumption; and packaging.
Source of secondary data	Background data was taken from the ecoinvent 3.9.1 "cut-off" database, the US LCI database of product EPD.[10], [11] Datasets were selected based on their representativeness of the products' composing materials. When appropriate, the dataset's grid mix was changed for the grid mix of the country where production takes place. Otherwise, ecoinvent data representative of the global market or "rest-of-the-world" were selected as proxies.
Geographical representativeness	Bendheim's manufacturing facility is located in the state of New Jersey; hence electricity consumption is based on the RFC grid mix. Geographical correlation of the material supply and the selected datasets are largely representative of the same area. When this was not possible, datasets representing a larger geographical area were used.
Temporal representativeness	Primary data was collected so as to be representative of the full 2023 production year. Datasets selected were not always published within the last ten years, although this is not always the case for ecoinvent and US LCI datasets. Nevertheless, ecoinvent and US LCI remain the reference LCI databases.
Technological representativeness	Primary data, obtained from the manufacturer, is representative of the current technologies and materials used by this company.
Completeness	All relevant process steps were considered and modelled to satisfy the goal and scope. No known flows were cut off.

4. LIFE CYCLE ASSESSMENT SCENARIOS

4.1. DELIVERY AND INSTALLATION (A4 & A5)

Glass marker boards are delivered by truck to customers at a weighted average distance of 713 km.

Transport to the building site (A4) scenario

Name	Value	Unit
Fuel type	50% diesel, 50% gasoline	
Liters of fuel	-	l/100km
Vehicle type	Transport, Single unit truck, diesel-powered, USLCI – RNA Transport, Single unit truck, gasoline-powered, USLCI - RNA	
Transport distance	713	km

Glass marker boards are installed using the patented Z-KISS™ system. The Z-KISS™ system is a concealed, frameless interior glass wall cladding system. There is no loss during installation. Packaging is considered recycled, incinerated or landfill according to the United States, data from the US EPA 2018 material management fact sheet.[12] Detail packaging material disposal pathways are presented in table below.

Installation into the building (A5) scenario

Name	Value	Unit
Ancillary materials	0	kg
Net freshwater consumption specified by water source and fate (e.g., X m3 river water evaporated, X m3 city water disposed to sewer)	-	m3
Other resources	-	kg
Electricity consumption	-	kWh
Other energy carriers	-	MJ
Product loss per functional unit	-	kg
Mass of packaging waste specified by type - total	0.28	kg/kg product
- wood (27% recycled, 14% incinerated, 59% landfilled)	0.16	kg/kg product
- polystyrene foam (100% landfilled)	0.10	kg/kg product
- cardboard (78% recycled, 4% incinerated, 18% landfilled)	0.02	kg

4.2. USE (B1 TO B7)

According to the BIFMA PCR for Office Furniture Workspace Products, if the product does not show compliance with ANSI/BIFMA X5.5 and 5.6 or equivalent, and the warranty period is five years or more, the maximum service life shall be five years. The warranty for Bendheim's Glass Marker Board is five years; hence, the product service life is set at five years.

Maintenance (B2) scenario

Name	Value	Unit
Maintenance process information	Cleaning with warm water once per week, 48 weeks per year	
Maintenance cycle - RSL = 10 years	Washing: 480	Cycles/RSL
Net freshwater consumption specified by water source and fate: tap water disposed in sewer after usage	240 l/m^2/year of water disposed to sewer	l/m2/year
Energy input- warming water	6.8	kWh/m2/year

The Glass Marker Board product reference service life is five years; hence, the glass marker boards are replaced one time during the reference period (10 years).

Replacement (B4) scenario

Name	Value	Unit
Reference Service Life (RSL)	5	years
Product in use period	10	years
Number of replacements	1	

4.3. END-OF-LIFE (C1-C4)

At the end of life, glass marker boards are sent to landfill by truck. Landfills are located at an estimated distance of 50 km.

Transport to waste disposal (C2) scenario

Name	Value	Unit
Fuel type	50% diesel, 50% gasoline	
Liters of fuel	-	l/100km
Vehicle type	Transport, refuse truck, diesel-powered/tkm/RNA Transport, refuse truck, gasoline-powered/tkm/RNA	
Transport distance	50	km

End-of-Life (C4) scenarios

Name		Value	Unit
Collection process (specified by type)	Collected separately	0	%
	Collected with mixed construction waste	100	%
Disposal (specified by type)	Reuse	0	%
	Recycling	0	%
	Landfill	100	%
	Incineration	0	%
	Incineration with energy recovery	0	%
	Energy conversion (specify efficiency rate)	0	%

5. LIFE CYCLE ASSESSMENT RESULTS

5.1. RESULTS TABLES

It should be noted that Life Cycle Impact Assessment (LCIA) results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

The table below presents the LCIA results using TRACI methodologies, as well as primary energy consumption, consumption of renewable and non-renewable materials, water consumption, and waste generation.

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Environmental Indicator	Unit	Monolithic Glass Marker Board (6 mm glass thickness)								
		A1	A2	A3	A4	A5	B2	B4	C1	C4
		(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)
TRACI 2.1										
GWP_{100}-AR5[1]	kg CO_2 eq.	3.92E+01	1.04E+01	8.17E+00	5.44E+00	2.19E-01	3.30E+01	7.17E+01	1.24E-01	8.08E+00
GWP_{100}-AR4[2]	kg CO_2 eq.	3.92E+01	1.02E+01	8.08E+00	5.29E+00	1.97E-01	3.26E+01	7.10E+01	1.24E-01	7.99E+00
AP	kg SO2 eq.	1.93E-01	9.94E-02	2.99E-02	4.25E-02	2.76E-04	8.71E-02	3.96E-01	1.20E-03	2.90E-02
EP	kg N eq.	3.29E-02	6.50E-03	3.22E-02	3.04E-03	1.30E-02	1.53E-01	1.20E-01	8.85E-05	3.20E-02
ODP	kg CFC-11 eq.	4.15E-07	3.68E-08	2.13E-07	1.16E-08	5.78E-10	1.01E-06	8.90E-07	4.27E-10	2.13E-07
SFP	kg O_3 eq.	3.75E+00	2.51E+00	3.53E-01	1.17E+00	4.86E-03	1.01E+00	8.16E+00	3.27E-02	3.30E-01
FFD	MJ Surplus	8.96E+01	1.26E+01	2.00E+00	6.32E+00	5.28E-02	3.63E+00	1.13E+02	2.37E-01	1.88E+00
ADP_{fossil}[3]	MJ	6.14E+02	9.10E+01	5.23E+01	4.56E+01	4.25E-01	1.83E+02	8.57E+02	1.68E+00	5.14E+01
Resource use										
RPR_E[4]	MJ, LHV	6.76E+01	2.41E-01	6.49E+01	8.77E-02	9.78E-03	7.81E+01	1.98E+02	3.24E-03	6.49E+01
RPR_M[5]	MJ, LHV	1.95E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.95E-02	0.00E+00	0.00E+00
RPR_T	MJ, LHV	6.76E+01	2.41E-01	6.49E+01	8.77E-02	9.78E-03	7.81E+01	1.98E+02	3.24E-03	6.49E+01
$NRPR_E$[6]	MJ, LHV	5.94E+02	9.08E+01	1.08E+02	4.54E+01	5.23E-01	3.74E+02	9.47E+02	1.68E+00	1.07E+02
$NRPR_M$[7]	MJ, LHV	3.06E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.06E+00	0.00E+00	0.00E+00
$NRPR_T$	MJ, LHV	5.97E+02	9.08E+01	1.08E+02	4.54E+01	5.23E-01	3.74E+02	9.50E+02	1.68E+00	1.07E+02
SM	kg	5.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E+00	0.00E+00	0.00E+00
RSF	MJ, LHV	4.17E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E-21	0.00E+00	0.00E+00
NRSF	MJ, LHV	4.91E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-20	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	1.00E+00	2.00E+00	3.00E+00	4.00E+00	5.00E+00	6.00E+00
FW[8]	m^3	3.85E+01	1.76E-03	1.56E-01	5.60E-04	3.57E-04	2.62E+00	3.88E+01	2.07E-05	1.56E-01
Output flows and waste categories										
HWD[9]	kg	3.82E+00	2.24E-01	1.78E+01	2.94E-02	1.75E-02	9.92E+01	3.97E+01	1.09E-03	1.78E+01
NHWD[10]	kg	6.91E+00	9.90E-02	9.66E+00	4.40E-02	1.80E+00	1.18E+00	3.54E+01	1.62E-03	1.69E+01
HLRW[11]	m^3	9.12E-06	8.11E-11	2.97E-08	3.39E-12	8.73E-12	1.86E-07	9.18E-06	1.25E-13	2.97E-08
ILLRW[12]	m^3	1.34E-05	4.26E-10	2.59E-07	2.01E-11	4.76E-11	8.64E-07	1.39E-05	7.43E-13	2.59E-07
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	8.30E-01	0.00E+00	6.22E+00	0.00E+00	7.83E-01	0.00E+00	7.83E+00	0.00E+00	0.00E+00
MER	kg	1.54E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E-05	0.00E+00	0.00E+00
EE	MJ, LHV	4.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-02	0.00E+00	0.00E+00

Environmental Indicator	Unit	Laminated Glass to Glass Marker Board (6 mm total glass thickness)								
		A1	A2	A3	A4	A5	B2	B4	C1	C4
		(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)
TRACI 2.1										
GWP_{100}-AR5[1]	kg CO_2 eq.	4.64E+01	1.14E+01	8.25E+00	5.77E+00	2.19E-01	3.30E+01	8.03E+01	1.31E-01	8.08E+00
GWP_{100}-AR4[2]	kg CO_2 eq.	4.63E+01	1.11E+01	8.15E+00	5.62E+00	1.97E-01	3.26E+01	7.95E+01	1.31E-01	7.99E+00
AP	kg SO2 eq.	2.13E-01	1.10E-01	3.01E-02	4.51E-02	2.76E-04	8.71E-02	4.28E-01	1.27E-03	2.90E-02
EP	kg N eq.	4.10E-02	7.15E-03	4.16E-02	3.22E-03	1.30E-02	1.53E-01	1.38E-01	9.40E-05	3.20E-02
ODP	kg CFC-11 eq.	4.42E-07	4.09E-08	2.13E-07	1.23E-08	5.78E-10	1.01E-06	9.23E-07	4.54E-10	2.13E-07
SFP	kg O_3 eq.	4.13E+00	2.76E+00	3.57E-01	1.25E+00	4.86E-03	1.01E+00	8.87E+00	3.47E-02	3.30E-01
FFD	MJ Surplus	1.11E+02	1.38E+01	2.04E+00	6.71E+00	5.28E-02	3.63E+00	1.36E+02	2.52E-01	1.89E+00
ADP_{fossil}[3]	MJ	7.72E+02	9.98E+01	5.26E+01	4.84E+01	4.25E-01	1.83E+02	1.03E+03	1.78E+00	5.15E+01
Resource use										
RPR_E[4]	MJ, LHV	8.26E+01	2.67E-01	6.49E+01	9.31E-02	9.78E-03	7.81E+01	2.13E+02	3.44E-03	6.49E+01
RPR_M[5]	MJ, LHV	4.47E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.47E+00	0.00E+00	0.00E+00
RPR_T	MJ, LHV	8.71E+01	2.67E-01	6.49E+01	9.31E-02	9.78E-03	7.81E+01	2.17E+02	3.44E-03	6.49E+01
$NRPR_E$[6]	MJ, LHV	6.73E+02	9.95E+01	1.08E+02	4.82E+01	5.23E-01	3.74E+02	1.04E+03	1.78E+00	1.07E+02
$NRPR_M$[7]	MJ, LHV	7.85E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.85E+01	0.00E+00	0.00E+00
$NRPR_T$	MJ, LHV	7.51E+02	9.95E+01	1.08E+02	4.82E+01	5.23E-01	3.74E+02	1.12E+03	1.78E+00	1.07E+02
SM	kg	5.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E+00	0.00E+00	0.00E+00
RSF	MJ, LHV	4.17E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E-21	0.00E+00	0.00E+00
NRSF	MJ, LHV	4.91E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-20	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	1.00E+00	2.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00
FW[8]	m^3	3.85E+01	1.95E-03	1.56E-01	5.94E-04	3.57E-04	2.62E+00	3.88E+01	2.20E-05	1.56E-01
Output flows and waste categories										
HWD[9]	kg	6.95E+00	2.52E-01	1.78E+01	3.13E-02	1.75E-02	9.92E+01	4.29E+01	1.16E-03	1.78E+01
NHWD[10]	kg	7.14E+00	1.09E-01	1.04E+01	4.67E-02	1.80E+00	1.18E+00	3.71E+01	1.72E-03	1.76E+01
HLRW[11]	m^3	1.36E-05	9.18E-11	2.97E-08	3.60E-12	8.73E-12	1.86E-07	1.36E-05	1.33E-13	2.97E-08
ILLRW[12]	m^3	1.77E-05	4.82E-10	2.59E-07	2.13E-11	4.76E-11	8.64E-07	1.82E-05	7.89E-13	2.59E-07
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	8.30E-01	0.00E+00	6.22E+00	0.00E+00	7.83E-01	0.00E+00	7.83E+00	0.00E+00	0.00E+00
MER	kg	1.54E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E-05	0.00E+00	0.00E+00
EE	MJ, LHV	4.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-02	0.00E+00	0.00E+00

Environmental Indicator	Unit	Monolithic Glass Magnetic Marker Board (6 mm glass thickness)								
		A1	A2	A3	A4	A5	B2	B4	C1	C4
		(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)
TRACI 2.1										
GWP_{100}-AR5[1]	kg CO_2 eq.	5.62E+01	1.09E+01	8.17E+00	7.07E+00	2.19E-01	3.30E+01	9.07E+01	1.61E-01	8.08E+00
GWP_{100}-AR4[2]	kg CO_2 eq.	5.61E+01	1.06E+01	8.08E+00	6.88E+00	1.97E-01	3.26E+01	9.00E+01	1.61E-01	7.99E+00
AP	kg SO2 eq.	2.33E-01	1.03E-01	2.99E-02	5.52E-02	2.76E-04	8.71E-02	4.52E-01	1.55E-03	2.90E-02
EP	kg N eq.	3.62E-02	6.78E-03	3.22E-02	3.95E-03	1.30E-02	1.53E-01	1.24E-01	1.15E-04	3.20E-02
ODP	kg CFC-11 eq.	4.17E-07	3.81E-08	2.13E-07	1.50E-08	5.78E-10	1.01E-06	8.97E-07	5.55E-10	2.13E-07
SFP	kg O_3 eq.	4.50E+00	2.61E+00	3.55E-01	1.53E+00	4.86E-03	1.01E+00	9.37E+00	4.25E-02	3.31E-01
FFD	MJ Surplus	1.11E+02	1.33E+01	2.02E+00	8.21E+00	5.28E-02	3.63E+00	1.37E+02	3.08E-01	1.89E+00
ADP_{fossil}[3]	MJ	8.46E+02	9.62E+01	5.24E+01	5.92E+01	4.25E-01	1.83E+02	1.11E+03	2.18E+00	5.15E+01
Resource use										
RPR_E[4]	MJ, LHV	8.61E+01	2.51E-01	6.49E+01	1.14E-01	9.78E-03	7.81E+01	2.16E+02	4.22E-03	6.49E+01
RPR_M[5]	MJ, LHV	1.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-01	0.00E+00	0.00E+00
RPR_T	MJ, LHV	8.62E+01	2.51E-01	6.49E+01	1.14E-01	9.78E-03	7.81E+01	2.16E+02	4.22E-03	6.49E+01
$NRPR_E$[6]	MJ, LHV	8.26E+02	9.59E+01	1.08E+02	5.90E+01	5.23E-01	3.74E+02	1.20E+03	2.18E+00	1.07E+02
$NRPR_M$[7]	MJ, LHV	3.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.15E+00	0.00E+00	0.00E+00
$NRPR_T$	MJ, LHV	8.29E+02	9.59E+01	1.08E+02	5.90E+01	5.23E-01	3.74E+02	1.20E+03	2.18E+00	1.07E+02
SM	kg	1.65E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E+01	0.00E+00	0.00E+00
RSF	MJ, LHV	4.17E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E-21	0.00E+00	0.00E+00
NRSF	MJ, LHV	4.91E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-20	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	1.00E+00	2.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00
FW[8]	m^3	3.88E+01	1.82E-03	1.56E-01	7.27E-04	3.57E-04	2.62E+00	3.91E+01	2.69E-05	1.56E-01
Output flows and waste categories										
HWD[9]	kg	3.83E+00	2.27E-01	1.78E+01	3.83E-02	1.75E-02	9.92E+01	3.97E+01	1.41E-03	1.78E+01
NHWD[10]	kg	7.03E+00	1.04E-01	9.93E+00	5.71E-02	1.80E+00	1.18E+00	3.66E+01	2.11E-03	1.77E+01
HLRW[11]	m^3	1.12E-05	8.14E-11	2.97E-08	4.41E-12	8.73E-12	1.86E-07	1.13E-05	1.63E-13	2.97E-08
ILLRW[12]	m^3	4.49E-05	4.28E-10	2.59E-07	2.61E-11	4.76E-11	8.64E-07	4.54E-05	9.66E-13	2.59E-07
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.88E+00	0.00E+00	6.74E+00	0.00E+00	7.83E-01	0.00E+00	9.41E+00	0.00E+00	0.00E+00
MER	kg	1.54E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E-05	0.00E+00	0.00E+00
EE	MJ, LHV	4.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-02	0.00E+00	0.00E+00

Environmental Indicator	Unit	Laminated Glass to Glass Magnetic Marker Board (6 mm total glass thickness)								
		A1	A2	A3	A4	A5	B2	B4	C1	C4
		(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)	(per m^2)
TRACI 2.1										
GWP_{100}-AR5[1]	kg CO_2 eq.	6.51E+01	1.21E+01	8.28E+00	7.48E+00	2.19E-01	3.30E+01	1.01E+02	1.70E-01	8.09E+00
GWP_{100}-AR4[2]	kg CO_2 eq.	6.49E+01	1.18E+01	8.17E+00	7.28E+00	1.97E-01	3.26E+01	1.01E+02	1.70E-01	8.00E+00
AP	kg SO2 eq.	2.56E-01	1.16E-01	3.03E-02	5.84E-02	2.76E-04	8.71E-02	4.91E-01	1.65E-03	2.91E-02
EP	kg N eq.	4.63E-02	7.58E-03	4.40E-02	4.18E-03	1.30E-02	1.53E-01	1.47E-01	1.22E-04	3.20E-02
ODP	kg CFC-11 eq.	4.52E-07	4.32E-08	2.13E-07	1.59E-08	5.78E-10	1.01E-06	9.38E-07	5.88E-10	2.13E-07
SFP	kg O_3 eq.	4.97E+00	2.92E+00	3.59E-01	1.62E+00	4.86E-03	1.01E+00	1.02E+01	4.50E-02	3.31E-01
FFD	MJ Surplus	1.38E+02	1.48E+01	2.06E+00	8.70E+00	5.28E-02	3.63E+00	1.66E+02	3.26E-01	1.91E+00
ADP_{fossil}[3]	MJ	1.04E+03	1.07E+02	5.27E+01	6.27E+01	4.25E-01	1.83E+02	1.32E+03	2.31E+00	5.16E+01
Resource use										
RPR_E[4]	MJ, LHV	1.05E+02	2.83E-01	6.49E+01	1.21E-01	9.78E-03	7.81E+01	2.35E+02	4.46E-03	6.49E+01
RPR_M[5]	MJ, LHV	5.73E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.73E+00	0.00E+00	0.00E+00
RPR_T	MJ, LHV	1.11E+02	2.83E-01	6.49E+01	1.21E-01	9.78E-03	7.81E+01	2.41E+02	4.46E-03	6.49E+01
$NRPR_E$[6]	MJ, LHV	9.24E+02	1.07E+02	1.08E+02	6.25E+01	5.23E-01	3.74E+02	1.31E+03	2.31E+00	1.07E+02
$NRPR_M$[7]	MJ, LHV	9.82E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.82E+01	0.00E+00	0.00E+00
$NRPR_T$	MJ, LHV	1.02E+03	1.07E+02	1.08E+02	6.25E+01	5.23E-01	3.74E+02	1.41E+03	2.31E+00	1.07E+02
SM	kg	1.65E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E+01	0.00E+00	0.00E+00
RSF	MJ, LHV	4.17E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E-21	0.00E+00	0.00E+00
NRSF	MJ, LHV	4.91E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-20	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	1.00E+00	2.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00
FW[8]	m^3	3.88E+01	2.06E-03	1.56E-01	7.70E-04	3.57E-04	2.62E+00	3.91E+01	2.85E-05	1.57E-01
Output flows and waste categories										
HWD[9]	kg	7.75E+00	2.62E-01	1.78E+01	4.05E-02	1.75E-02	9.92E+01	4.37E+01	1.50E-03	1.78E+01
NHWD[10]	kg	7.31E+00	1.16E-01	1.08E+01	6.05E-02	1.80E+00	1.18E+00	3.87E+01	2.23E-03	1.86E+01
HLRW[11]	m^3	1.68E-05	9.47E-11	2.97E-08	4.67E-12	8.73E-12	1.86E-07	1.69E-05	1.72E-13	2.97E-08
ILLRW[12]	m^3	5.03E-05	4.98E-10	2.59E-07	2.77E-11	4.76E-11	8.64E-07	5.09E-05	1.02E-12	2.59E-07
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.88E+00	0.00E+00	6.74E+00	0.00E+00	7.83E-01	0.00E+00	9.41E+00	0.00E+00	0.00E+00
MER	kg	1.54E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E-05	0.00E+00	0.00E+00
EE	MJ, LHV	4.22E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-02	0.00E+00	0.00E+00

(1) GWP 100, excludes biogenic CO_2 removals and emissions associated with biobased products and packaging; 100-year time horizon. GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).
(2): GWP 100, excludes biogenic CO_2 removals and emissions associated with biobased products and packaging; 100-year time horizon. GWP factors are provided by the IPCC 2007 Fourth Assessment Report (AR4).
(3): $RPR_E = RPR_T - RPR_M$, where RPR_T is equal to the value for renewable energy obtained using the CED methodology (LHV).
(4): Calculated according to CML-baseline, v.4.8, August 2016.[13]
(5) Calculated as per ACLCA ISO 21930 Guidance, 6.2 Renewable primary resources with energy content used as a material, RPR_M.
(6): $NRPR_E = NRPR_T - NRPR_M$, where $NRPR_T$ is equal to the value for non-renewable energy obtained using the CED methodology (LHV).
(7): Calculated as per ACLCA ISO 21930 Guidance, 6.4 Non-renewable primary resources with energy content used as a material, $NRPR_M$.
(8): Represents the use of net fresh water calculated from life cycle inventory results, i.e., water consumption.
(9): Calculated from life cycle inventory results, based on datasets classified under "treatment and disposal of hazardous waste." The manufacturer does not generate hazardous waste.
(10): Calculated from life cycle inventory results, based on waste that is neither "hazardous" nor "radioactive" and EPD values.
(11): Calculated from life cycle inventory results, based on ecoinvent waste flow "high-level radioactive waste for final repository." The manufacturer does not generate radioactive waste.
(12): Calculated from life cycle inventory results, based on ecoinvent waste flow "low-level radioactive waste for final repository." The manufacturer does not generate radioactive waste.

Environmental indicator acronyms

GWP: Global Warming Potential; **AP**: Acidification Potential; **EP**: Eutrophication Potential; **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **FFD**: Fossil Fuel Depletion Potential; **ADP_{fossil}**: Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources; **RPR_E**: Renewable Primary Resources Used as Energy Carrier (Fuel); **RPR_M**: Renewable Primary Resources with Energy Content Used as Material; **RPR_T**: Renewable Primary Resources Total; **$NRPR_E$**: Non-Renewable Primary Resources Used as Energy Carrier (Fuel); **$NRPR_M$**: Non-Renewable Primary Resources with Energy Content Used as Material; **$NRPR_T$**: Non-Renewable Primary Resources Total; **SM**: Secondary Materials; **RSF**: Renewable Secondary Fuels; **NRSF**: Non-Renewable Secondary Fuels; **RE**: Recovered Energy; **FW**: Use of Net Fresh Water Resources; **HWD**: Hazardous Waste Disposed; **NHWD**: Non-Hazardous Waste Disposed; **RWD**: Radioactive Waste Disposed; **HLRW**: High-Level Radioactive Waste, Conditioned, to Final Repository; **ILLRW**: Intermediate and Low-Level Radioactive Waste, Conditioned, to Final Repository; **CRU**: Components for Re-Use; **MFR**: Materials for Recycling; **MER**: Materials for Energy Recovery; **E**E: Exported Energy.

5.2. CALCULATING IMPACT CATEGORY RESULTS FOR PRODUCTS WITH OTHER GLASS & MIRROR THICKNESSES

The results were presented for products with a total glass thickness of 6 mm.

To obtain the results for other glass thicknesses, use the equation below.

$$Impact\ result_t = sf * (t - 6) + Impact\ result_{6mm}$$

Where

Impact result$_t$: Impact results for the desired glass and/or mirror thickness

t: Desired glass and/or mirror thickness (mm)

sf: Scaling factor

Impact result6mm: Impact results for products with a total glass and/or mirror thickness of 6 mm

For example, to calculate the global warming potential (GWP-AR5) of a Laminated Glass to Glass Marker Board product with a total glass thickness of 12 mm, the calculation is as follows:

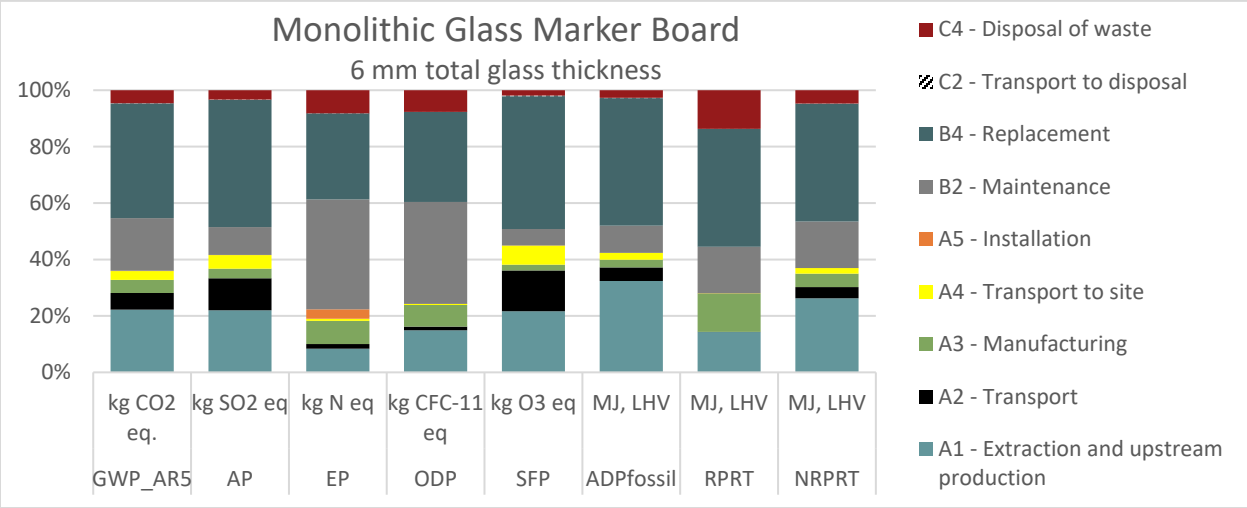
Impact result$_{12}$ = 21.7 * (12-6) + 194 = 324 kg CO_2 eq./m2

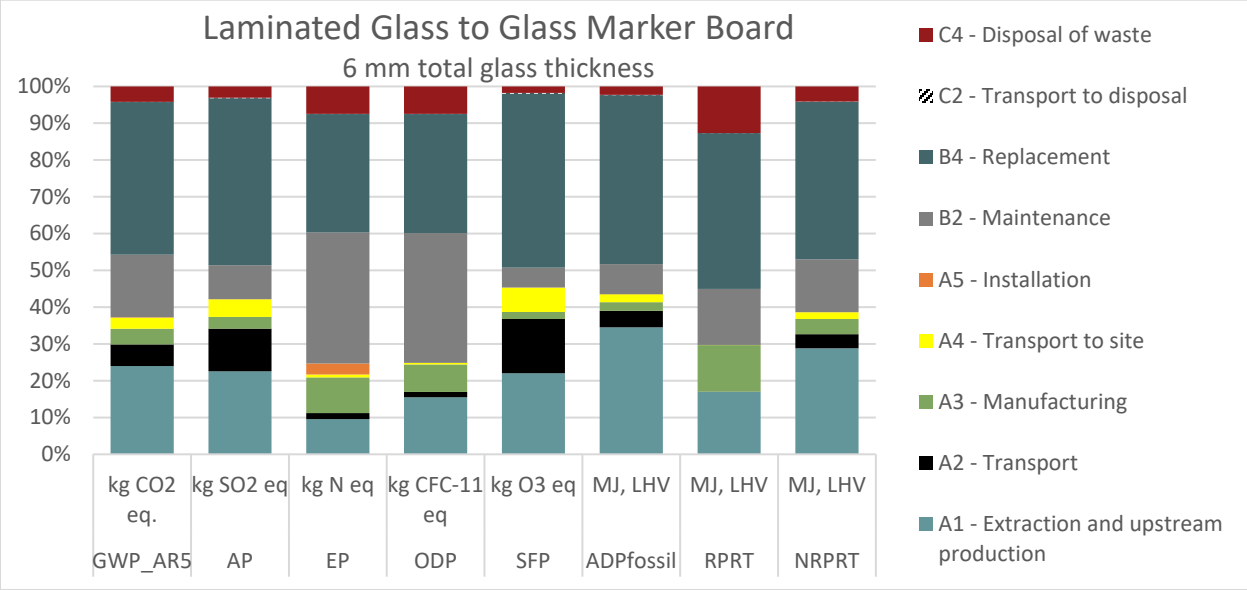
Glass marker boards scaling factor (A1-C4)

Environmental Indicator	All products
	sf
TRACI 2.1	
GWP_{100}-AR5	2.17E+01
AP	1.24E-01
EP	3.81E-02
ODP	2.85E-07
SFP	2.59E+00
FFD	3.48E+01
ADP_{fossil}	2.62E+02
RPRT	6.05E+01
NRPRT	2.92E+02

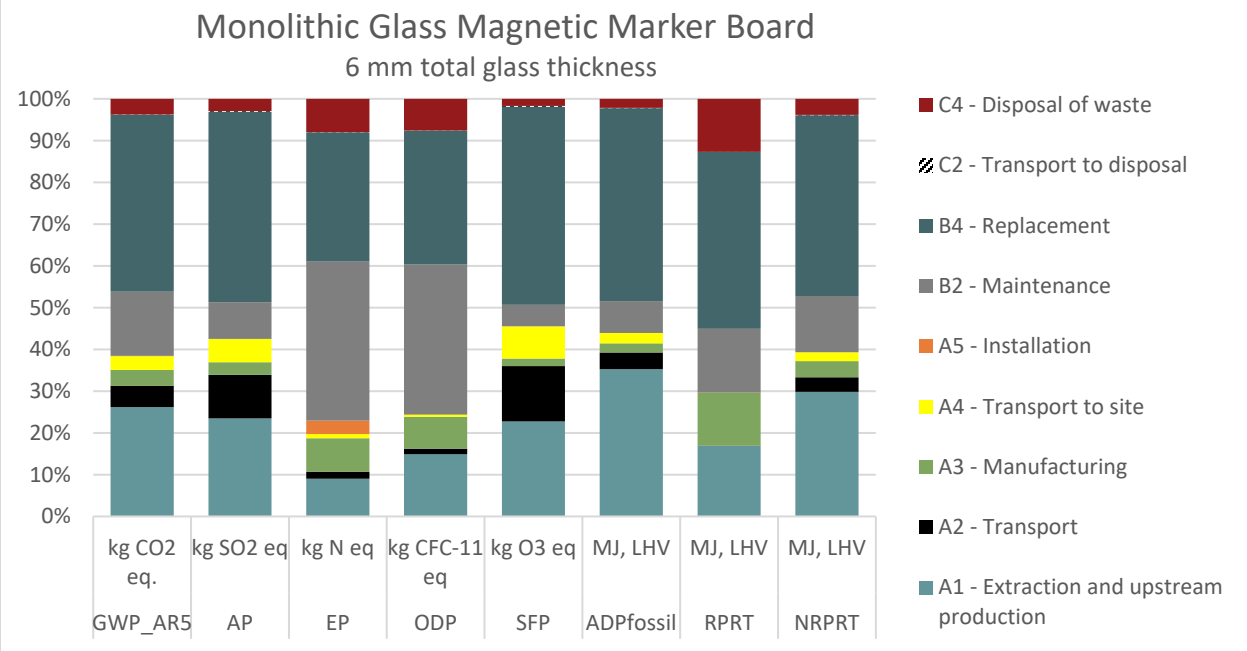
5.3. CONTRIBUTION ANALYSIS

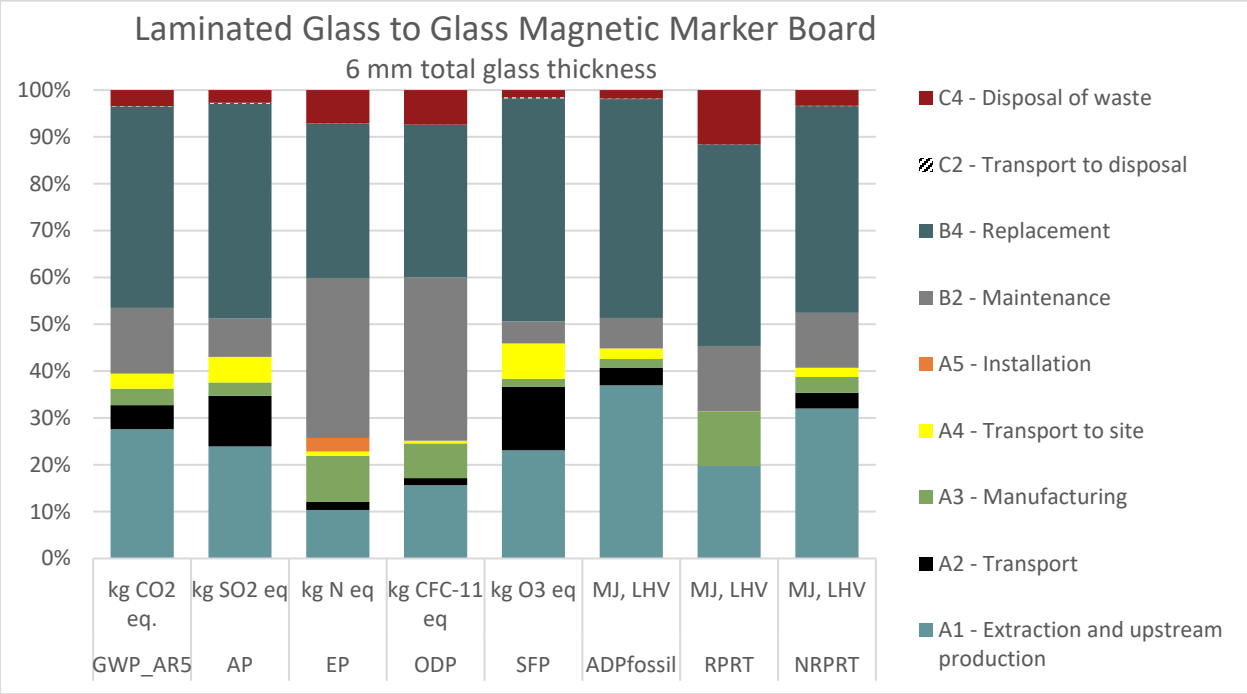
As can be seen from the four figures below, replacement (B4) is the main contributor to global warming potential (GWP), acidification potential (AP), smog formation potential (SFP), fossil fuel depletion potential (FFD), as well as renewable and non-renewable primary resource consumption (RPR_T, $NRPR_T$). It should be noted that one replacement has been considered and that the replacement module (B4) is equal to the sum of modules A1-A5, C2 and C4. Maintenance (B2) is the main contributor to eutrophication potential (EP) and ozone layer depletion potential (ODP).





GWP: Global Warming Potential; **AP**: Acidification Potential; **EP**: Eutrophication Potential; **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **ADP_{fossil}**: Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources; **RPRT**: Renewable Primary Resources – Total; **NRPRT**: Non-Renewable Primary Resources – Total.





GWP: Global Warming Potential; **AP**: Acidification Potential; **EP**: Eutrophication Potential; **ODP**: Ozone Layer Depletion Potential; **SFP**: Smog Formation Potential; **ADP_{fossil}**: Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources; **RPRT**: Renewable Primary Resources – Total; **NRPRT**: Non-Renewable Primary Resources – Total.

6. ADDITIONAL ENVIRONMENTAL INFORMATION

6.1. REGULATED HAZARDOUS SUBSTANCES

No substances required to be reported as hazardous are associated with the products.

6.2. DANGEROUS SUBSTANCES

The products are not known to release dangerous substances.

6.3. FURTHER INFORMATION

Bendheim has also published a Health Product Declaration® for all their products. More details are available on the HPDC public repository: https://www.hpd-collaborative.org/hpd-public-repository/.

Private Office, New York, NY, Magnetic glass marker board [Picture courtesy of Bendheim LLC]

7. REFERENCES

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