



Processed Glass: Monolithic Glass, Laminated Glass and Insulated Glass Unit



Multiver Ltd.

ENVIRONMENTAL PRODUCT DECLARATION

ISO 14025:2006 and ISO 21930:2017



Multiver Ltd. is pleased to present this Environmental Product Declaration (EPD) for their Monolithic Glass, Laminated Glass and Insulated Glass Unit 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 the EPD were prepared by Vertima Inc. The EPD includes cradle-to-gate life cycle assessment (LCA) results.

For more information about Multiver Ltd., visit www.multiver.ca/en.

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

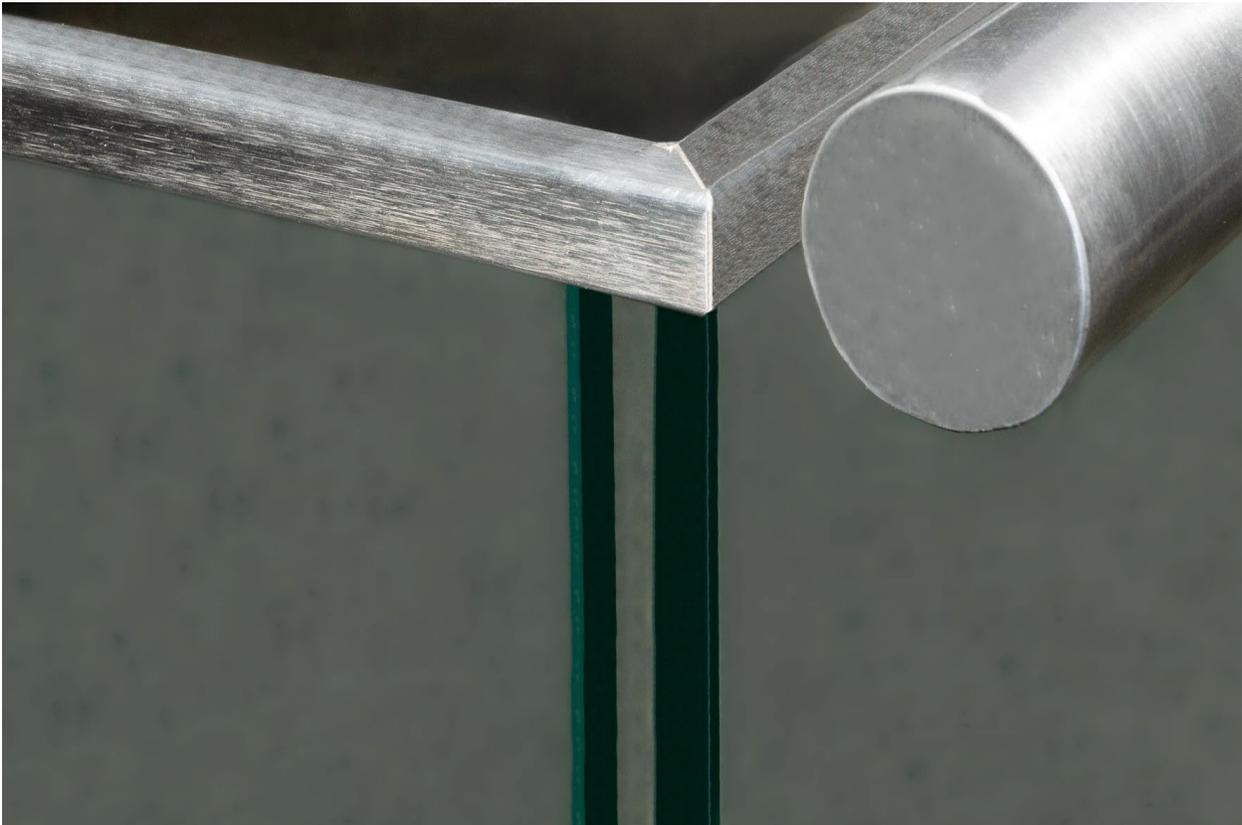
1. GENERAL INFORMATION

PCR GENERAL INFORMATION			
Reference PCR	PCR 2019:14 Construction products version 1.11 and its c-PCR-009 Flat glass products (EN17074:2019) The International EPD® System 2021-01-25 to 2024-12-20		
The PCR review was conducted by:	<i>The Technical Committee of the International EPD® System Chair: Claudia A. Peña. Contact via info@environdec.com</i>		
EPD GENERAL INFORMATION			
Program Operator	ASTM International 100 Barr Harbor Drive West Conshohocken, PA 19428 www.astm.org		
Declared Product	Product group 1: Monolithic Glass Product group 2: Laminated Glass Product group 3: Insulated Glass Unit		
EPD Registration Number 342	EPD Date of Issue August 1, 2022	EPD Period of Validity July 31, 2027	
EPD Recipient Organization	Multiver Ltd. 436 Bérubé St. Quebec City (Quebec) G1M 1C8 Canada www.multiver.ca/en		
EPD Type/Scope and Declared Unit Product-specific cradle-to-gate EPD with declared unit of 1 m ² of processed glass.		Year of Reported Manufacturer primary data March 1, 2019 to February 29, 2020	
Geographical scope North America	LCA Software OpenLCA v1.10.3	LCI databases Ecoinvent 3.8	LCIA Methodology TRACI 2.1 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 International EPD System PCR “c-PCR-009 Flat glass products (EN17074:2019).”		 Lindita Bushi, Ph.D. Athena Sustainable Materials Institute	
<input type="checkbox"/> Internal <input checked="" type="checkbox"/> External			



LIMITATIONS

Environmental declarations within the same product category but from different programs may not be comparable.[1] Furthermore, “comparison of construction products using an EPD shall be carried out in the context of the construction works. Consequently, comparisons of the environmental performance of construction products using the EPD shall consider all the relevant information modules over the full life cycle of the products within the construction works. Such a comparison requires scenarios in the construction works context. The provision of ISO 14025:2006, 6.7.2 on comparability shall apply.”[2] “Comparison of EPDs is not a simple and direct process. It requires the assurance of comparable conditions and assumptions to avoid inaccurate conclusions. Functional requirements, as well as technical and environmental characteristics and conditions must be the same.”[3]



2. PRODUCT SYSTEM DESCRIPTION

Multiver is a Canadian manufacturing company that designs and manufactures glass products for residential, commercial and industrial buildings. Facilities producing the products under study are located in Montreal (Quebec) and Quebec City (Quebec).

2.1. PRODUCT DESCRIPTION

Monolithic Glass¹, Laminated Glass¹ and Insulating Glass Units¹ are processed glass made of flat glass, which can be tempered or heat strengthened, that meet ASTM C1036-21 Standard Specification for Flat Glass.[5] The glass can be coated with ceramic or silicone opacifying coating.

Monolithic glass is made of single sheet of flat glass which can be tempered or heat-strengthened. Laminated glass is made of two or more pieces of monolithic glass permanently bonded together with interlayers of polyvinyl butyral (PVB) film or SGP (ionoplast). The Insulating Glass Unit consists of an assembly of two or more individual monolithic glass panes separated by a dehydrated and hermetically sealed air space as illustrated in Figure 1. The Insulating Glass Units are assembled with a spacer bar (three options), a desiccant (one option), a primary sealant (one option), a secondary sealant (two options), and filling gas (argon).

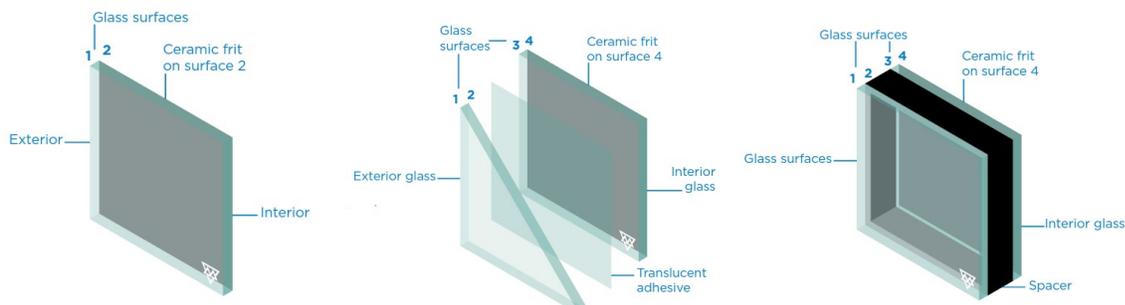


Figure 1: From left to right, representations of Monolithic Glass with ceramic coating, Laminated Glass, and an Insulated Glass Unit [Photos courtesy of Multiver].

2.2. PRODUCT APPLICATION

Multiver's Monolithic Glass, Laminated Glass and Insulating Glass Unit can be used in both residential and commercial applications.

Monolithic glass is used for structural purposes, soundproofing and meets the design challenges of interior or exterior building aesthetics.

¹ Monolithic Glass, Laminated Glass and the Insulated Glass Unit are all classified under the United Nations Standard Products and Services Code (UNSPSC) 3711 and the Construction Specification Institute (CSI) MasterFormat code 08 81 00.

Laminated glass has the same application as monolithic glass but provides more safety (protection against breaking and entering, vandalism, hurricanes, etc.) with its increased mechanical strength and thermal resistance. If the glass breaks, the interlayer ensures that the broken glass stays in place for a certain period of time or until a determined load level is reached.

The Insulating glass unit is used in building envelopes as windows and curtain walls, in glass partitions, skylights or door glazing.

To see projects where Multiver's glass is used, visit www.multiver.ca. [6]

2.3. PLACING ON THE MARKET

Multiver's products respect the following standards per product type:

a) Monolithic Glass Products

- ASTM C1036-21 - Standard Specification for Flat Glass [5]
- ASTM-C1048-18 - Standard Specification for Heat-Strengthened and Fully Tempered Glass [7]
- ANSI Z97.1-2015 (R2020)- American National Standard for Safety Glazing Materials Used in Buildings [8]
- CAN/CGSB-12.1-2017 - Canadian Standard - Safety glazing [9]
- CPSC 16 CFR-1201 (2012) – Safety Standard for Architectural Glazing Materials [10]

b) Laminated Glass Products (in addition to the standards that apply to Monolithic Glass Products)

- ASTM C1172-19 - Laminated Architectural Flat Glass [11]

c) Insulating Glass Units (in addition to the standards that apply to Monolithic and Laminated Glass Products)

- ASTM E 2190-19 - Standard Specification for Insulating Glass Unit [12]
- CAN/CGSB 12.8-2017 – Insulating Glass Units [13]
- IGCC/IGMA - Certification Program for the Harmonized Insulating Glass Standard [14]

2.4. PROPERTIES OF DECLARED PRODUCT AS DELIVERED

All products are available with various glass types: clear, low-iron, tinted, reflective, solar control or low emissivity and can be opacified (spandrel glass) with a silicone or ceramic-based coating. The glass can also be tempered or heat-strengthened.

Monolithic glass thickness varies from 2.7 mm to 19 mm. Maximum size of glass is 2500 mm x 4200 mm (98 inches X 165 inches). Upon request, larger glass dimensions can be prepared. [15]

Laminated glass can be prepared with glass from 3 mm up to 19 mm with a PVB or SGP (ionoplast) interlayer of 0.38 mm to 2.29 mm and 0.76 mm to 2.29 mm, respectively. Maximum size of glass is 2438 mm x 4200 mm (96 inches x 165 inches). Upon request, larger glass dimensions can be prepared. Specific properties in terms of safety, energy performance, aesthetics and acoustics, depend on the make-up, i.e., glass thickness, glass type and interlayer type. [16]

Insulating glass units are composed of two or more panes of glass 6 mm to 15 mm-thick assembled with regular or nonconductive spacers. The panes of glass can be monolithic or laminated glass. Maximum size of an insulating glass unit is 2500 mm X 3700 mm (98 inches X 145 inches). Upon request, larger glass dimensions can be prepared.[17]

Details can be found on Multiver's website www.multiver.ca. [18]

2.5. MATERIAL COMPOSITION

Materials/Components	Monolithic Glass		Laminated Glass		Insulating Glass Unit	
	kg per m ²	%	kg per m ²	%	kg per m ²	%
Glass	1.50E+01	99.56%	2.72E+01	96.04%	2.87E+01	96.81%
Ceramic coating	5.93E-02	0.39%	-	-	2.18E-02	0.07%
Silicone coating	6.85E-03	0.05%	-	-	5.20E-04	0.00%
PVB or ionoplast	-	-	1.12E+00	3.96%	6.54E-02	0.22%
Spacer Bar / PP-based	-	-	-	-	1.72E-01	0.58%
Spacer Bar / Steel-based	-	-	-	-	0.00E+00	0.00%
Spacer Bar / Al-based	-	-	-	-	1.12E-02	0.04%
Primary Seal / PIB	-	-	-	-	2.91E-02	0.10%
Secondary Seal / Silicone	-	-	-	-	5.29E-01	1.79%
Desiccant	-	-	-	-	1.15E-01	0.39%
TOTAL	15.1	100.00%	28.4	100.00%	29.6	100.00%

For details on material content, refer to the Health Product Declaration (HPD) available at <http://www.hpd-collaborative.org/hpd-public-repository/>. [19]

2.6. MANUFACTURING

The glass is cut using a computer numerical control (CNC) machine. It is then, if required, chamfered to refine the edges of the glass, thus limiting the risk of breakage in the tempering furnace. At this stage of the manufacturing process, it is possible to make notches or holes in the glass, under certain conditions. The glass is then washed to remove any impurities or dirt that could still be on the glass, and finally, dried.

For ceramic-coated glass, the glass moves forward on a conveyor belt where an even coating of enamel of the desired colour is applied as it passes under a rotating roller that simultaneously touches both the paint and the glass. The ceramic coating is lightly dried using ventilators to make the tempering process easier.[20]

The glass is tempered by increasing the temperature of the glass and then rapidly cooling it to increase its safety and resistance factors. When the glass has been ceramic-coated, the increase in temperature during the tempering process allows the enamel (composed of frits and coloured pigments) to merge into the glass surface.

For silicone-coated glass, the silicone coating in the desired colour is applied after the tempering process in the same way as the application of ceramic coating.[21]

For Laminated Glass, if a tempering process is required, the laminating process will take place afterwards. During the laminating process, the glass is first heated under pressure and then placed inside a pressurized autoclave. As for the Insulating Glass Unit, the glass is prepared as stated above prior to assembly with sealant, desiccant, spacer, and gas.

The sequence of the different process steps done at Multiver's facilities are illustrated in section A3 – Manufacturing of Figure 2. The Montreal facility produces all three types of products, while the two joint Quebec City facilities produce Monolithic Glass and Insulated Glass Units.

2.7. ENVIRONMENT AND HEALTH DURING MANUFACTURING

Multiver follows provincial and federal rules on Health, Safety and Environment (HSE) for a safe workplace.

During the manufacturing process, all clean glass loss is recycled, thus reducing Multiver's waste.

2.8. PACKAGING

Multiver's products are stacked vertically on reusable steel racks and/or wooden crates, if necessary. The glass products are separated using cardboard. The corners are protected with cardboard or Styrofoam which are held in place with polypropylene straps. Nylon straps hold everything together. Finally, the package is shrink wrapped.

2.9. PRODUCT INSTALLATION

Multiver highly suggests that the installation of its products comply with the regulations currently in effect. Furthermore, the installation of Insulated Glass Units must be approved by a curtain wall specialist or supplier.[17]

When installing laminated glass/laminated sealed units, it is imperative to ensure the compatibility of sealants that are close to or in contact with the laminate films.[16]

For glass with silicone coating, in order to avoid undesirable colour changes, it is essential to ensure the compatibility of adhesive tapes, sealants and gaskets that are close to or in contact with the spandrel glass.[21]

2.10. USE CONDITIONS

During the use of the processed glass products, it is recommended that all exposed surfaces are cleaned, if needed, in order to preserve the aesthetic qualities of the product, gently with a soft cloth, using cold or warm water and nonaggressive chemicals for all glass surfaces. Caution should be exercised when choosing cleaners. Abrasive cleaners must never be used as they can cause damage to the glass surface. Several products are specifically designed to clean glass. Metallic objects should not be used because they could scratch the glass. Never use any products containing solvents.

2.11. PRODUCT REFERENCE SERVICE LIFE AND BUILDING ESTIMATED SERVICE LIFE

For this EPD, the system boundaries encompass a cradle-to-gate scope. Environmental impacts of products in the use phase are excluded from this declaration, per c-PCR-009 (to PCR 2019:14), "Flat glass products used in buildings and other construction works (EN 17074)" (2021-01-25).

2.12. RE-USE PHASE

The process glass product itself can be re-used if still is good condition.

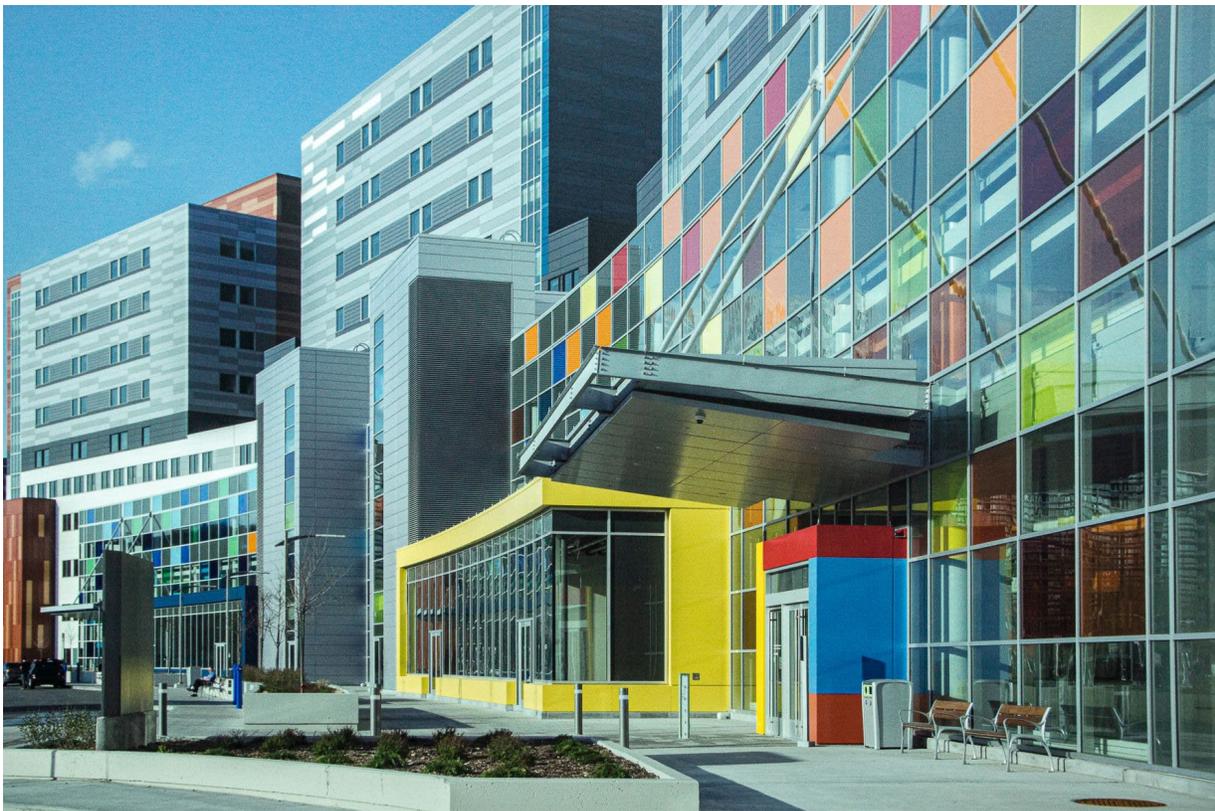
2.13. DISPOSAL

At their end-of-life, processed glass can be recycled into new products as often as desired if they are free of contaminants (e.g., non-glass components).[22][23] Industries using crushed glass as raw materials included the fiberglass, glass container, roadways, highway paint, terrazzo flooring, polishing material and landscaping industries.

However, worldwide, the recycling rate for flat glass is only 11%,[23] while in the United States, in 2018, waste glass products from durable goods are landfilled (86.6%) or combusted with energy recovery (13.4%).[24]

2.14. FURTHER INFORMATION

Further information about Multiver's products is available at www.multiver.ca.



3. LCA CALCULATION RULES

3.1. DECLARED UNIT

The selected declared unit (DU) for this study is **1 m² of processed glass**. All flat glass used in the products has the same density (2500 kg/m³).

Item	Unit	Monolithic Glass	Laminated Glass	Insulated Glass Unit
Declared unit (DU)	m ²	1	1	1
Mass per piece	kg	15.1	28.4	29.6
Conversion factor to 1 kg		0.066	0.035	0.034
Average glass thickness (range)*	mm	6.0 (2.7 - 19.0)	10.9 (3.0 - 19.0)	11.5 (6.0 - 36.0)
Glass percent mass	%	99.56%	96.04%	96.81%
Interlayer percent mass	%	0.00%	3.96%	0.22%
Rest of materials percent mass	%	0.44%	0.00%	2.97%

*: For Insulated Glass Unit, average glass thickness is the sum of the glass panes' thicknesses.

3.2. PRODUCTION AVERAGE

Multiver has three manufacturing facilities: one in Montreal (Quebec) and two in Quebec City (Quebec). The facilities were considered as one as there are material exchanges between the three facilities occurring at different steps in the production process. The glass weight for each product thus represents the average production of the three facilities for one full year. The production data was collected from March 1, 2019 to February 29, 2020.

3.3. SYSTEM BOUNDARIES

The system boundaries are **cradle-to-gate**, i.e., only cover the production life cycle stage as illustrated in Table 1. Within this 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 not included in this study. Figure 2 presents the process flow diagram for Monolithic Glass, Laminated Glass, and Insulating Glass Units.

Table 1: Description of the system boundary life cycle stages and related information modules

PRODUCTION STAGE			CONSTRUCTION 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	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

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

Extraction and upstream production (module A1): This module includes the extraction and transformation of raw materials needed to produce flat glass (soda-lime glass), all the chemicals used for the coatings, the PVB or SGP (ionoplast) interlayer for laminating, as well as raw materials to produce the Insulating Glass Units.

Transport to factory (module A2): This module includes the transportation of raw materials from Multiver's suppliers to Multiver's facilities.

Manufacturing (module A3): This module includes water and energy (electricity, propane) consumption for manufacturing processes (e.g., cutting, shaping, tempering, coating, laminating, and assembling), and the use of fork lifts to transport the glass on site are also included. No air or water emissions from the manufacturing facilities were reported. Transport between facilities is included.

There is an average 30% loss of glass during the glass cutting processes steps (e.g., broken, trims) as well as 2.7% to 7.6% loss of products (e.g., scraps, defects). These losses have been determined by production weight. Clean glass waste is sent to a recycling center while glass with coatings, laminated film or sealants, as well as component waste, are sent to landfill.

Finally, packaging materials to make products ready for shipment, as well as their transport to Multiver's facilities, are covered by this module.

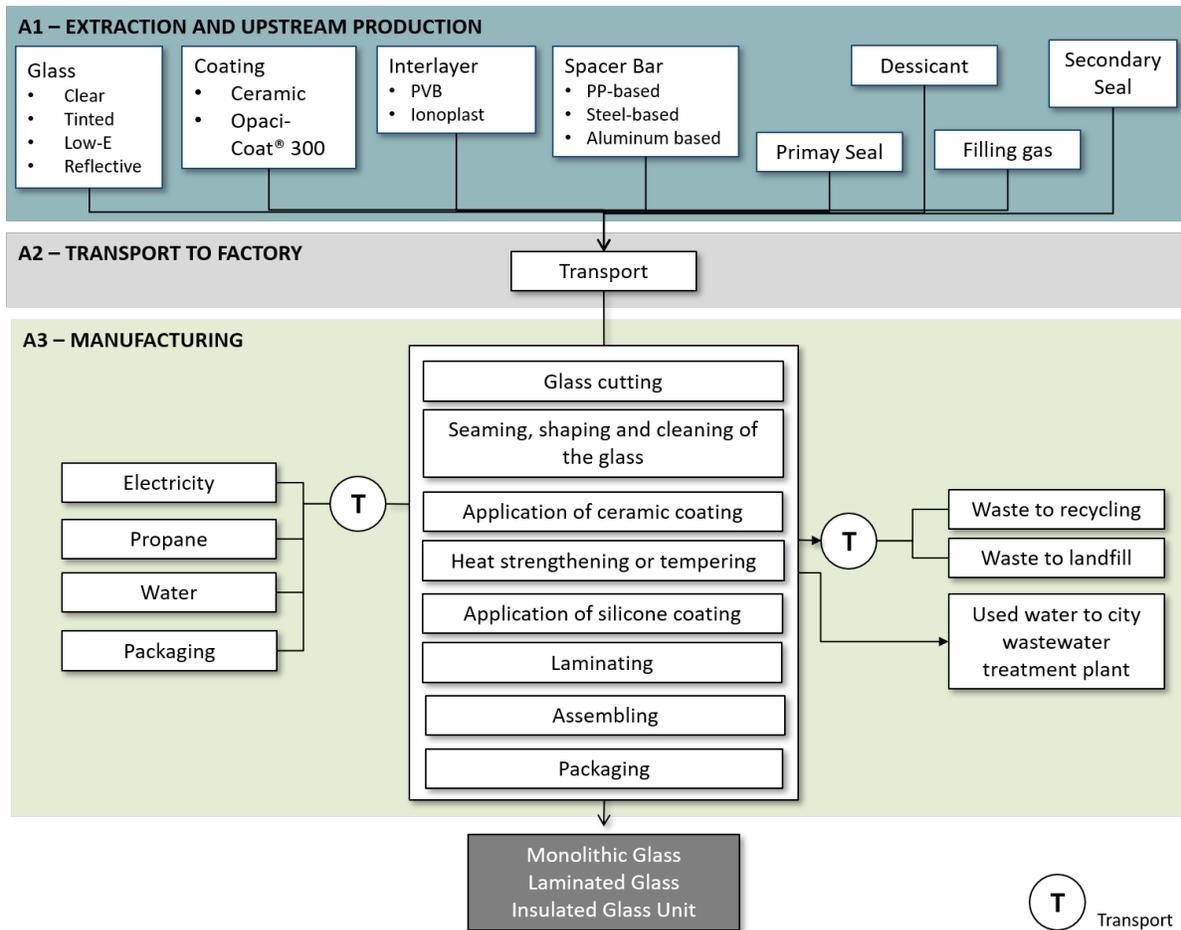


Figure 2: System boundaries of cradle-to-gate LCA of Multiver’s Monolithic Glass, Laminated Glass, and Insulating Glass Units produced in Quebec (Canada).

3.4. CUT-OFF CRITERIA

No known flows are deliberately excluded from this study.

As specified by EN 17074:2019,[3] “flows related to human activities such as lighting, heating, cleaning of workshops, administration and employee transport are excluded from the system boundaries. [Furthermore, the] production of plants, machines and transportation systems inside the factories is also excluded. The model only takes into account the processes associated with infrastructures that are already included in theecoinvent unit processes.”

3.5. ALLOCATION

According to EN 17074:2019, section 9.7, allocation should be avoided to the extent possible. If such partitioning cannot be avoided, then it shall be done based on mass.[3] Data was provided for the whole manufacturing plants; thus, **mass allocation** was used for energy input, water flows, waste flows and packaging.

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).

3.6. DATA SOURCES AND QUALITY REQUIREMENTS

Data Quality Parameter	Data Quality Discussion
Source of manufacturing data: Description sources of data	Manufacturing data was collected from Multiver’s manufacturing facilities located in Montreal (Quebec) and Quebec City (Quebec). This data included: total annual mass and area of products under study; raw materials entering the production of the products under study, materials losses, transport distance of materials, energy consumption, water consumption, waste treatment, and packaging for each manufacturing facility.
Source of secondary data: Description sources of raw materials, fuels and electricity data	Data used to model flat glass and coated glass was taken from multiple EPDs. In priority, background data were taken from ecoinvent 3.8 “cut-off” datasets representative of Quebec.[25] Otherwise, ecoinvent data representative of the global market or “rest-of-the-world” were selected as proxies. Wood data and transport data was taken from the US LCI database,[26] which is specific to a North American context.
Geographical representativeness	Manufacturing facilities are based in the province of Quebec; hence electricity consumption is based on the consumption ratio of the Quebec grid mix. Geographical correlation of the material supply and the selected datasets are, in majority, representative of the same area. When this was not possible, datasets that represent a larger geographical area were taken.
Temporal representativeness	Primary data was collected so as to be representative of one full year starting March 1 st 2019 and ending February 29 th 2020. Life cycle inventory datasets selected from published EPDs were published within the last ten years, although is not always the case for ecoinvent and US LCI datasets. Nevertheless, ecoinvent and US LCI remain 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 RESULTS

4.1. RESULTS TABLES

Results are presented for **1 m² of processed glass**. 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.

Environmental Indicator	
<i>TRACI 2.1</i>	
AP	Acidification potential
EP	Eutrophication potential
GWP-AR4	Global warming potential
GWP-AR5	Global warming potential
ODP	Ozone layer depletion potential
SFP	Smog formation potential
<i>Resource use</i>	
RPR _E	Renewable primary resources used as an energy carrier (fuel)
RPR _M	Renewable primary resources with energy content used as material
RPR _T	Total use of renewable primary energy resources
NRPR _E	Non-renewable primary resources used as an energy carrier (fuel)
NRPR _M	Non-renewable primary resources with energy content used as material
NRPR _T	Total use of non-renewable primary energy resources
SM	Use of secondary material
RSF	Use of renewable secondary fuels
NRSF	Use of non-renewable secondary fuels
RE	Use of recovered energy
FW ⁽⁶⁾	Use of net fresh water
<i>Output flows and waste categories</i>	
HWD	Hazardous waste disposed
NHWD	Non-hazardous 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
EE	Exported energy

Environmental Indicator	Unit	Monolithic Glass			
		A1 - Extraction and upstream production (per m ²)	A2 - Transport to factory (per m ²)	A3 - Manufacturing (per m ²)	Total (A1 - A3) (per m ²)
TRACI 2.1					
AP	kg SO ₂ eq.	1.41E-01	3.59E-02	3.26E-03	1.80E-01
EP	kg N eq.	7.16E-03	2.54E-03	2.20E-03	1.19E-02
GWP-AR4 ⁽¹⁾	kg CO ₂ eq.	3.35E+01	2.76E+00	7.61E-01	3.71E+01
GWP-AR5 ⁽²⁾	kg CO ₂ eq.	3.35E+01	2.77E+00	7.67E-01	3.71E+01
ODP	kg CFC-11 eq.	4.94E-08	9.23E-08	4.79E-08	1.90E-07
SFP	kg O ₃ eq.	3.00E+00	1.05E+00	6.42E-02	4.11E+00

Environmental Indicator	Unit	Laminated Glass			
		A1 - Extraction and upstream production (per m ²)	A2 - Transport to factory (per m ²)	A3 - Manufacturing (per m ²)	Total (A1 - A3) (per m ²)
TRACI 2.1					
AP	kg SO ₂ eq.	2.77E-01	7.37E-02	6.17E-03	3.57E-01
EP	kg N eq.	1.84E-02	5.21E-03	4.02E-03	2.76E-02
GWP-AR4 ⁽¹⁾	kg CO ₂ eq.	6.62E+01	5.90E+00	1.40E+00	7.35E+01
GWP-AR5 ⁽²⁾	kg CO ₂ eq.	6.63E+01	5.93E+00	1.41E+00	7.37E+01
ODP	kg CFC-11 eq.	1.19E-07	1.90E-07	9.20E-08	4.01E-07
SFP	kg O ₃ eq.	5.82E+00	2.16E+00	1.23E-01	8.10E+00

Environmental Indicator	Unit	Insulated Glass Unit			
		A1 - Extraction and upstream production (per m ²)	A2 - Transport to factory (per m ²)	A3 - Manufacturing (per m ²)	Total (A1 - A3) (per m ²)
TRACI 2.1					
AP	kg SO ₂ eq.	2.95E-01	7.28E-02	6.25E-03	3.74E-01
EP	kg N eq.	2.04E-02	5.14E-03	4.20E-03	2.97E-02
GWP-AR4 ⁽¹⁾	kg CO ₂ eq.	6.95E+01	5.69E+00	1.45E+00	7.67E+01
GWP-AR5 ⁽²⁾	kg CO ₂ eq.	6.96E+01	5.72E+00	1.46E+00	7.68E+01
ODP	kg CFC-11 eq.	1.99E-07	1.87E-07	9.16E-08	4.77E-07
SFP	kg O ₃ eq.	5.81E+00	2.14E+00	1.23E-01	8.08E+00

(1): GWP indicator is based on IPCC 2007 (AR4) 100 years.[27]

(2): GWP indicator is based on IPCC 2013 (AR5) 100 years.[28]

Environmental Indicator	Unit	Monolithic Glass			
		A1 - Extraction and upstream production (per m2)	A2 - Transport to factory (per m2)	A3 - Manufacturing (per m2)	Total (A1 - A3) (per m2)
Resource use					
RPR _E ⁽¹⁾	MJ, LHV	2.13E+01	6.68E-02	5.41E+01	7.55E+01
RPR _M ⁽²⁾	MJ, LHV	8.00E-01	0.00E+00	0.00E+00	8.00E-01
RPR _T	MJ, LHV	2.21E+01	6.68E-02	5.41E+01	7.63E+01
NRPR _E ⁽³⁾	MJ, LHV	4.87E+02	3.79E+01	1.04E+01	5.35E+02
NRPR _M ⁽⁴⁾	MJ, LHV	1.62E+00	0.00E+00	0.00E+00	1.62E+00
NRPR _T	MJ, LHV	4.88E+02	3.79E+01	1.04E+01	5.37E+02
SM ⁽⁵⁾	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW ⁽⁶⁾	m ³	6.90E+01	5.10E-05	7.36E-02	6.90E+01

Environmental Indicator	Unit	Laminated Glass			
		A1 - Extraction and upstream production (per m2)	A2 - Transport to factory (per m2)	A3 - Manufacturing (per m2)	Total (A1 - A3) (per m2)
Resource use					
RPR _E ⁽¹⁾	MJ, LHV	4.18E+01	1.38E-01	9.80E+01	1.40E+02
RPR _M ⁽²⁾	MJ, LHV	1.52E+00	0.00E+00	0.00E+00	1.52E+00
RPR _T	MJ, LHV	4.34E+01	1.38E-01	9.80E+01	1.42E+02
NRPR _E ⁽³⁾	MJ, LHV	9.66E+02	7.80E+01	1.94E+01	1.06E+03
NRPR _M ⁽⁴⁾	MJ, LHV	3.70E+01	0.00E+00	0.00E+00	3.70E+01
NRPR _T	MJ, LHV	1.00E+03	7.80E+01	1.94E+01	1.10E+03
SM ⁽⁵⁾	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW ⁽⁶⁾	m ³	1.31E+02	1.05E-04	1.34E-01	1.32E+02

Environmental Indicator	Unit	Insulated Glass Unit			
		A1 - Extraction and upstream production (per m2)	A2 - Transport to factory (per m2)	A3 - Manufacturing (per m2)	Total (A1 - A3) (per m2)
Resource use					
RPR _E ⁽¹⁾	MJ, LHV	6.39E+01	1.35E-01	1.03E+02	1.67E+02
RPR _M ⁽²⁾	MJ, LHV	1.53E+00	0.00E+00	0.00E+00	1.53E+00
RPR _T	MJ, LHV	6.55E+01	1.35E-01	1.03E+02	1.69E+02
NRPR _E ⁽³⁾	MJ, LHV	1.02E+03	7.65E+01	1.99E+01	1.12E+03
NRPR _M ⁽⁴⁾	MJ, LHV	1.52E+01	0.00E+00	0.00E+00	1.52E+01
NRPR _T	MJ, LHV	1.04E+03	7.65E+01	1.99E+01	1.13E+03
SM ⁽⁵⁾	MJ, LHV	5.67E-03	0.00E+00	0.00E+00	5.67E-03
RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW ⁽⁶⁾	m ³	1.34E+02	1.03E-04	1.40E-01	1.34E+02

- (1): $RPR_E = RPR_T - RPR_M$, where RPR_T is equal to the value for renewable energy obtained using the CED LHV methodology.
- (2) Calculated as per ACLCA ISO 21930 Guidance,[37] 6.2 Renewable primary resources with energy content used as a material, RPR_M .
- (3): $NRPR_E = NRPR_T - NRPR_M$, where $NRPR_T$ is equal to the value for non-renewable energy obtained using the CED LHV methodology.
- (4): Calculated as per ACLCA ISO 21930 Guidance,[37] 6.4 Non-renewable primary resources with energy content used as a material, $NRPR_M$.
- (5): Calculated as per ACLCA ISO 21930 Guidance,[37] 6.5 Secondary materials, SM: includes aluminum spacer materials.
- (6) FW represents the consumption of water and not the usage. Multiver does not consume water in its process.

Environmental Indicator	Unit	Monolithic Glass			
		A1 - Extraction and upstream production (per m ²)	A2 - Transport to factory (per m ²)	A3 - Manufacturing (per m ²)	Total (A1 - A3) (per m ²)
<i>Output flows and waste categories</i>					
HWD ⁽¹⁾	kg	3.52E-04	9.58E-03	1.42E-03	1.14E-02
NHWD ⁽²⁾	kg	4.77E+00	7.76E-02	8.46E-01	5.69E+00
HLRW ⁽³⁾	m ³	3.68E-05	2.45E-12	9.82E-09	3.69E-05
ILLRW ⁽⁴⁾	m ³	3.59E-05	8.09E-11	1.11E-08	3.59E-05
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR ⁽⁵⁾	kg	9.28E-01	0.00E+00	6.93E+00	7.86E+00
MER	kg	6.39E-06	0.00E+00	0.00E+00	6.39E-06
EE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

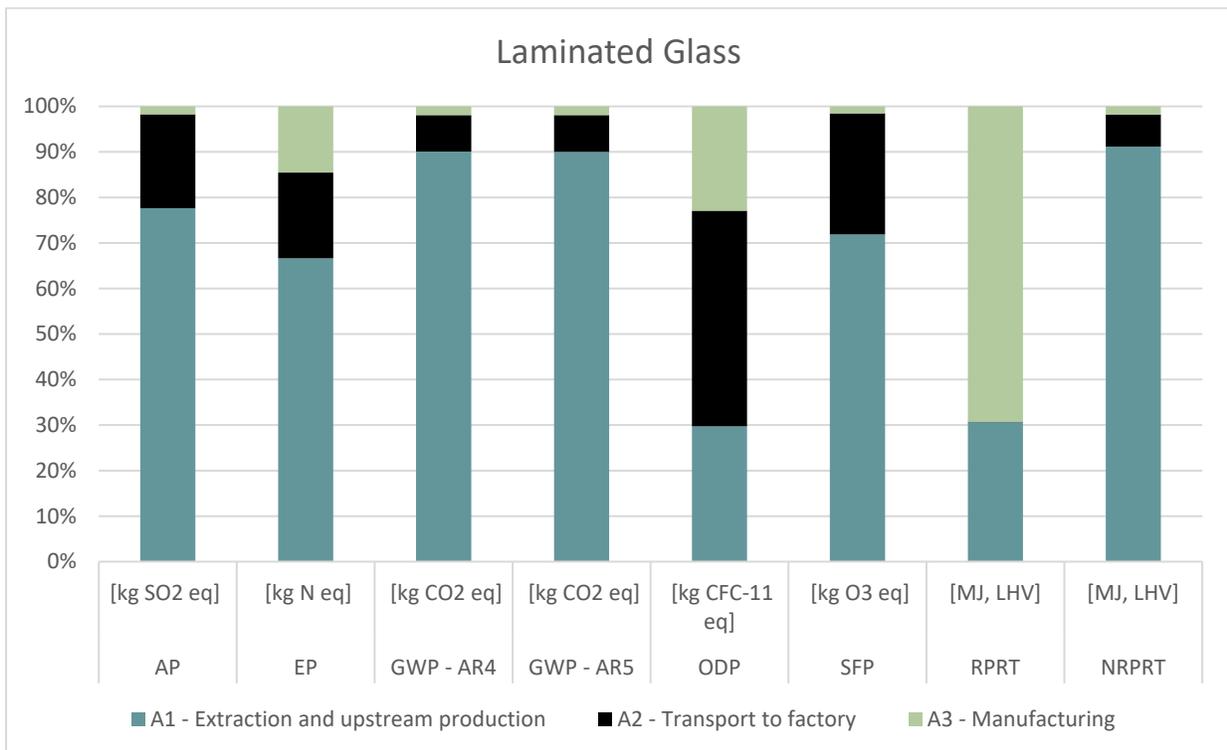
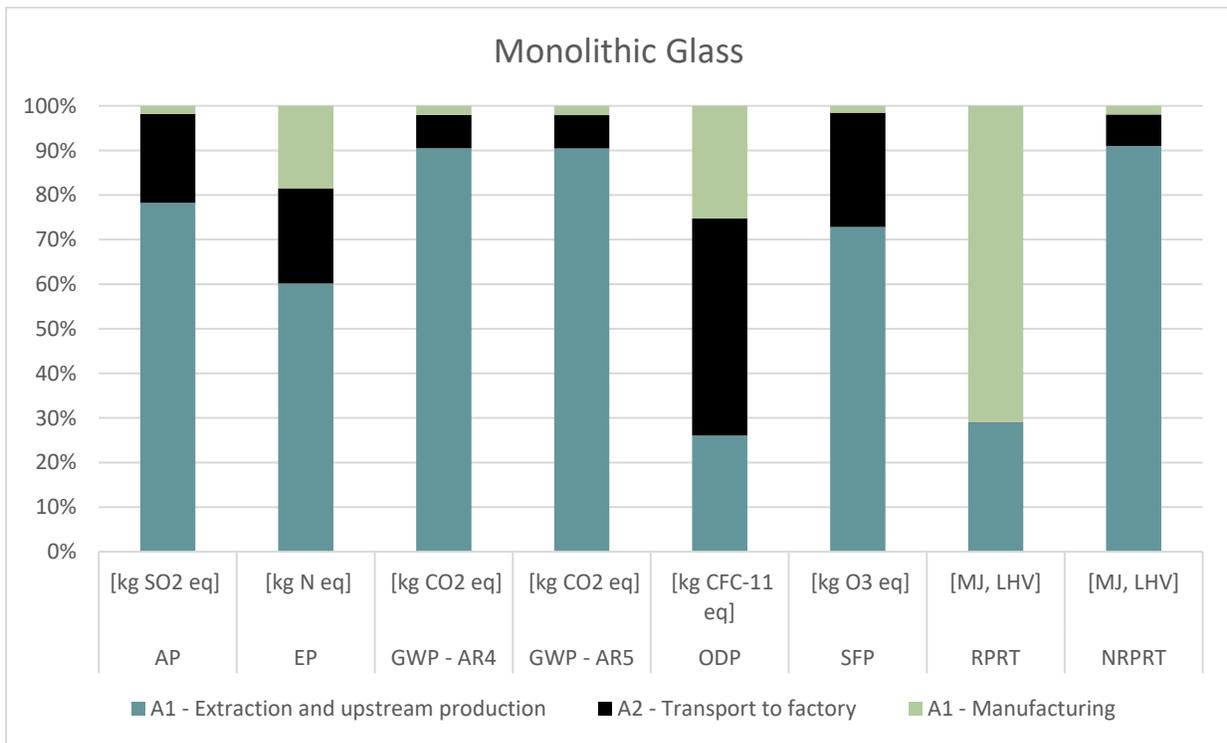
Environmental Indicator	Unit	Laminated Glass			
		A1 - Extraction and upstream production (per m ²)	A2 - Transport to factory (per m ²)	A3 - Manufacturing (per m ²)	Total (A1 - A3) (per m ²)
<i>Output flows and waste categories</i>					
HWD ⁽¹⁾	kg	2.29E-03	1.98E-02	2.66E-03	2.47E-02
NHWD ⁽²⁾	kg	8.81E+00	1.60E-01	3.62E+00	1.26E+01
HLRW ⁽³⁾	m ³	7.02E-05	5.05E-12	1.78E-08	7.02E-05
ILLRW ⁽⁴⁾	m ³	6.83E-05	1.67E-10	2.09E-08	6.83E-05
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR ⁽⁵⁾	kg	1.77E+00	0.00E+00	1.26E+01	1.44E+01
MER	kg	1.22E-05	0.00E+00	0.00E+00	1.22E-05
EE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Environmental Indicator	Unit	Insulated Glass Unit			
		A1 - Extraction and upstream production (per m2)	A2 - Transport to factory (per m2)	A3 - Manufacturing (per m2)	Total (A1 - A3) (per m2)
<i>Output flows and waste categories</i>					
HWD ⁽¹⁾	kg	2.33E-02	1.94E-02	2.72E-03	4.54E-02
NHWD ⁽²⁾	kg	7.70E+00	1.57E-01	1.68E+00	9.53E+00
HLRW ⁽³⁾	m ³	8.74E-05	4.95E-12	1.87E-08	8.74E-05
ILLRW ⁽⁴⁾	m ³	8.51E-05	1.64E-10	2.12E-08	8.51E-05
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR ⁽⁵⁾	kg	1.78E+00	0.00E+00	1.35E+01	1.53E+01
MER	kg	1.22E-05	0.00E+00	0.00E+00	1.22E-05
EE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

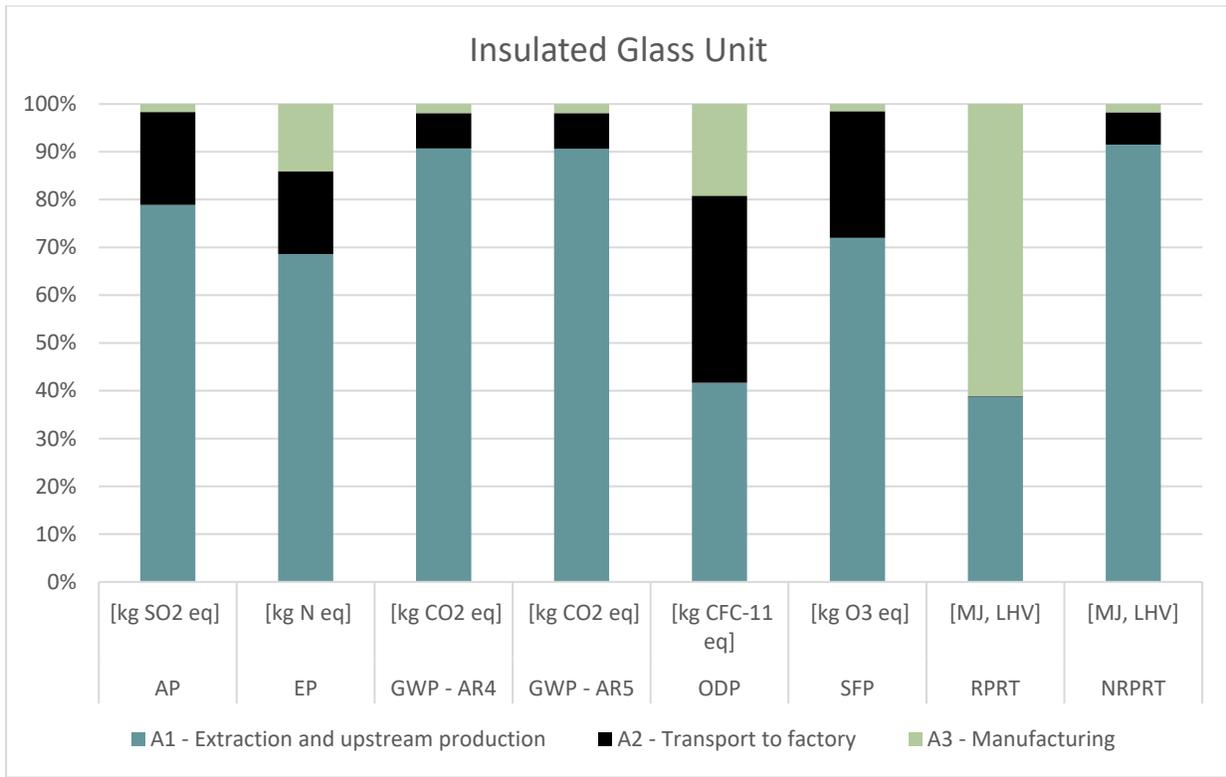
- (1): Calculated from life cycle inventory results, based on datasets marked as "hazardous" and EPD values.
- (2): Calculated from life cycle inventory results, based on waste that is neither "hazardous" nor "radioactive" and EPD values.
- (3): Calculated from life cycle inventory results, based on the ecoinvent waste flow "high-level radioactive waste for final repository" and EPD values.
- (4): Calculated from life cycle inventory results, based on the ecoinvent waste flow "low-level radioactive waste for final repository" and EPD values.
- (5): Calculated based on the amounts leaving the system boundary when they have reached the end-of-waste state.

4.2. INTERPRETATION

For all processed glass at Multiver, Extraction and Upstream Production (A3) is the module with the highest potential environmental impacts for 5 out of 6 environmental impact indicators, and for total use of non-renewable primary energy resources (NRPRT). Transport (A2) is the main contributor to stratospheric ozone layer depletion potential (ODP) and Manufacturing (A3) for the total use of renewable primary energy resources (RPRT).



AP: Acidification potential; EP: Eutrophication potential; GWP: 100-year global warming potential; ODP: Ozone layer depletion potential; SFP: Smog formation potential; RPRT: Total use of renewable primary energy resources; NRPRT: Total use of non-renewable primary energy resources.



AP: Acidification potential; **EP:** Eutrophication potential; **GWP:** 100-year global warming potential; **ODP:** Ozone layer depletion potential; **SFP:** Smog formation potential; **RPRT:** Total use of renewable primary energy resources; **NRPRT:** Total use of non-renewable primary energy resources.

5. ADDITIONAL ENVIRONMENTAL INFORMATION

5.1. VALIDATED ECO-DECLARATION® AND HEALTH PRODUCT DECLARATION®

Multiver is part of a third-party verification process with Vertima Inc. where Multiver's products and its entire supply chain are assessed. At the end of the process, they will be receiving a Validated Eco-Declaration® summarizing verified environmental claims, as well as Vertima's Environmental Data Sheet.



Multiver has also published Health Product Declaration® for their Monolithic Glass, Laminated Glass and Insulated Glass Unit products. More details are available on the HPDC public repository: <https://www.hpdcollaborative.org/hpd-public-repository/>.

5.2. REGULATED HAZARDOUS SUBSTANCES

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

5.3. DANGEROUS SUBSTANCES

No dangerous substances are known to be associated with the production of the products.

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Multiver Ltd.
436 Bérubé St.
Quebec City (Quebec)
G1M 1C8 Canada
www.multiver.ca

EPD

This LCA and EPD were prepared by Vertima Inc.

604 Saint Viateur Street
Quebec, QC
(418) 990-2800
G2L 2K8 CANADA


Environmental certification experts

vertima.ca