Environmental Product Declaration

Guardian® Glass Wet Coated and Sputter Coated Products

AME & I Region Coated Glass Products

Guardian Glass is dedicated to continually improving the science and process of its core competency, flat glass manufacturing.

Photo Credit: Surat Diamond Bourse, PSP

Guardian Glass is committed to the efficient use of natural resources while operating in a way that protects the safety, health, and well-being of its employees, customers, the environment, and society.

As a manufacturing leader of high performance, energy-efficient glass products for commercial, residential, interior, transportation, solar, and specialty applications, Guardian Glass makes products that help improve people's lives. By allowing abundant natural light into homes, offices, and vehicles, glass products can help contribute to occupants' well-being and low-emissivity glass helps reduce energy consumption for heating and cooling.

By publishing this EPD, Guardian Glass intends to support architects and designers who strive to enhance the environmental profiles of the buildings they design through the products they specify. The goal is to provide them with the information needed to achieve credits in global building rating systems.

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
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The values stated in this environmental product declaration (EPD) are reported in accordance with ISO 14025, and ISO 21930:2017. EPDs rely on a Life Cycle Assessment (LCA) and associated Product Category Rules (PCR) to estimate various environmental impacts of products over their life cycle. Environmental impact data and other metrics reported in this EPD may differ from values reported elsewhere as there may be differences in reporting expectations, methodology, assumptions, and allocation methods. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these other impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, thus the level of accuracy for any estimated effect may differ between product lines and reported impacts. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable (ISO 14025).

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Solutions www.spot.ul.com 2211 Newmarket Pkwy, Marietta, GA 30067 USA
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	UL Solutions: General Program Instructions v2.7. 2022.
MANUFACTURER NAME AND HEADQUARTERS ADDRESS	Guardian Glass Global Headquarters 2300 Harmon Road Auburn Hills, MI 48306
DECLARATION NUMBER	4791768198.102.2
DECLARED PRODUCT & FUNCTIONAL UNIT OF DECLARED UNIT	Guardian Glass Coated Glass, AME&I Products Declared Unit = 1 m^2 of 4mm Processed Glass
REFERENCE PCR AND VERSION NUMBER	ISO 21930: 2017; UL Part A v4.0; UL Part B : PCR for Processed Glass v1
DESCRIPTION OF PRODUCT(S) APPLICATION/USE	AME&I Coated Glass Products
PRODUCT RSL DESCRIPTION	N/A
MARKETS OF APPLICABILITY	AME&I Region, covering facilities in Africa, Middle East & India
DATE OF ISSUE	October 20, 2025
PERIOD OF VALIDITY	5 years
EPD TYPE	Product Specific
DATASET VARIABILITY	N/A
EPD SCOPE	Cradle-to-Gate
YEAR(S) OF REPORTED PRIMARY DATA	Calendar Year 2023 & 2024
LCA SOFTWARE & VERSION NUMBER	LCA for Experts (formerly GaBi) 10.9
LCI DATABASE(S) & VERSION NUMBER	Sphera Managed LCA Content (formerly GaBi) and USLCI databases
LCIA METHODOLOGY & VERSION NUMBER	CML 4.1
The sub-category PCR review was conducted by:	International Standards Organization – ISO 21930:2017
This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment: Product Category Rules for Building-Related Products and Services in Brazil, Part A: Life Cycle Assessment Calculation Rules and Report Requirements, v.3.2, December 2018, based on ISO 21930 serves as the core PCR. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Solutions
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria, Industrial Ecology Consultants

Comparison of the environmental performance using EPD information shall consider all relevant information modules over the full life cycle of the products within the building. It should be noted that different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared. Comparison of the environmental performance of construction works and construction products using EPD information shall be based on the product's use and impacts at the construction works level. In general, EPDs may not be used for comparability purposes when not considered in a construction works context. Given this PCR ensures products meet the same functional requirements, comparability is permissible provided the information given for such comparison is transparent and the limitations of comparability explained.

Summary of Declaration and Global Warming Potential Results

This Environmental Product Declaration covers Africa, Middle East and India (AME&I) wet coated (mirror), and sputter (vacuum) coated glass products. The following product families and manufacturing facilities are included within this declaration. Although specific products names and ranges are listed, the EPD is inclusive of our Ultramirror™, DecoCristal™, SunGuard™, ShowerGuard™, ClimaGuard™, MODIGUARD™, and other product ranges.

Product Families/Categories Covered – Wet Coated:

- Guardian® Ultramirror™
- MODIGUARD™ UltraMirror™
- Guardian® DecoCristal™
- MODIGUARD™ DecoCristal™
- Guardian® UltraMirror Mirage™

Product Families/Categories Covered – Sputter Coated:

- SunGuard™ Solar
- SunGuard™ Solar Plus
- Guardian® ShowerGuard™
- SunGuard™ High Durable Colors
- SunGuard™ High Performance
- SunGuard™ Double Silver
- SunGuard™ High Durable Plus
- SunGuard™ Super Neutral
- ClimaGuard™ Sunlight
- Guardian® ClimaGuard™

Manufacturing Facilities Covered:

- Ras Al-Khaimah (RAK), UAE
- Al Jubail (GulfGuard), Saudi Arabia
- Gujarat, India

Global Warming Potential Cradle-to-Gate Impact Assessment Results:

The following tables detail the A1-A3 Global Warming Potential (GWP) results as found in Table 5 and Table 8 but scaled to each thickness available. The calculation by given thickness is from scaling factors found in Table 11 which are based on the weight per square meter of glass at each thickness. CML v4.2 2016 Baseline global warming potential impact assessment values (IPCC AR6) are provided.

Table 1 - Global Warming Potential per Thickness of Wet Coated Glass

Thickness	Cradle to Gate (A1- A3) GWP (kg CO_2 eq/m^2)
2 mm	9.3
3 mm	12.5
4 mm	15.6
5 mm	18.8
6 mm	21.9
8 mm	28.3

Table 2 - Global Warming Potential per Thickness of Sputter Coated Glass

Thickness	Cradle to Gate (A1- A3) GWP (kg CO_2 eq/m^2)
2 mm	7.7
3 mm	10.8
4 mm	13.8
5 mm	16.9
6 mm	19.9
8 mm	26.0
10 mm	32.1
12 mm	38.2

General Information

Description of Company / Organization

Guardian Glass is one of the largest flat glass producers and innovators in the world. We've been working with glass since 1932 and manufacturing float glass since 1970, and yet the limitless potential of this amazing material still fascinates and inspires us every day. We are committed to advancing glass technology and exploring every application possible. Not only to enhance our customers' well-being with light and space, but to help conserve energy, regulate temperatures, protect privacy, preserve history and help us See What's Possible™.

Through pioneering research, the dedication of our people and a firm belief in close collaboration with our partners and customers, we find new ways to build, design and inspire with glass. We continue to build our expertise on each and every project, whether that's an iconic, energy-efficient building or a new glass coating that will help solve the challenges of today and beyond.

Every day, we work to create more value, using fewer resources than the day before. We constantly challenge ourselves to identify opportunities to build upon the benefits of glass. We expertly combine glass types to maximize energy savings and bring light and an unrivalled aesthetic to people's lives. We're committed to the efficient use of natural resources while operating in a way that protects the safety, health and well-being of our employees, customers, the environment and society.

For more information visit our website at www.guardianglass.com; www.gujaratguardianglass.com

Product Description

This EPD covers AME&I sputter and wet coated products:

Guardian Wet Coated Glass

- Guardian® Ultramirror™
- Guardian® MODIGUARD™ UltraMirror™
- Guardian® DecoCristal™
- Guardian® MODIGUARD™ DecoCristal™
- Guardian® UltraMirror Mirage™

Guardian Sputter Coated Glass

- SunGuard™ Solar
- SunGuard™ Solar Plus
- SunGuard™ High Durable Colors
- SunGuard™ High Performance
- SunGuard™ Double Silver
- SunGuard™ High Durable Plus
- SunGuard™ Super Neutral
- ClimaGuard™ Sunlight
- Guardian® ShowerGuard™
- Guardian® ClimaGuard™

Manufacturer-Specific EPD

This product-average EPD was developed based on the Guardian Glass AME&I Cradle-to-Gate Processed Glass Life Cycle Assessment. The EPD accounts for raw material extraction and processing, transport, and product manufacturing. Manufacturing data were gathered directly from company personnel. When updated company-specific data were not available the ratio of production units, within the calendar year 2023 for the RAK, Cairo and

Gujarat sites and 2024 for the GulfGuard site, was used as a proxy. Wet coated glass is made at GulfGuard and Gujarat, while Sputter Coated Glass is made at GulfGuard, RAK, and Gujarat. Cairo's manufacturing site creates float glass as it's available for potential coating process at any of the other three sites. For any product grouping EPDs, an impact assessment was completed for each product, and the highest impacts were reported as conservative representations of the product group. Product grouping was considered appropriate if the individual product impacts differed by no more than ±10% in any impact category.

Application

Coated glass products are used in a variety of applications including commercial, residential, interior, transportation, and specialty applications. Guardian Glass typically supplies float glass and coated glass products to either its fabricator customers or its own fabrication facilities who further process that glass into the final product by cutting, heat-treating, laminating, insulating, or otherwise fabricating the glass into the desired size and makeup for use in the intended application. The glass makeup is typically specified by architects, glazing contractors, window manufacturers, and other design professionals.

Material Composition

Flat glass is typically manufactured from virgin, non-renewable raw materials such as silica sand, soda ash, dolomite, limestone, and cullet (internal cullet is comprised of the afore-mentioned raw materials). It can also contain recycled cullet. The crystalline raw materials chemically and structurally transform into amorphous glass through a fusion (melting) process, thereby producing a product which is >99.9% glass oxide. Guardian tinted and patterned glass are similar in composition to clear float glass but may include slight variations of trace elements to achieve required optical properties.

The flat glass product is then processed by sputter (vacuum) coating or wet coating, depending on application needs. These processed glass products are similar in composition to uncoated / unprocessed flat glass but include slight additions of trace elements to achieve required optical properties.

Guardian Glass typically produces the flat glass that is used for the coated processed glass; while plant-specific flat glass life cycle data was leveraged for this declaration, more details on the flat glass life cycle assessment can be found in the Guardian Glass AME&I (Unprocessed) Flat Glass Environmental Product Declaration published via UL Environment (Declaration Number 4791213166.102.1) to the *Product Category Rules for Environmental Product Declarations: National Glass Association (NGA) PCR for Flat Glass: UN CPC 3711. v2 standard* (NSF International, Issued September 2020).

Technical Data

Technical data on Guardian Glass products is available on at www.guardianglass.com.

Placing on the Market / Application Rules

The standard that can be applied for Guardian Coated Glass Products:
- BS EN 1096 & SASO 1096 for Vacuum Sputter Coated products
- EN 1036 for Wet Coated products.
- JIS R 3220 for Wet Coated products.
- SASO 1036 for Wet Coated products
- ABNT NBR NM 294:2004 Float Glass
- ABNT NBR 7199:2016 Design, Execution and Application of Glass in Civil Construction
- ABNT NBR 16673:2018 Coated glasses for solar control - Processing and Handling Requirements
- ABNT NBR 16023:2020 Coated Glass for Solar Control - Requirements, Classification and Test Methods
- ABNT NBR 15575-1:2021 Building Performance - General Requirements.

Properties of Declared Product as Shipped

Product Sizes: While products are primarily cut to customers' specified dimensions, common dimensions include:

- 1220 mm x 1830 mm
- 1830 mm x 2440 mm
- 2250 mm x 3210 mm
- 2550 mm x 3660 mm
- 2440 mm x 3660 mm
- 3210 mm x 6000 mm

Additionally, some standard thicknesses for wet coated glass include:

- 2 mm
- 4 mm
- 2.5 mm
- 5 mm
- 3 mm
- 6 mm
- 3.5 mm
- 8 mm

While thickness of glass also varies based on customer needs, some standard thicknesses for sputter coated glass include:

- 3 mm
- 5 mm
- 10 mm
- 3.5 mm
- 6 mm
- 12 mm
- 4 mm
- 8 mm

Other sizes may be available, so please contact a local sales representative for available sizes in your area.

Declaration Type: Business-to-Business

Geographic Scope: This declaration is valid for coated products produced in Africa, Middle East & India (AME&I) from Guardian Glass.

Additional Notes: This analysis represents the performance of a production-weighted average of Guardian glass products, based on calendar year 2023 production volumes for the RAK, Cairo and Gujarat sites and calendar year 2024 production volumes for the GulfGuard site.

Methodological Framework

Functional Unit

The declaration refers to the functional unit of 1 square meter of processed (sputter and wet coated) glass as specified in the PCR.

Table 3 – Declared Unit Description

Name	Value	Unit
Declared Unit	1	m^2
Mass Covered by Declared Unit	100	kg
Thickness	4	mm

System Boundary

This is a cradle-to-grave environmental product declaration. The following life cycle phases were considered:

Table 4 - Description of the System Boundary

Product			Construction Installation		Use							End-of-Life*				Benefits of loads beyond the system boundary		
Raw Material Extraction and Processing	Transport	Manufacturing	Transport	Construction/ Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport	Waste Processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Description of the System Boundary Stages Corresponding to the PCR
(X = Included; MND = Module Not Declared)
*This includes provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues.

Allocation

Where manufacturing inputs, such as electricity use, were not sub-metered, allocation was determined on a per metric tonne basis for primary data for float glass production. For the processing of the glass (that is, the wet coating process and sputter coating process), allocation per area was conducted as coating is contingent on the surface area being treated. For secondary data, the cut-off methodology was used.

Cut-off Criteria

Processes whose total contribution to the final result, with respect to their mass and in relation to all considered impact categories, is less than 1% can be neglected. The sum of the neglected processes may not exceed 5% by mass of the considered impact categories. For that a documented assumption is admissible.

For Hazardous Substances the following requirements apply:

- The Life Cycle Inventory (LCI) of hazardous substances will be included, if the inventory is available.
- If the LCI for a hazardous substance is not available, the substance will appear as an input in the LCI of the product, if its mass represents more than 0.1% of the product composition.
- If the LCI of a hazardous substance is approximated by modeling another substance, documentation will be provided.

This EPD is in compliance with the cut-off criteria. No processes were neglected or excluded. Capital items for the production processes (machine, buildings, etc.) were not taken into consideration.

Data Sources

Primary data were collected for every process in the product system under the control of Guardian Glass. Secondary data from the LCA for Experts Managed LCA Content (formerly GaBi) databases were utilized. These data were evaluated and have temporal, geographic, and technical coverage appropriate to the scope of the glass product category.

Data Quality

The data sources used are complete and representative of the AME&I in terms of the geographic and technological coverage and are a recent vintage (i.e., less than ten years old). The data used for primary data are based on direct

information sources of the manufacturer. Secondary data sets were used for raw materials extraction and processing, end of life, transportation, and energy production flows. Wherever secondary data is used, the study adopts critically reviewed data for consistency, precision, and reproducibility to limit uncertainty.

Comparability and Benchmarking

A comparison or an evaluation of EPD data is only possible if all data sets to be compared were created according to ISO 21930, and the building context, respectively the product-specific characteristics of performance, are taken into account. Environmental declarations from different programs may not be comparable.
Full conformance with the ISO 21930 allows EPD comparability only when all stages of the product's life cycle have been considered. However, variations and deviations are possible.

Estimates and Assumptions

Due to limitations in data availability, assumptions were made in allocating important manufacturing inputs and outputs including process materials, natural gas, and facility emissions. The allocation approaches taken may therefore overestimate the environmental burden for glass production.

Additionally, the “average” glass pane used in modeling is a calculated average and does not represent a specific product manufactured by Guardian Glass.

Units

The LCA results within this EPD are reported in the International System (SI) units.

Additional Environmental Information

Background data

For life cycle modeling of the considered products, the LCA for Experts for Life Cycle Engineering, developed by Sphera, is used. The LCA for Experts-database contains consistent and documented datasets which are documented in the online LCA for Experts Managed LCA Content documentation. To ensure comparability of results in the LCA, the basic data of the LCA for Experts database were used for energy, transportation and auxiliary materials.

Product System

Manufacturing

Flat glass production involves heating the raw materials to a liquid state and then floating the subsequent ribbon of glass atop a bath of molten tin. Once the ribbon has sufficiently cooled, it is transferred onto rollers and annealed to limit residual stresses, its edges are trimmed, and the ribbon is cut to the desired sizes. The finished flat glass products are stored for additional processing (e.g., heat- treating or coating) or directly packaged and shipped to customers or Guardian's other sites for further processing.

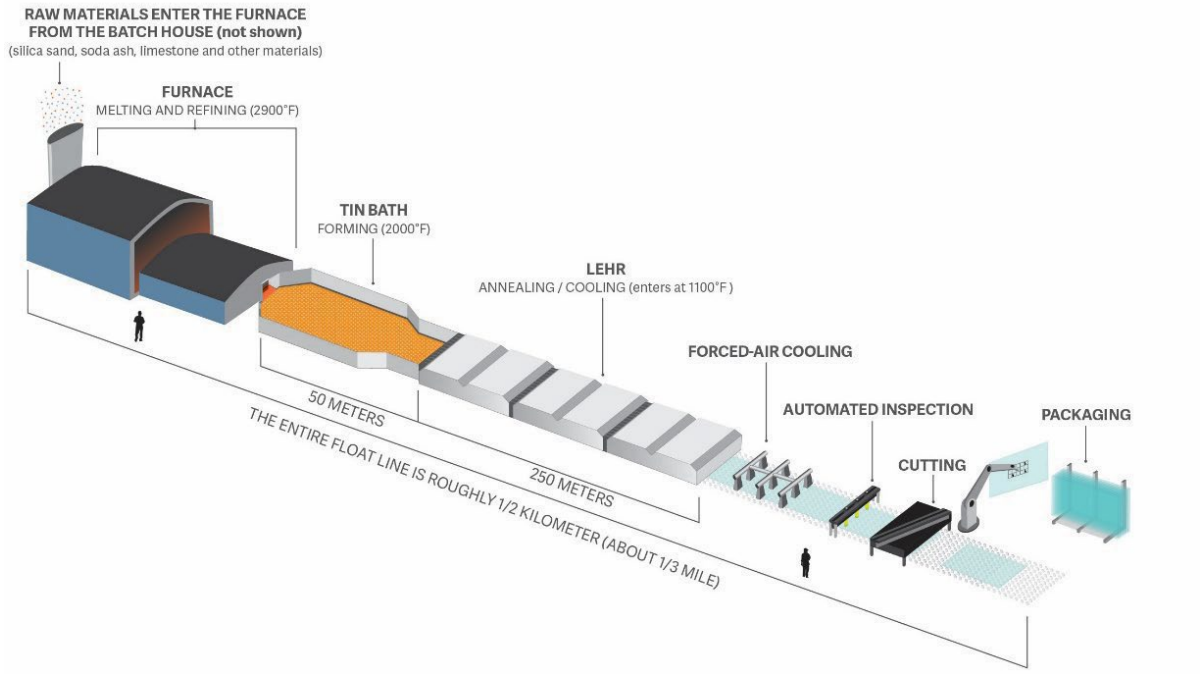

Figure 1 - Flat Glass Manufacturing Process

Manufacturing of 'Flat Glass' in the AME&I region is done at the Guardian RAK, Cairo, GulfGuard and Gujarat plants.

Wet Coated products – The wet-coated line produces high quality silvered mirror and decorative glass by applying a wet coating that undergoes an infrared (IR) cure to flat glass. Following the production of float glass, Mirror products are produced by applying a reflective layer of silver which chemically bonds with the glass. This reflective layer is protected by application of passivator and activator chemicals along with alkyd/acrylic resin-based paint. For Deco products, the process involves application of adhesion promoter layer followed by layer of alkyd/acrylic resin-based paint. The finished glass is stored, packaged and shipped to customers.

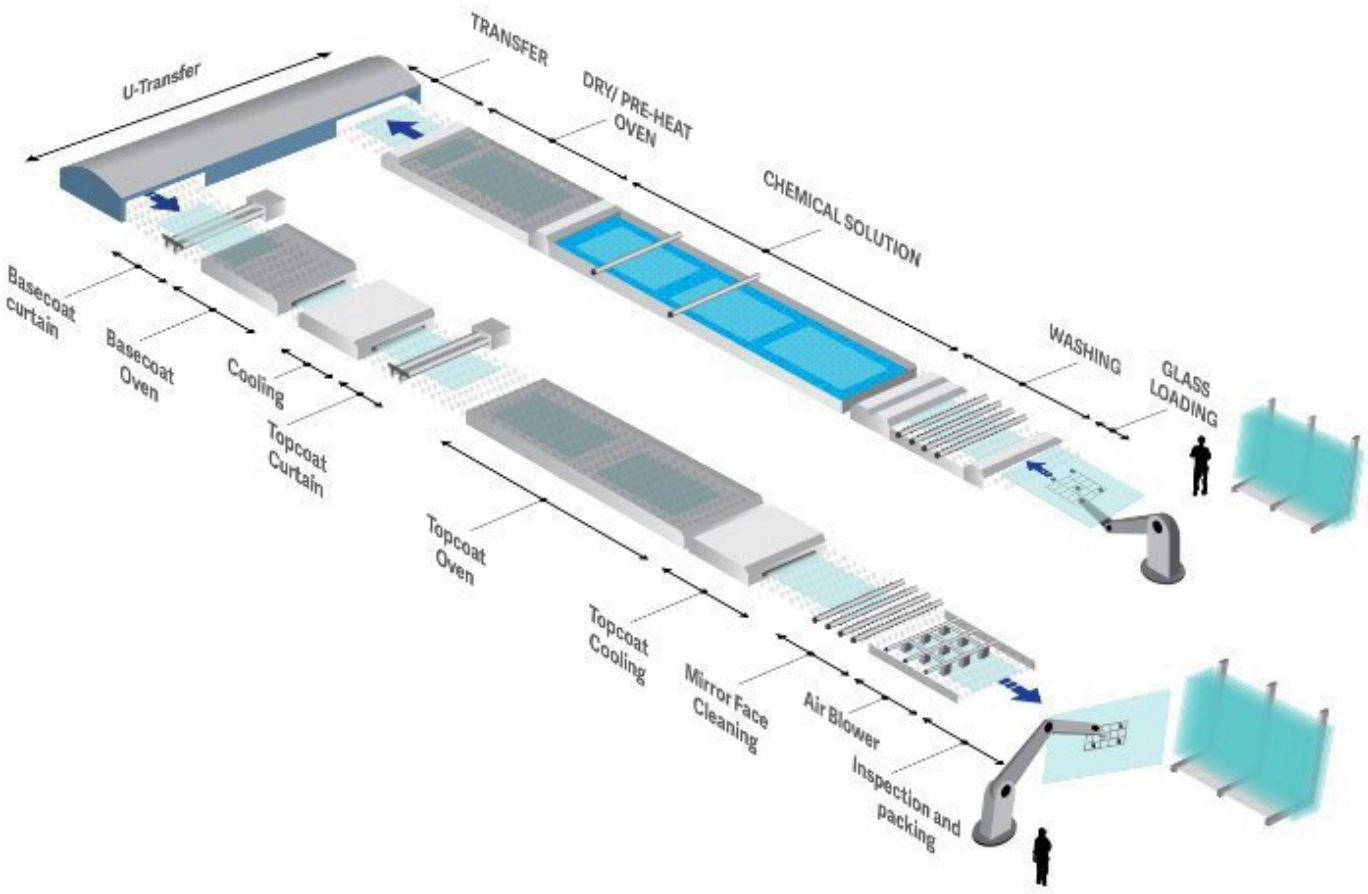

Figure 2 - Wet Coated Glass Production

Manufacturing of 'Wet Coated Glass' the AME&I region is done at the Guardian GulfGuard and Gujarat plants.

Sputter (Vacuum) Coated products – Following the production of float glass, the product can be sputter coated, which takes place via magnetron sputter deposition. The exact coating composition and thickness depends on the application. The finished glass is then stored, packaged and shipped to customers.

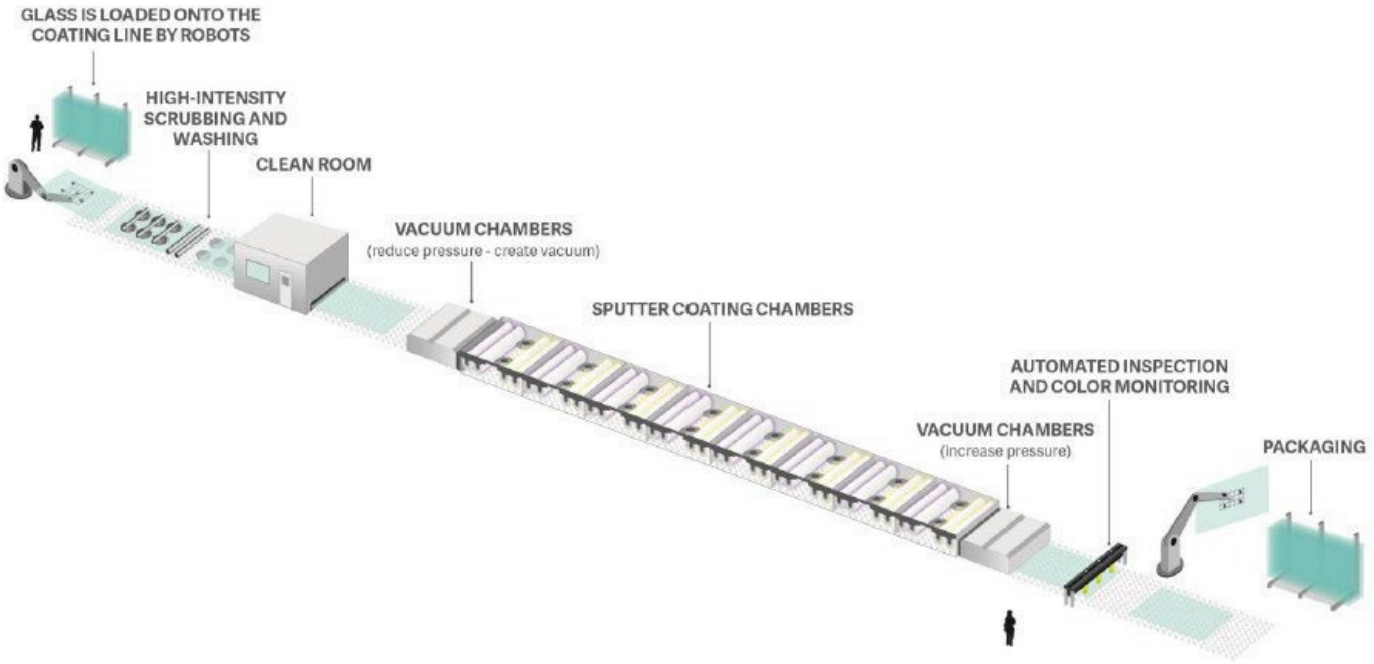

Figure 3 - Vacuum Sputter Coated Glass Production

Manufacturing of 'Sputter (Vacuum) Coated Glass' in the AME&I region is done at the Guardian RAK, GulfGuard and Gujarat plants.

Packaging

The final product is usually shipped via steel racks (typically for larger sizes) or wood crates (typically for smaller sizes). These racks are reused many times both in the manufacturing plant and shipped to the customer and returned to Guardian Glass plants. The wood crates are typically single-use and end-of-life management is usually determined by the customer; depending on the region, there are secondary markets available, and it could be sold for reuse, or the product could be recycled or otherwise disposed of.

Glass packaging may also be comprised of corrugated cardboard (b-board) spacers and/or polystyrene foam separators as well as steel banding; while cardboard and steel are typically considered recyclable in many municipalities, these materials are assumed to be disposed per general waste disposal statistics including recycling, landfilling, and incinerating.

Product Installation

Guardian Glass products should be processed and installed according to industry best practices and according to all applicable building codes in the given jurisdiction. Guardian Glass typically supplies float glass and coated glass to fabricator customers who further process that glass into the final product by cutting, heat-treating, laminating, insulating or otherwise fabricating the glass into the desired size and makeup for use in the intended application.

Product Disposal

At the end of life, flat glass is typically landfilled or reclaimed and recycled. Glass has the possibility to be recovered from the final assembly and recycled into new glass products as secondary cullet.

Wet Coated Glass Results per Square Meter Over the Building Lifetime of 75 Years

Results below show the life cycle impact assessment results throughout the product per CML Baseline 2001- April 2016 methodology. CML 2001 is a methodology used globally for life cycle impact assessments.

Table 5 - Life Cycle Impact Assessment Results per Square Meter of Wet Coated Glass (4mm)

Rest of World: CML Impact Assessment							
Parameter Name		**Unit**	**Flat Glass**	**A1**	**A2**	**A3**	**Total**
GWP	Global warming potential	kg CO_2-Eq.	1.26E+01	1.18E+00	4.55E-02	1.51E+00	**1.54E+01**
ODP	Depletion potential of the stratospheric ozone layer	kg CFC-11 Eq.	5.61E-10	1.53E-09	1.44E-12	5.81E-12	**2.10E-09**
AP Air	Acidification potential for air emissions	kg SO_2-Eq.	5.66E-02	6.56E-02	6.48E-04	1.45E-02	**1.37E-01**
EP	Eutrophication potential	kg PO_4-Eq.	7.78E-03	2.89E-04	1.26E-04	7.31E-04	**8.92E-03**
POCP	Photochemical ozone creation potential	kg C_2H_4-Eq.	3.76E-03	4.26E-03	5.45E-05	7.85E-04	**8.85E-03**
ADPE	Abiotic depletion (elements) [1]	kg Sb Eq.	6.43E-05	9.29E-04	1.58E-11	6.66E-08	**9.93E-04**
ADPF	Abiotic depletion (fossil)	MJ	1.45E+02	1.31E+01	4.85E-01	1.71E+01	**1.76E+02**

[1] Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

Results below contain the resource use throughout the life cycle of the product.

Table 6 - Resource Use per Square Meter of Wet Coated Glass (4mm)

Resource Use							
Parameter		**Unit**	**Flat Glass**	**A1**	**A2**	**A3**	**Total**
PERE	Renewable primary energy as energy carrier	MJ	4.87E+00	2.27E+00	0.00E+00	3.20E+00	**1.03E+01**
PERM	Renewable primary energy resources as material utilization	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
PERT	Total renewable primary energy resources	MJ	4.87E+00	2.27E+00	0.00E+00	3.20E+00	**1.03E+01**
PENRE	Nonrenewable primary energy as energy carrier	MJ	1.47E+02	1.47E+01	4.90E-01	1.79E+01	**1.80E+02**
PENRM	Nonrenewable primary energy as material utilization	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
PENRT	Total nonrenewable primary energy resources	MJ	1.47E+02	1.47E+01	4.90E-01	1.79E+01	**1.80E+02**
SM	Use of secondary material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
RSF	Use of renewable secondary fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
NRSF	Use of nonrenewable secondary fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
RE	Energy recovered from disposed waste	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
FW	Use of net fresh water	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**

Results below contain the wastes and outflows throughout the life cycle of the product.

Table 7 - Waste and Outflows per Square Meter of Wet Coated Glass (4mm)

Wastes and Outflows						
Parameter	**Unit**	**Flat Glass**	**A1**	**A2**	**A3**	**Total**
Incineration with energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Incineration without energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Landfill (non-hazardous solid waste)	kg	1.70E-01	4.58E-01	0.00E+00	2.49E-01	**8.77E-01**
Hazardous waste	kg	8.11E-09	2.73E-08	0.00E+00	5.11E-09	**4.05E-08**
Recycling (landfill avoidance)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
High-level radioactive waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Intermediate- and low-level radioactive waste	kg	2.36E-04	5.59E-04	0.00E+00	1.70E-04	**9.64E-04**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Recovered energy exported from system	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Biogenic carbon content in product	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Biogenic carbon content in packaging	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Calcination Carbon Emissions	kg CO_2	1.98E-02	0.00E+00	0.00E+00	0.00E+00	**1.98E-02**
Carbonation Carbon Removals	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Process	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**

LCA Interpretation

The production of float glass dominates the impacts across all impact categories, except ozone depletion. This is due to the electricity and natural gas used to make the float glass. The wet coating raw materials (A1) drive the impacts in the ozone depletion.

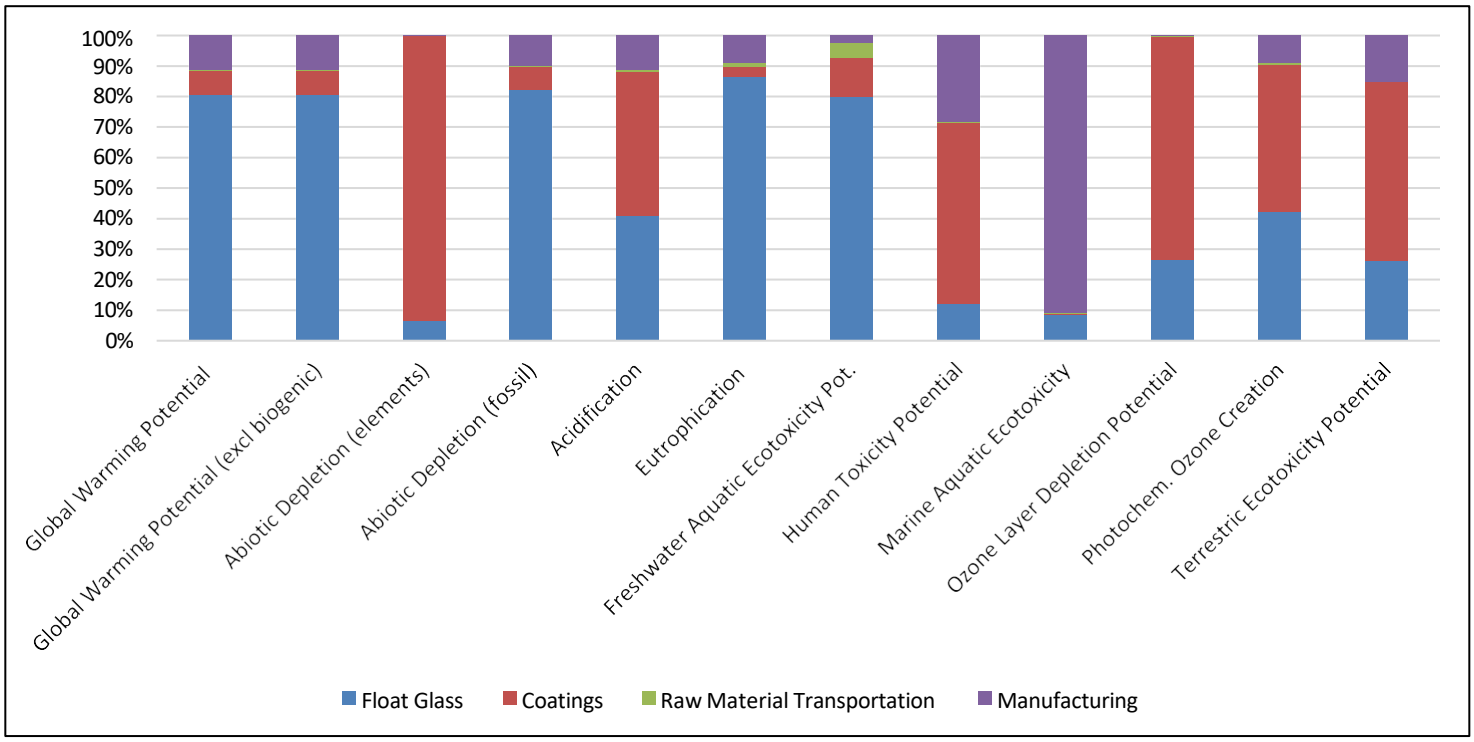

Figure 4 - Relative Contributions of Cradle to Gate Life Cycle Stages for Wet Coated Glass (4mm)

Glass can come in a variety of different sizes, but its impacts can be scaled to different glass thicknesses. For this EPD, results are reported with flat glass impacts reported separately in addition to the cradle to gate total for 4mm glass. To convert to other given thickness, please see the scaling factor above for different sizes in Table 11.
Multiply the flat glass results in Tables 5 through 7 by the scaling factors below using Equation 1 and then add the processing impacts (which are the total A1-A3 impacts found in the final column in each table minus the listed flat glass impacts).

Sputter Coated Glass Results per Square Meter Over the Building Lifetime of 75 Years

Results below show the life cycle impact assessment results throughout the product per CML Baseline 2001- April 2016 methodology. CML 2001 is a methodology used globally for life cycle impact assessments.

Table 8 - Life Cycle Impact Assessment Results per Square Meter of Sputter Coated Glass (4mm)

Rest of World: CML Impact Assessment							
Parameter Name		**Unit**	**Flat Glass**	**A1***	**A2**	**A3**	**Total**
GWP	Global warming potential	kg CO_2-Eq.	1.22E+01	0.00E+00	0.00E+00	1.61E+00	**1.38E+01**
ODP	Depletion potential of the stratospheric ozone layer	kg CFC-11 Eq.	5.62E-10	0.00E+00	0.00E+00	8.72E-12	**5.71E-10**
AP Air	Acidification potential for air emissions	kg SO_2-Eq.	4.94E-02	0.00E+00	0.00E+00	1.15E-02	**6.09E-02**
EP	Eutrophication potential	kg PO_4-Eq.	6.63E-03	0.00E+00	0.00E+00	6.38E-04	**7.27E-03**
POCP	Photochemical ozone creation potential	kg C_2H_4-Eq.	5.62E-10	0.00E+00	0.00E+00	5.98E-04	**5.98E-04**

Rest of World: CML Impact Assessment							
Parameter Name		**Unit**	**Flat Glass**	**A1***	**A2**	**A3**	**Total**
ADPE	Abiotic depletion (elements) [1]	kg Sb Eq.	4.92E-05	0.00E+00	0.00E+00	8.48E-08	**4.93E-05**
ADPF	Abiotic depletion (fossil)	MJ	1.47E+02	0.00E+00	0.00E+00	1.92E+01	**1.66E+02**

* A1: As the coating materials applied to the product are many magnitudes lower than the flat glass, due to rounding the values of the processing materials are negligible or cut-off.
[1] Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

Results below contain the resource use throughout the life cycle of the product.

Table 9 - Resource Use per Square Meter of Sputter Coated Glass (4mm)

Resource Use							
Parameter		**Unit**	**Flat Glass**	**A1***	**A2**	**A3**	**Total**
PERE	Renewable primary energy as energy carrier	MJ	5.21E+00	0.00E+00	0.00E+00	5.71E+00	**1.09E+01**
PERM	Renewable primary energy resources as material utilization	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
PERT	Total renewable primary energy resources	MJ	5.21E+00	0.00E+00	0.00E+00	5.71E+00	**1.09E+01**
PENRE	Nonrenewable primary energy as energy carrier	MJ	1.58E+02	0.00E+00	0.00E+00	1.98E+01	**1.77E+02**
PENRM	Nonrenewable primary energy as material utilization	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
PENRT	Total nonrenewable primary energy resources	MJ	1.58E+02	0.00E+00	0.00E+00	1.98E+01	**1.77E+02**
SM	Use of secondary material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
RSF	Use of renewable secondary fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
NRSF	Use of nonrenewable secondary fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
RE	Energy recovered from disposed waste	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
FW	Use of net fresh water	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**

* A1: As the coating materials applied to the product are many magnitudes lower than the flat glass, due to rounding the values of the processing materials are negligible or cut-off.

Results below contain the wastes and outflows throughout the life cycle of the product.

Table 10 - Waste and Outflows per Square Meter of Sputter Coated Glass (4mm)

Wastes and Outflows						
Parameter	**Unit**	**Flat Glass**	**A1***	**A2**	**A3**	**Total**
Incineration with energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Incineration without energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Landfill (non-hazardous solid waste)	kg	1.80E-01	0.00E+00	0.00E+00	7.56E-03	**1.88E-01**
Hazardous waste	kg	8.68E-09	0.00E+00	0.00E+00	7.94E-09	**1.66E-08**
Recycling (landfill avoidance)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
High-level radioactive waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Intermediate- and low-level radioactive waste	kg	2.52E-04	0.00E+00	0.00E+00	1.94E-04	**4.46E-04**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Recovered energy exported from system	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Biogenic carbon content in product	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**

Wastes and Outflows						
Parameter	**Unit**	**Flat Glass**	**A1***	**A2**	**A3**	**Total**
Biogenic carbon content in packaging	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Calcination Carbon Emissions	kg CO_2	2.11E+00	0.00E+00	0.00E+00	0.00E+00	**2.11E+00**
Carbonation Carbon Removals	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Process	kg CO_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**

* A1: As the coating materials applied to the product are many magnitudes lower than the flat glass, due to rounding the values of the processing materials are negligible or cut-off.

LCA Interpretation

The production of float glass drives the impacts across all impact categories, except global warming potential, eutrophication potential, and abiotic depletion for fossil resources where manufacturing (A3) is the driver. This is due to the electricity and natural gas used to make the float glass.

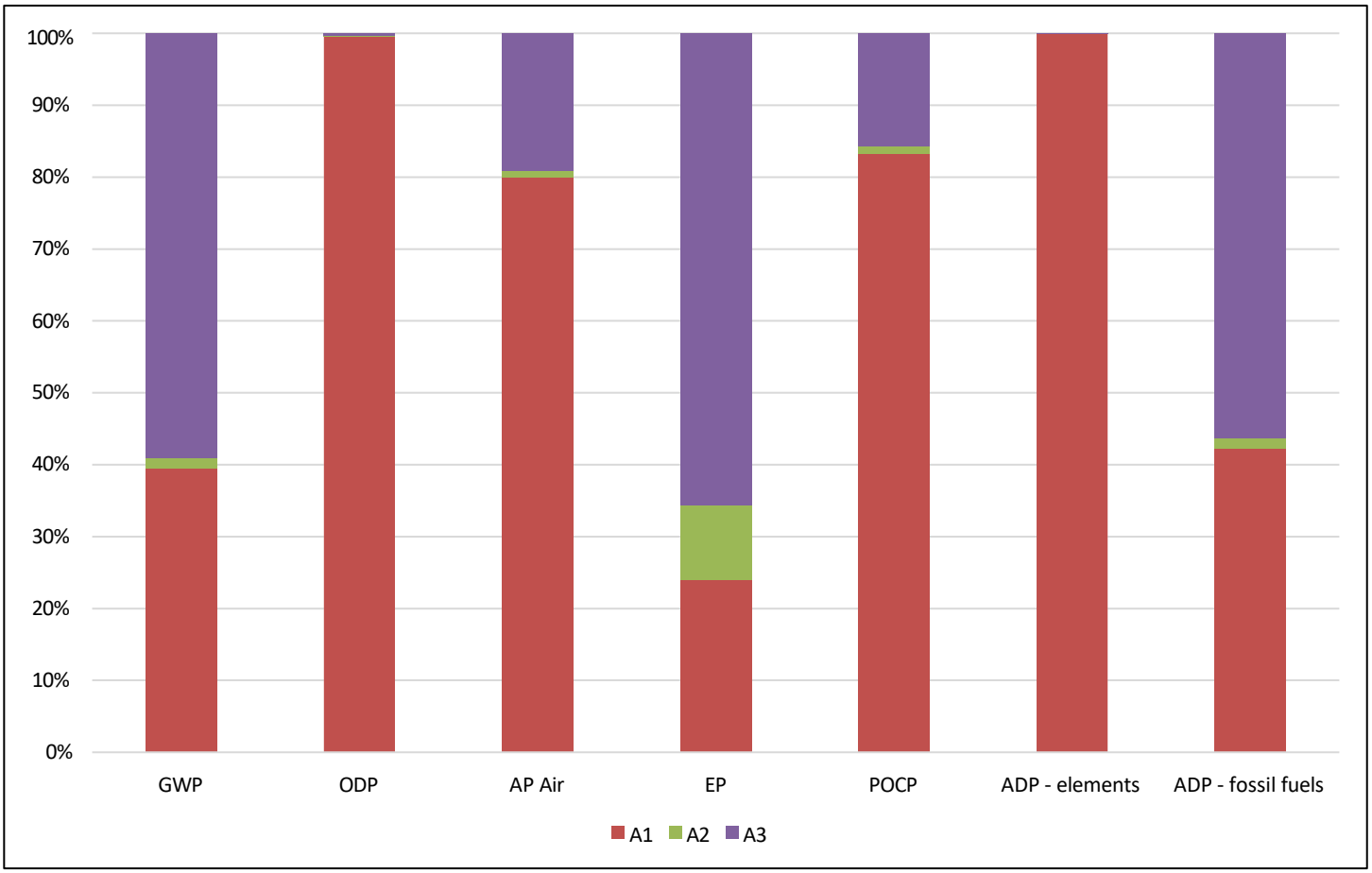

Figure 5 - Relative Contributions of Cradle to Gate Life Cycle Stages for Sputter Coated Glass (4mm)

Glass can come in a variety of different sizes, but its impacts can be scaled to different glass thicknesses. For this EPD, results are reported with flat glass impacts reported separately in addition to the cradle to gate total for 4mm glass. To convert the processed glass to other given thickness, please see the scaling factor below for different sizes. The equation and scaling factors are the same for both wet and sputter (vacuum) coated glass. Multiply the flat

glass results in Tables 8 through 10 by the scaling factors below using Equation 1 and then add the processing impacts (which are the total A1-A3 impacts found in the final column in each table minus the listed flat glass impacts).

Equation 1. A1-A3 Scaling Results to an Area at an Assumed Thickness

$$\begin{aligned} &Impact\ Assessment\ Result\ per\ m^2 \\ &= Scaling\ Factor\ at\ Desired\ Thickness\ (Table\ 7)\ x\ Flat\ Glass\ Impacts\ (Tables\ 4\ through\ 6) \\ &+ Coating\ Process\ Impacts\ (Total\ Impacts\ minus\ Flat\ Glass\ Impacts) \end{aligned}$$

Table 11 - Scaling Factors Used to Multiply the Results to Various Thicknesses

Thickness	Scaling Factor
2 mm	0.50
3 mm	0.75
4 mm	1.00
5 mm	1.25
6 mm	1.50
8 mm	1.75
10 mm	2.00
12 mm	2.25

Additional Environmental Information

Environmental and Health During Manufacturing

At Guardian Glass, our vision is to help people improve their lives by providing the products and services they value more highly than their alternatives. We do this responsibly, while consuming fewer resources; seeking mutually beneficial outcomes with customers, employees, suppliers, communities, and other key constituencies.

Our Stewardship Framework flows directly from this vision, describing our commitment and priorities around Environmental, Social and Governance (ESG) topics. Stewardship broadly encompasses the responsible management of our actions and the resources entrusted to our care in a manner that respects the rights of others.

Guardian has invested in socially responsible policies and practices to help our businesses embed stewardship into the company culture and business decisions. Through responsible practices in the areas of environmental management and health and safety, Guardian's goal is to reduce potential environmental impacts to the communities in which it operates and create an exceptional workplace for its employees.

The safety and well-being of our employees and communities is our first priority. We build capability through our employees and resilience in our systems to prevent serious outcomes when the unexpected happens. We promote a principle-based, bottom-up approach to safety, involving front-line employees and supervisors in the identification of hazards and implementation of solutions all around the world. Each person is expected to raise concerns and share ideas about opportunities for improvement. Each manufacturing site has completed a risk evaluation that identified priorities with a focus on critical hazards. Action plans are developed, and knowledge networks are leveraged across the organization to better manage risk in those areas.

We pride ourselves on being solution providers, especially in the context of environmental stewardship, which involves considering each stage of the life cycle – from the sourcing of raw materials for each product, through to its production, application and end-of-life. Our approach to environmental stewardship is twofold – we strive to discover new and innovative technologies that improve both the environmental performance and effectiveness of our manufacturing processes and of our products.

We're committed to improving the energy efficiency of our manufacturing processes and reducing our use of resources. One way to achieve these is to maximize the amount of glass cullet (broken or old glass) used. Wider use of cullet in the glass manufacturing process helps to reduce consumption of virgin raw materials, save energy and reduce emissions. In line with our environmental stewardship priorities, Guardian Glass has started various initiatives aiming to use more cullet

in glass manufacturing instead of virgin raw materials. The ratio of cullet in batch and glass can vary from site to site and over time, depending on cullet availability.

Extraordinary Effects

There are no known negative effects from the use of this product during fire, water, or mechanical destruction.

Delayed Emissions

Global warming potential is calculated using the CML 4.1 impact assessment methodologies. Delayed emissions are not considered.

Environmental Activities and Certifications

In an effort to provide greater support to the architects and designers who strive to meet increasingly stringent regulations, codes and standards and achieve ratings within various global building rating systems such as LEED and BREEAM, Guardian Glass provides product and regionally specific documents and certifications to communicate transparent information about the life-cycle environmental impact of many of our products. More information on Guardian Glass's product certifications and declarations is available at www.guardianglass.com.

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