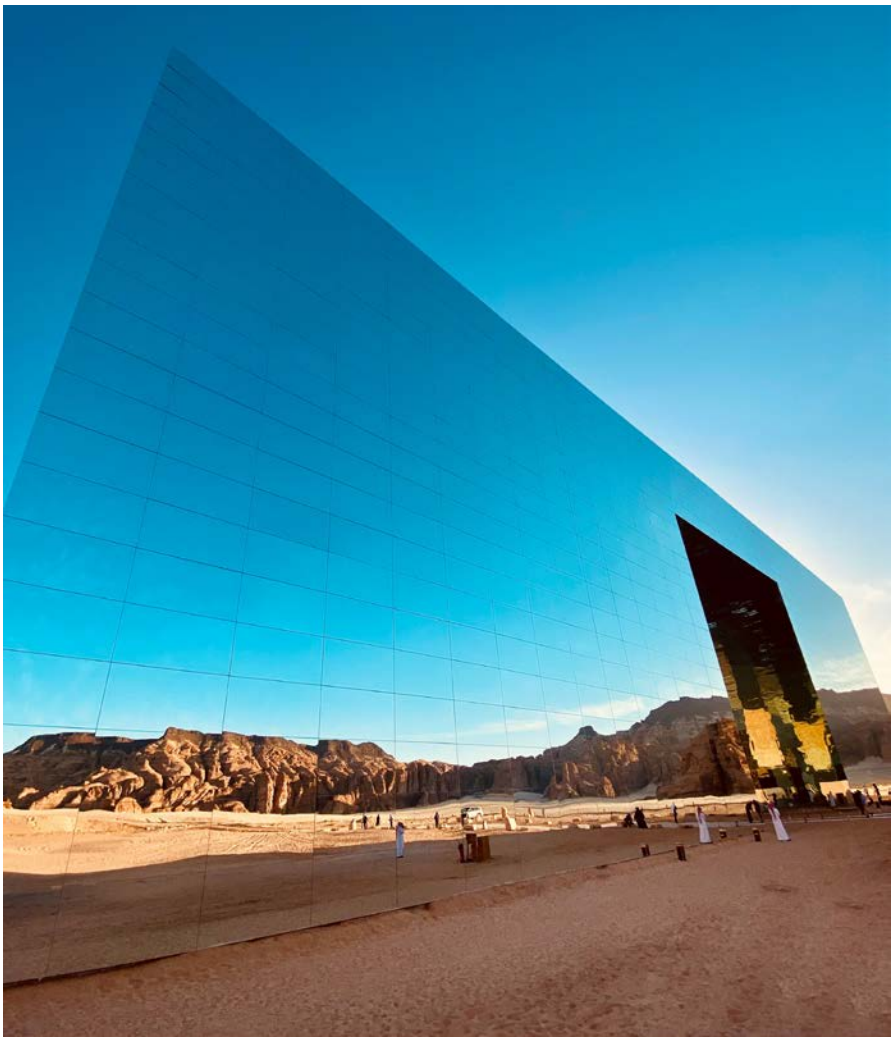
ENVIRONMENTAL PRODUCT DECLARATION

PROCESSED GLASS

GUARDIAN GLASS
AME & I REGION



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

This EPD was not written to support comparative assertions. Even for similar produc differences in declared unit, use and end-of-life stage assumptions and data quality produce incomparable results. It is not recommended to compare EPDs with anothe organization, as there may be differences in methodology, assumptions, allocation methods, data quality such as variability in data sets and results of variability in assessment software tool.

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 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 occupant's well-being and low-emissivity glass reduces energy consumption for heating and cooling.

By publishing this EPD, Guardian Glass intends to support architects and designers who strive to enhance the sustainability 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 green building rating systems.

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
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ENVIRONMENTAL PRODUCT DECLARATION

GUARDIAN PROCESSED
GLASS AME & I REGION

According to ISO 14025 & EN 15804

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. 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 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, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. 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.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Gujarat Guardian Limited
DECLARATION NUMBER	4788827138.102.1
DECLARED PRODUCT	Guardian Processed Glass
REFERENCE PCR	UL PCR Part B: Processed Glass v.1.0 2016
REFERENCE PCR STANDARD	☒ EN 15804 (2012) ☐ ISO 21930 (2007) ☐ ISO 21930 (2017)
DATE OF ISSUE	July 1, 2020
PERIOD OF VALIDITY	5 Years
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	UL Environment
	PCR Review Panel
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin
	Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria
	Thomas Gloria, Industrial Ecology Consultants

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Product System

Company Description

Guardian Industries, a global company headquartered in Auburn Hills, Michigan, employs 18,000 people and operates facilities throughout North America, Europe, South America, Africa, Middle East, and Asia.

Guardian Glass is the go-to solutions provider for the global glass industry, whether you want to solve a practical problem or challenge architectural conventions. With the infrastructure, know-how and capability to work with the entire supply chain, we are ready to embrace a future where glass is an even greater part of what the world builds. We are here to help you realize your vision, overcome obstacles and be partners in your progress.

We are one of the world's largest glass manufacturers with leading positions in float and fabricated glass products for commercial, residential, interior, technical and transportation applications. We aim to create value for our customers and society and to constantly innovate to improve the value we create.

We also pride ourselves on creating a work environment that recognizes and celebrates individuality, teamwork, and success. The foundation of our culture rests upon our Guiding Principles. Our entrepreneurial spirit encourages employees to think bigger and creates opportunities to learn from and collaborate with very skilled and knowledgeable mentors. Award-winning scientists and engineers at our Science & Technology Center are constantly working to create new glass products and solutions using the most advanced technologies.

Guardian Glass is part of Guardian Industries, a wholly owned subsidiary of Koch Industries, Inc. Koch companies conduct their worldwide operations in compliance with all relevant environmental laws and regulations, while protecting the health and safety of their customers, employees, and neighbors. In 2017, Koch was awarded the U.S. Environmental Protection Agency’s ENERGY STAR Partner of the Year Award.

Product Description

Guardian Glass brings the process and results of glassmaking to new levels, applying deep knowledge of chemistry, physics and advanced technologies to create glass with optimal light transmission, clarity and integrity for custom treatments and fabrication. As part of the Guardian Glass manufacturing process, sputter-coatings can be deposited on the glass to support application based energy performance and occupant comfort. These coatings also facilitate aesthetics involving light transmission, color and reflectivity.

This EPD is valid for the following processed glass product produced in AME & I region from Guardian Glass including those that are Vacuum Sputter Coated & Wet-Coated Glass.

For more information about these products, please visit www.guardianglass.com or email info@guardianglass.com.

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Low-emissivity and solar control coated glass specifically designed for a wide variety of commercial applications, including office buildings, high-rise apartments, schools, hospitals, libraries, government buildings and more.

Guardian SunGuard® Solar product range is the versatile product range for any project. With a flexible colour and light transmission range, the Solar products provide industry leading solar protection and aesthetic quality.

Guardian SunGuard® Solar	Silver 20	Grey 33	Light Blue 52
	Royal Blue 20	Neutral 34	Neutral 67
	Silver Grey 32	Silver Grey 40	

Guardian introduces the High Durable Colors series with enhanced coating resistance, coupled with vivid and clear colour reproduction. SunGuard® HD Colors not only looks fantastic from the outside, but also enables you to see clearly and without any distortions from the interiors.

Guardian SunGuard® High Durable Colors	HD Blue	HD Grey	
	HD Green	HD Bronze	

Guardian High Performance® range of products provide industry leading solar protection as well as thermal protection for all season protection. It is available in a range of distinctive colour and light transmission choices to suit any project.

Guardian SunGuard® High Performance	Gold 31	Royal Blue 40	Neutral 60
	Silver 35	Neutral 40	Neutral 70
	Silver 40	Neutral Plus 50	

Guardian SunGuard® Double Silver range provides a wide range of colours with high selective performance. For commercial projects that want to stand out from the rest.

Guardian SunGuard® Double Silver	DS 30	DS Blue	DS Emerald Green T
	DS 40	DS Bronze	DS Steel Grey T
	DS Neutral 40	DS Silver	
	DS 50	DS Grey	

GUARDIAN PROCESSED GLASS
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Guardian ClimaGuard® range of products provide all season thermal protection with very high light transmission. Can be used on surface #2 or on Surface #3, in combination with a Solar or HD product or alone.

ClimaGuard®	Neutral 70	Premium 2 S	Sun T
	Neutral 70 D	Shadow Grey T	

Guardian SunGuard® HD Plus is the modern standard for residential products_ With a wide range of vibrant colours and excellent solar protection it meets the required standards for residential building codes.

SunGuard® High Durable Plus	HD Plus Blue T	HD Plus GREEN T	HD Plus Grey T
	HD Plus Blue-Green T	HD Plus Bronze T	

Guardian SunGuard® SuperNeutral product range offers the highest selectivity available within the region. It comes in a neutral colour with a wide range of light transmission to fit any architectural design, no matter how iconic.

SunGuard® Super Neutral	SN 30 T	SN 50 T	SN 66 T
	SN 40 T	SN 60 T	SN 70 T

Mirror and Decorative Glass used for Interior application

Guardian Ultra Mirror®	Clear
MODIGUARD® Ultra Mirror®	Clear
Guardian DecoCristal®	Deco black
MODIGUARD® DecoCristal®	Deco black

Application

Guardian Glass products are designed for a variety of interior and exterior commercial, residential, technical and transportation applications as outlined in the product description section above. Guardian Glass typically supplies float glass and coated glass to fabricator customers who fulther process that glass into the final product by cutting, heat-treating, laminating, insulating or othemise 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. Guardian glass may also be used in a range of transportation and specialty glass applications.

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Technical Data

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

Technical data on MODIGUARD® products is available on www.gujaratguardianglass.com

Properties of Declared Product as Delivered

Products are either cut to customers' specified dimensions or supplied in common stock sizes for further processing by customers. Common dimension of processed glass includes.

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

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

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

Additionally, some standard thicknesses for wet-coated glass includes:

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

Declaration Type: Business-to-business

Period of Validity: 5 years

Geographic Scope:This EPD is valid for processed glass products sold in Africa, Middle East & India (AME & I) from Guardian Glass.

Additional Notes: Further processing of processed glass like coating, tempering, laminating etc are beyond the scope of this EPD. This EPD is based on production data of processed glass for 2018 collected from Guardian Glass plants located in Egypt, Saudi Arabia, UAE & India.

Placing on the Market

The products validated in this EPD conforms to BS EN 1096 & SASO 1096 for Vacuum Sputter Coated products and EN 1036, JIS R 3220, & SASO 1036 for WetCoated products.

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Base and Ancillary Materials

Float glass is made by floating molten glass on a bed of molten tin. It is manufactured from raw materials such as silica sand, soda ash, dolomite, limestone and 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.

The float glass product is then processed by either coating or heat treating—or sometimes both, depending on application needs. Guardian processed glass products are similar in composition to clear float glass but include slight additions of trace elements to achieve required optical properties. Please refer to the Guardian Glass Health Product Declaration for additional information.

Manufacture

Float glass production involves heating the raw materials to a molten 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.

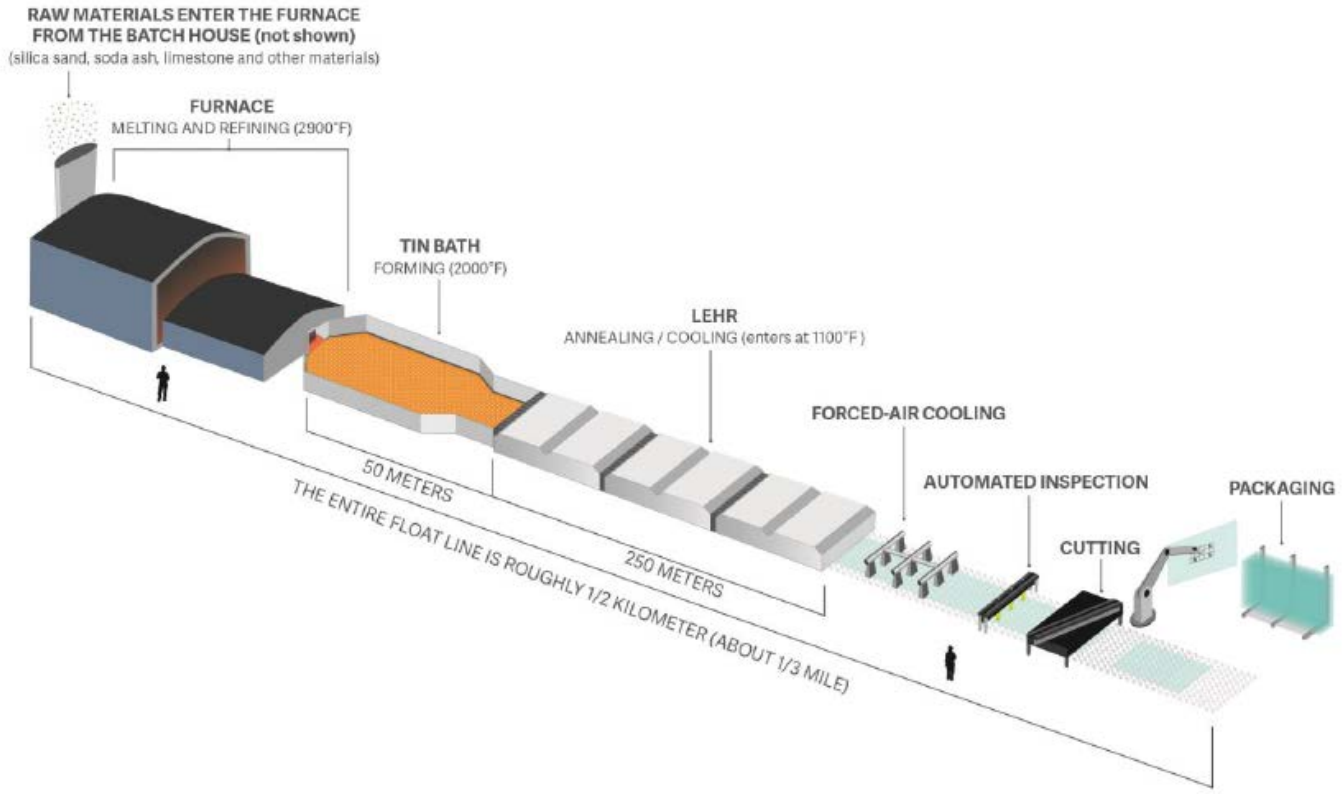

Figure 1: Float Glass Production

Manufacturing of 'Float Glass' product in AME & I region is done at Guardian facilities as Guardian Egypt, "Egypt"; Saudi Guardian International Float Glass Ltd, "Saudi Arabia"; Guardian Zoujaj International Float Glass Co. L.L.C, "United Arab Emirates" & Gujarat Guardian Ltd, "India"

Coated products - Following the production of float glass, the product is then coated and/or heat treated. Coating takes place via magnetron sputter deposition. The exact coating composition and thickness depends on the application. Some coatings require heat activation, in which case the glass is subsequently heat treated. Both coated and uncoated glass can also be tempered (e.g., heat treated) in order to adjust its properties. The finished glass is then packaged and shipped to customers.

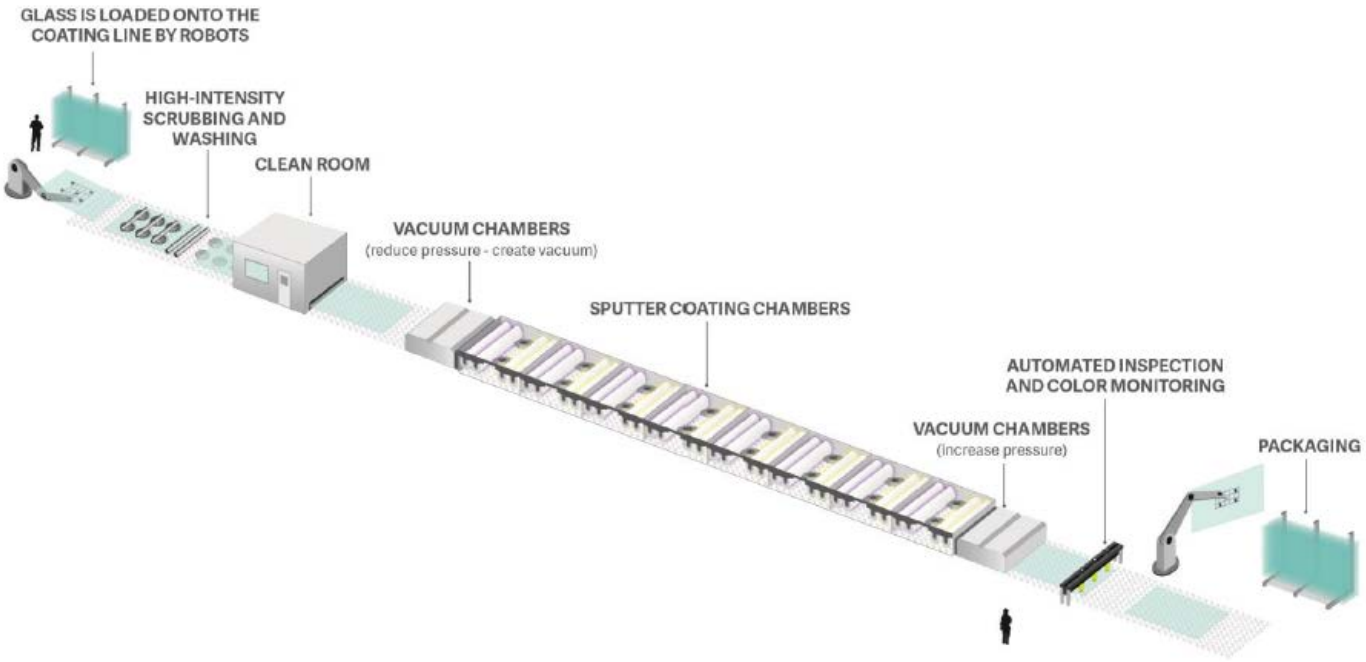

Figure 2: Coated Glass Production

Manufacturing of 'Vacuum Sputter Coated Glass' product in AMEI region is done at Saudi Guardian International Float Glass Ltd, Saudi Arabia; Guardian Zoujaj International Float Glass Co. L.L.C "Guardian RAK", U.A.E; Gujarat Guardian Ltd, "India".

Mirror & Deco products - Wet-Coated line produces high quality silvered mirror & decorative glass on raw glass sourced from its float line. Following the production of float glass, the product is then wet-coated, and Infrared (IR) cured for producing mirror & decorative glass. This process takes place in wet-coating facility, where for Mirror a reflective layer of silver chemically bonds with the glass. This reflective layer is protected by application of passivator and activator chemicals along with alkyd/acrylic resin-based paint. Deco glass process involves application of adhesion promoter layer followed by layer of alkyd/acrylic resin-based paint. The finished glass is then packaged and shipped to customers.

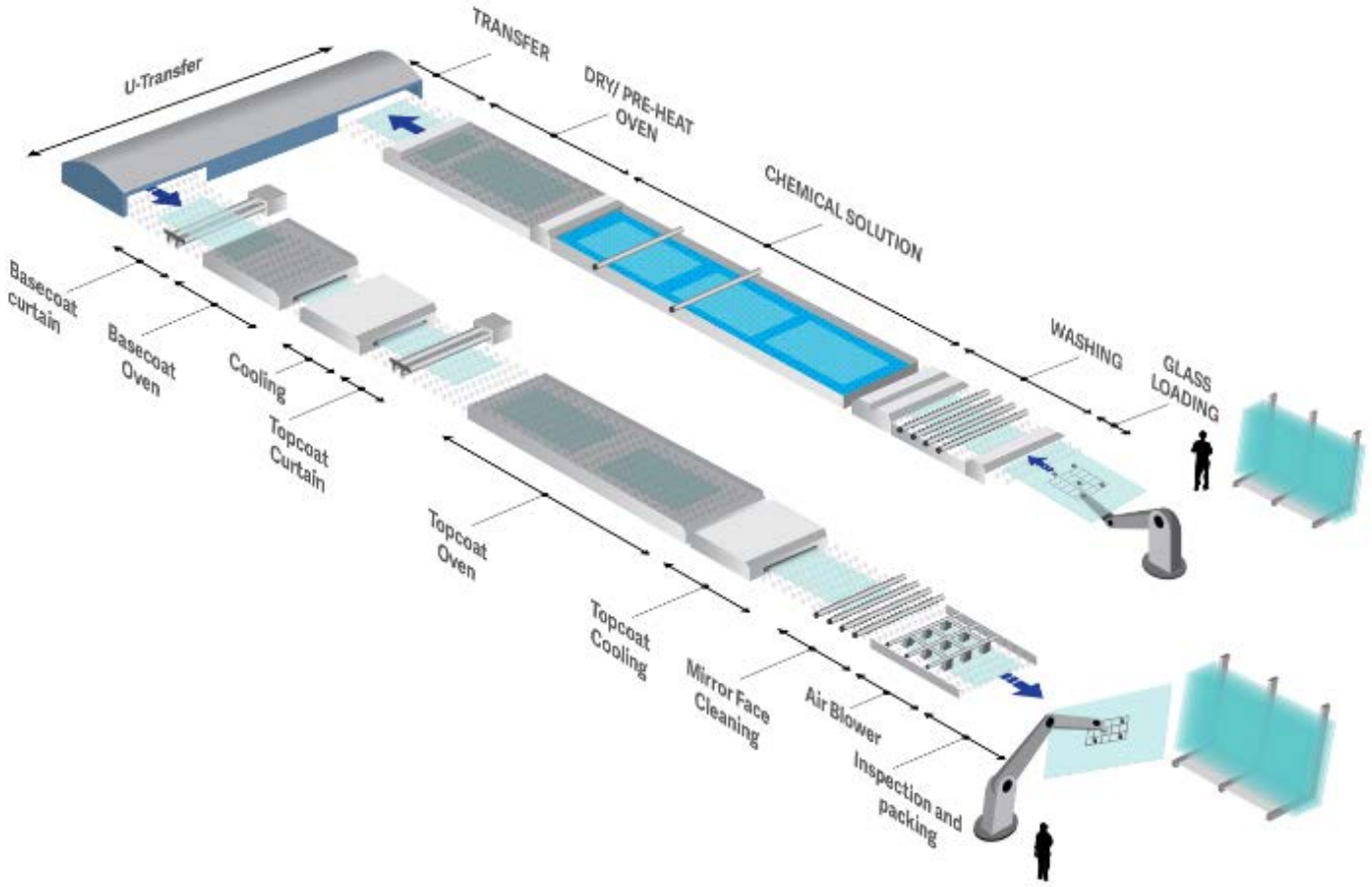

Figure 3: Mirror & Deco Glass Production

Manufacturing of 'Mirror & Deco Glass' product in AMEI region is done at Saudi Guardian International Float Glass Ltd, Saudi Arabia & Guardian facilities as Gujarat Guardian Ltd, "India".

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Environment and Health during Manufacturing

Guardian Glass implements measures to reduce waste and reuse/recycle materials internally within its manufacturing processes. Consistent with industry practice, batch ingredients include "cullet", broken glass from prior in-plant ribbon-trimming operations and other potential sources. A limited amount of cullet from outside the plant may be implemented if it complies with Guardian's rigorous quality criteria. The use of cullet helps to moderate consumption of batch materials and furnace fuel, both affecting carbon dioxide (CO_2) emissions.

Guardian Glass benefits from recycling in several ways. Although never 100% recycled, the recycled glass used reduces CO_2 process emissions and consumption of virgin raw materials; extends the life of plant equipment (such as furnaces); and saves energy. Recycled glass is always part of the recipe for glass, and the more that is used, the greater the decrease in energy used in the furnace. This makes using recycled glass profitable in the long run — lowering costs and benefiting the environment while ensuring greater product sustainability without negatively impacting quality.

Product Processing / Installation

Guardian Glass products should be processed and installed according to best industry standards and according to all applicable building codes in the given jurisdiction.

Packaging, Handling and Storage

Guardian Glass products in the AMEI region are primarily packaged or boxed in wooden crates and handled through the use of forklifts & cranes with spreader bar/box lifting booms & pack lifters. Open glass packs are typically stored with polystryene foam or rubber used as a separator and handled with forklifts or cranes with nylon salings or side loaders. Various types of racks are used for storage in the warehouse with glass shipped to the customers utilizing trucks & containers.

For all handling and storage related activities, extreme care is required as the greatest risks are lacerations from cut/broken glass and injury from falling glass. Due to the risk of serious injuries as a result of improper handling and transportation, it is imperative that all persons involved in the handling and storage of glass receive proper training, wear adequate personal protective equipment and adhere to all best handling and safety procedures.

Conditions of Use

Float glass products are used in applications ranging from equipment components to transportation vehicles and architectural products. 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.

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Environment and Health during use

The life cycle assessment is conducted for a cradle-to-gate system boundary, as per UL Environment (2014) PCR for Building-Related Products and Services – Part A: Calculation Rules for the LCA and Requirements Project Report, (IBU/UL E,V1.3, 06.19.2014) and UL Environment (2016) Part B: PCR Guidance for Building-Related Products and Services: Processed Glass EPD Requirements (UL E, V1.0 Aug. 2016). Life cycle stages and environmental impacts downstream of Guardian's North America float glass facilities are not included in this declaration. Additionally, transportation to waste or scrap facilities is excluded from the system boundary, as are capital goods, infrastructure, and personnel-related activities.

Reference Service Life

As this analysis does not include the use stage of the glass, no reference service life is declared for Guardian's processed glass products.

Distribution, Use, and end of Life

Upon leaving Guardian Glass facilities, float glass can be further processed through a nationwide network of independent fabricators. Racks used for distribution of glass are reused many times both in the manufacturing plants and shipped to the customer and returned to Guardian Glass plants.

Glass should be installed according to industry standards and according to all applicable building codes in the given jurisdiction. Glass should be washed frequently to remove surface dirt and to protect the glass from staining. Glass staining occurs when the sodium within the glass reacts with moisture in the air. Sodium, when combined with small amounts of water, can create sodium hydroxide, which is corrosive to glass.

Once installed, Guardian Glass products do not consume energy or require maintenance beyond general cleaning to fulfill their estimated service life. At end-of-life, glass is typically landfilled and in some instances recycled.

Further Information

Further information about Guardian Glass products is available at www.guardianglass.com

Further information about MODIGUARD® products is available at www.gujaratguardianglass.com

LCA Calculation Rules

Declared Unit

Attributional approch has been taken in this study and declared unit is 1 m^2 of 'Coated Glass' and 'Mirrors'.

Name	Unit	Coated Glass	Mirrors
Declared Unit	mm	1	1
Mass per piece	kg / m^2	10	10
Conversion factor to 1 Kg	m^2 / kg	0.1	0.1
Thickness	mm	4	4

The geographical coverage of the study is India, Saudi Arabia and UAE. Recent data from 2018-19 have been collected to model this LCA study.

System Boundary

The reference products, as per PCRs ["UL Environment (2014) PCR for Building-Related Products and Services – Part A: Calculation Rules for the LCA and Requirements Project Report, (IBU/UL E,V1.3, 06.19.2014)"] and ["UL Environment (2016) Part B: PCR Guidance for Building-Related Products and Services: Processed Glass EPD Requirements (UL E, V1.0 Aug. 2016)"], are "coated glass" and "mirror." Environmental impacts from raw material extraction and energy flows, manufacturing, packaging, and storage are to be calculated per the PCR. The PCR does not include the use phase or end of life phase. Also capital goods, infrastructure, personnel-related activities, waste treatment facilities, etc are not included in EPD.

A1: Raw Material Supply: Upstream extraction and processing of raw materials and secondary materials used as input.

A2: Raw Material Transportation: Transportation of raw materials through road, pipeline, and sea routes up to factory gate.

A3: Manufacturing: Manufacturing of products and co-products. This also includes packaging materials and waste material treatment.

Raw materials like silica sand, soda ash, limestone, dolomite, feldspar, sodium sulphate etc are procured from suppliers and brought to production facility through in-bound transportation. These raw materials are converted into finished product at Guardian's manufacturing plants. The finished product is packed and stored for delivery.

Estimates and Assumptions

Due to limitations in data availability, assumptions were made in selection of appropriate processes for manufacturing inputs like materials, natural gas, electricity and facility emissions. The allocation approaches taken may, therefore, overestimate the environmental burden for float glass production.

Additionally, the "average" glass pane used in modeling is a calculated average pane thickness and area and does not a specific product manufactured by Guardian Glass.

Background Data

Regional and national averages for fuel inputs, electricity grid mixes, materials, transportation, and disposal methods were obtained from the GaBi (2019) Service Pack 37 database. Documentation for all Gabi datasets can be found at www.gabi-software.com/international/databases/gabi-databases/.

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Raw Material Composition of Coated Glass and Mirror

The raw material composition for the 'Coated Glass' product is shown below. Data captured here are approximate.

Raw Material Composition of Coated Glass [10 kg]

Sl. No.	Raw Materials	In Kg per declared unit	% of total Weight
1	Glass	9.944	> 99
2	Aluminum	0.002	< 0.02

The raw material composition for the 'Mirror' product is shown below. Data captured here are approximate.

Raw Material Composition of Mirrors [10 kg]

Sl. No.	Raw Materials	In Kg per declared unit	% of total Weight
1	Glass	9.7 - 9.9	97 - 99
2	Paint	0.1 - 0.2	1 - 2
3	Silver	0.0007 - 0.0008	0.007 - 0.008

Data Quality

A number of tests and checks were performed throughout the project to ensure the high quality of the completed LCA. Checks included relevance of selected processes, review of LCA model, as well as the background data used.
Data included first-hand company manufacturing data in combination with consistent background LCI information from the GaBi (2019) Service Pack 37 database.

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Period Under review

The data are representative of production at Saudi Guardian International Float Glass Ltd, Saudi Arabia; Guardian Zoujaj International Float Glass Co. L.L.C "Guardian RAK", U.A.E and Gujarat Guardian Ltd, India; plants for the 2018 calendar year.

Allocation

Allocation by mass has been used to model mirror, coated glass, and their cullets. No material was sent off site for recycling. The external cullet brought to plant was purchased at every location. The purchased price for external cullet was different for every plant. Internal cullet process, assumed to have a similar burden, is used to model external cullet plus transportation.

Cut-Off Rules

Mass and energy flows having less than 1% environmental burden are not considered in this study. Flocculant [SNF5640] used for washing, LPG, transportation of water, oxygen, nitrogen, hydrogen through pipeline from a very short distance etc have not been considered. No known flows are deliberately excluded from this EPD.

Comparability

A comparison or evaluation of EPD data is possible only when all data sets to be compared are 1) created according to EN 15804 and 2) are considered in a whole building context or utilize identical defined use stage scenario. Given this PCR is cradle-to-gate in scope, comparison of EPD data from one product to another are not allowed.

Comparison of the environmental performance of processed glass using EPD information shall be based on the product's use and impacts at the building level; therefore, EPDs may not be used for comparability purposes when not considering the building energy phase as instructed under this PCR.

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LCA Results

As per PCR cradle to gate phase results are calculated for the declared unit 1m^2 for every glass type and mirror. The coated glass and mirrors are available in many thicknesses. However, results have been calculated and presented for 1 m2 of 4mm size for every glass type. The lower heating value is used for all energy results.

Life Cycle Impact Assessment Results per declared unit for Coated Glass

Parameter	Parameter	Unit	A1. Raw Materials	A2. Raw Material Transport	A3. Manufacturing	A1 – A3 Total
TRACI 2.1						
GWP	Global warming (GWP100a)	kg CO2 eq	1.08E+01	7.58E-02	3.34E+00	1.425E+01
ODP	Stratospheric ozone layer depletion potential	kg CFC-11 eq	1.10E-11	2.58E-12	1.31E-13	1.37E-11
AP	Acidification potential	kg SO2 eq	1.13E+00	4.36E-02	2.29E-01	1.40E+00
EP	Eutrophication potential	kg N eq	5.83E-02	1.34E-03	3.75E-02	9.71E-02
POCP	Photochemical ozone creation potential	kg O3 eq	2.86E-03	8.15E-05	4.62E-02	3.67E-03
CML 4.1						
GWP	Global warming (GWP100a)	kg CO2 eq	1.09E+01	7.61E-02	3.36E+00	1.43E+01
ODP	Stratospheric ozone layer depletion potential	kg CFC-11 eq	1.18E-11	2.57E-12	1.45E-13	1.45E-11
AP	Acidification potential	kg SO2 eq	5.06E-02	1.00E-03	4.08E-02	9.24E-02
EP	Eutrophication potential	kg PO4--- eq	7.42E-03	2.32E-04	1.64E-03	9.29E-03
POCP	Photochemical ozone creation potential	kg C2H4 eq	2.22E-03	6.67E-05	1.90E-03	4.19E-03
ADP, elements	Abiotic resource depletion potential, minerals	kg Sb eq	3.46E-05	3.19E-10	3.40E-05	6.87E-05
ADP, fossil fuels	Abiotic resource depletion potential, fossil fuels	MJ	1.42E+02	9.75E-01	3.63E+01	1.79E+02

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Life Cycle Impact Assessment Results per declared unit for Mirror

Parameter	Parameter	Unit	A1. Raw Materials	A2. Raw Material Transport	A3. Manufacturing	A1 – A3 Total
TRACI 2.1						
GWP	Global warming (GWP100a)	kg CO2 eq	1.28E+01	5.31E-02	1.58E+02	1.71E+02
ODP	Stratospheric ozone layer depletion potential	kg CFC-11 eq	1.36E-11	1.81E-12	-6.74E-13	1.47E-11
AP	Acidification potential	kg SO2 eq	1.23E+00	3.06E-02	1.54E+01	1.66E+01
EP	Eutrophication potential	kg N eq	7.92E-02	9.40E-04	1.71E+00	1.79E+00
POCP	Photochemical ozone creation potential	kg O3 eq	3.72E-03	5.71E-05	3.78E-02	4.20E-02
CML 4.1						
GWP	Global warming (GWP100a)	kg CO2 eq	1.29E+01	5.32E-02	1.58E+02	1.72E+02
ODP	Stratospheric ozone layer depletion potential	kg CFC-11 eq	1.46E-11	1.80E-12	2.34E-13	1.67E-11
AP	Acidification potential	kg SO2 eq	7.38E-02	7.03E-04	1.83E+00	1.91E+00
EP	Eutrophication potential	kg PO4--- eq	8.10E-03	1.63E-04	8.58E-02	9.41E-02
POCP	Photochemical ozone creation potential	kg C2H4 eq	3.72E-03	4.72E-05	9.38E-02	9.75E-02
ADP, elements	Abiotic resource depletion potential, minerals	kg Sb eq	3.44E-04	2.19E-10	6.74E-06	3.50E-04
ADP, fossil fuels	Abiotic resource depletion potential, fossil fuels	MJ	1.81E+02	6.82E-01	1.62E+03	1.80E+03

Resource Use per declared unit for Coated Glass

Parameter	Parameter	Unit	A1. Raw Materials	A2. Raw Material Transport	A3. Manufacturing	A1 – A3 Total
PERE	Renewable primary energy as energy carrier	[MJ, LHV]	1.25E+01	5.48E-04	5.24E+00	1.78E+01
PERM	Renewable primary energy resources as material	[MJ, LHV]	-	-	-	-
PERT	Total use of renewable primary energy resources	[MJ, LHV]	1.25E+01	5.48E-04	5.24E+00	1.78E+01
PENRE	Non-renewable primary energy as energy carrier	[MJ, LHV]	1.45E+02	9.83E-01	3.73E+01	1.83E+02
PENRM	Non-renewable primary energy resources as material	[MJ, LHV]	-	-	-	-
PENRT	Total use of non-renewable primary energy resources	[MJ, LHV]	1.45E+02	9.83E-01	3.73E+01	1.83E+02
SM	Use of secondary material	[MJ, LHV]	-	-	-	-
RSF	Use of renewable secondary fuels	[MJ, LHV]	-	-	-	-
NRSF	Use of non-renewable secondary fuels	[MJ, LHV]	-	-	-	-
FW	Use of net fresh water	[m^3]	4.19E+03	2.26E-01	8.33E+03	1.25E+04

Resource Use per declared unit for Mirror

Parameter	Parameter	Unit	A1. Raw Materials	A2. Raw Material Transport	A3. Manufacturing	A1 – A3 Total
PERE	Renewable primary energy as energy carrier	[MJ, LHV]	2.48E+01	3.75E-04	2.07E+02	2.32E+02
PERM	Renewable primary energy resources as material	[MJ, LHV]	-	-	-	-
PERT	Total use of renewable primary energy resources	[MJ, LHV]	2.48E+01	3.75E-04	2.07E+02	2.32E+02
PENRE	Non-renewable primary energy as energy carrier	[MJ, LHV]	1.87E+02	6.88E-01	1.67E+03	1.86E+03
PENRM	Non-renewable primary energy resources as material	[MJ, LHV]	-	-	-	-
PENRT	Total use of non-renewable primary energy resources	[MJ, LHV]	1.87E+02	6.88E-01	1.67E+03	1.86E+03
SM	Use of secondary material	[MJ, LHV]	-	-	-	-
RSF	Use of renewable secondary fuels	[MJ, LHV]	-	-	-	-
NRSF	Use of non-renewable secondary fuels	[MJ, LHV]	-	-	-	-
FW	Use of net fresh water	[m^3]	6.75E+03	1.55E-01	4.05E+05	4.12E+05

Output flows and waste categories per declared unit for Coated Glass

Parameter	Parameter	Unit	A1. Raw Materials	A2. Raw Material Transport	A3. Manufacturing	A1 – A3 Total
HWD	Hazardous waste disposed	[kg]	1.84E-07	1.51E-11	2.45E-08	2.08E-07
NHWD	Non-hazardous waste disposed	[kg]	1.47E+01	2.25E-04	1.14E+01	2.61E+01
RWD	Radioactive waste disposed	[kg]	-	-	-	-
CRU	Components for re-use	[kg]	-	-	-	-
MFR	Materials for recycling	[kg]	-	-	-	-
MER	Materials for energy recovery	[kg]	-	-	-	-
EE	Exported energy	[MJ, LHV]	-	-	-	-

Output flows and waste categories per declared unit for Mirror

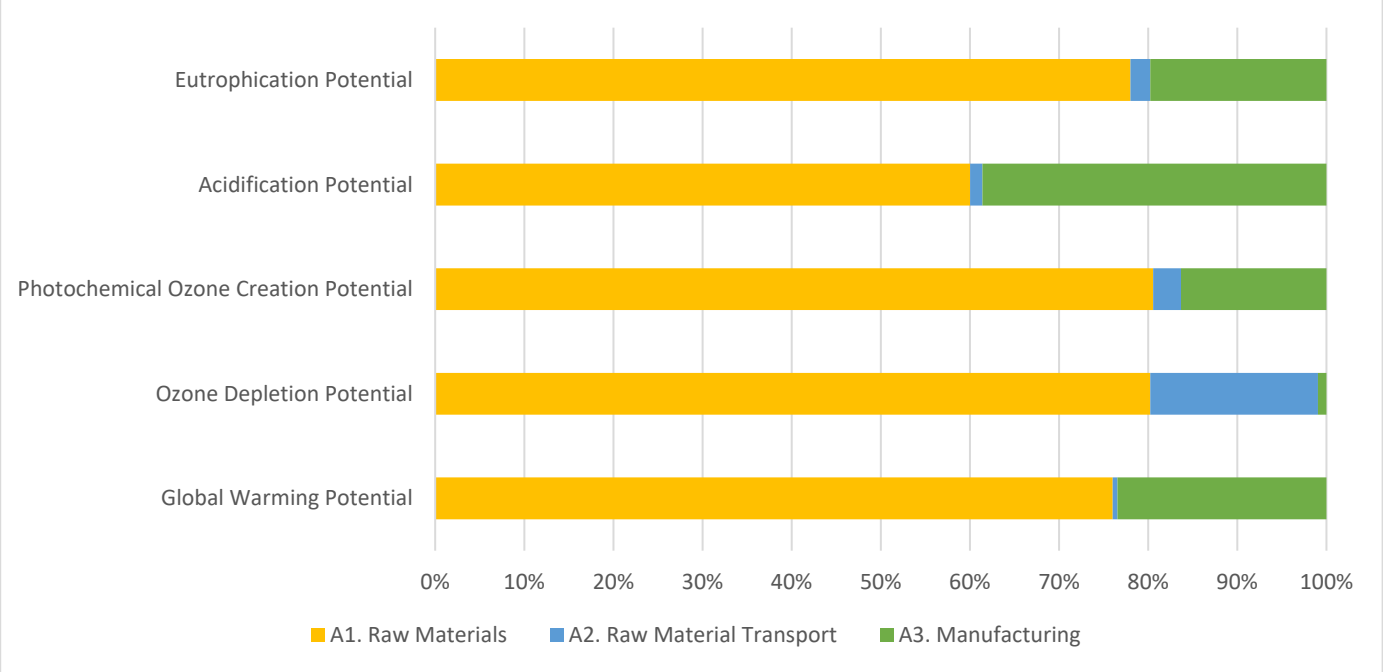
Parameter	Parameter	Unit	A1. Raw Materials	A2. Raw Material Transport	A3. Manufacturing	A1 – A3 Total
HWD	Hazardous waste disposed	[kg]	3.06E-07	1.03E-11	1.30E-06	1.61E-06
NHWD	Non-hazardous waste disposed	[kg]	2.52E+01	1.54E-04	5.14E+02	5.39E+02
RWD	Radioactive waste disposed	[kg]	-	-	-	-
CRU	Components for re-use	[kg]	-	-	-	-
MFR	Materials for recycling	[kg]	-	-	-	-
MER	Materials for energy recovery	[kg]	-	-	-	-
EE	Exported energy	[MJ, LHV]	-	-	-	-

LCA: Interpretation

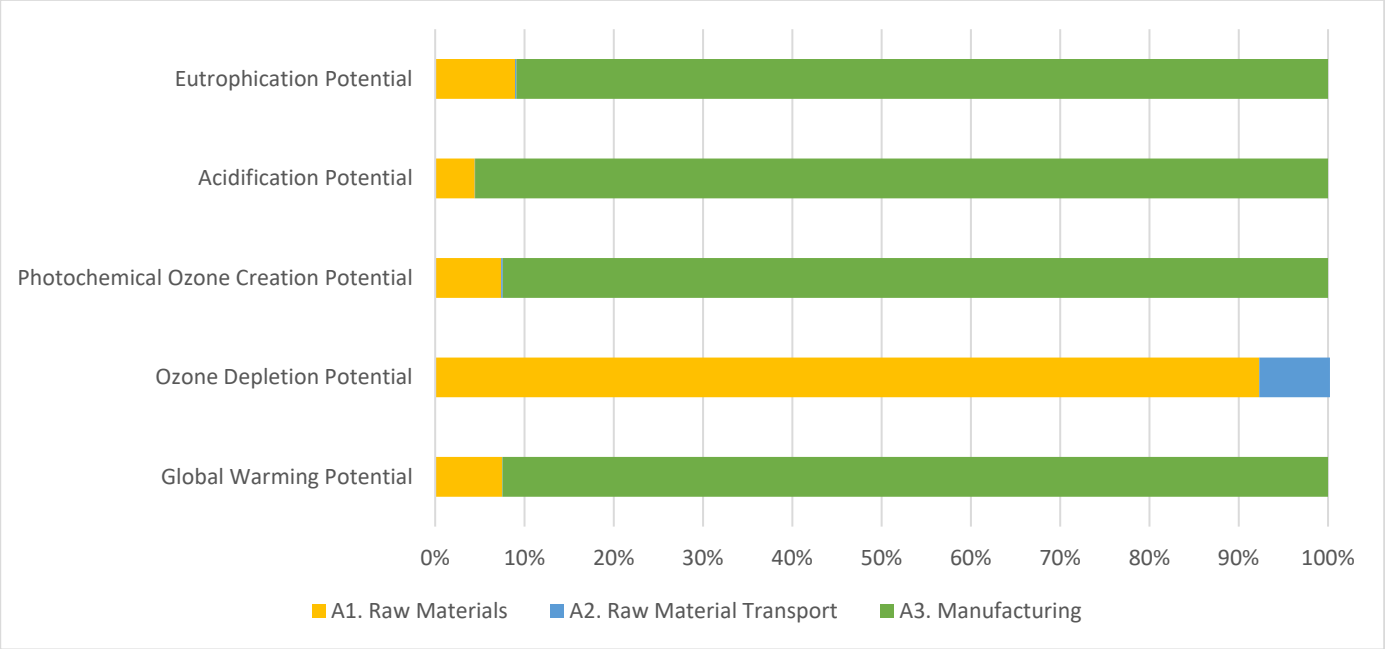
This LCA study is only up to cradle-to-gate phase for every glass type. The type of inputs used in different glass types vary a lot and this explains the difference in their environmental impacts. Majority of input materials are imported from Germany, Australia, and Thailand. Due to this, transportation impacts are also prominent.

GUARDIAN PROCESSED GLASS
AME & I REGION

According to ISO 14025, ISO 21930:2007, EN 15804



Environmental Impacts of 1 m² of Coated Glass [TRACI Impact Assessment Methodology]



Environmental Impacts of 1 m² of Mirror [TRACI Impact Assessment Methodology]

For coated glass, the raw materials phase contributes a majority of the impact in most categories. The ozone depletion, eutrophication, and smog impact categories are all over 75% attributed to the raw materials phase. Transport has the biggest impact on the ozone depletion impact category. Sea transport and road transport are extensively used to transport the raw materials, explaining the impacts. Manufacturing has the biggest impacts in the acidification potential category, attributing to 39%.

For mirror glass, the manufacturing phase contributes a majority of the impact in most categories. For ozone depletion, nearly all of the impact is driven by the raw materials at 92%. The other impact categories are all under 10% attributed to the raw materials phase. Raw material transportation accounts for 8% of the ozone depletion impact category. Sea transport and road transport are extensively used to transport the raw materials, explaining the impacts. Manufacturing has the biggest impacts in the acidification, global warming potential, eutrophication, and smog categories, attributing to over 90%.

Additional Environmental Information

Glass is by nature an inert material that does not release volatile organic compound (VOCs). There are no VOCs present in finished uncoated, tinted or patterned float glass products. Processed glass products are similar in composition to uncoated float glass but may include slight variations of intentionally added trace components to achieve required optical properties. Processed glass products are treated with coatings that may contain the following substances or their oxides/nitrides at <0.1% (w/w): tin, zinc, silver, silicon, aluminum, zirconium, titanium, nickel, chromium, niobium, copper, cobalt, iron, manganese, molybdenum, tungsten, vanadium, indium, and lead (mirror product only). Float glass is not classified as toxic, has no known hazardous decomposition products. Processed glass is not classified as flammable or combustible per EU Regulation (EC) No. 1272/2008. Processed glass will not pose an exposure hazard under the intended conditions of use. However, sanding, grinding, or similar activities can create nuisance dust particles.

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