Environmental Product Declaration (EPD)

Declaration code: EPD-GFEV-GB-19.2

Guardian Europe S.à r.l.

Flat glass

Uncoated flat glass, laminated safety glass and coated flat glass

Basis:

DIN EN ISO 14025
EN15804

Company-EPD
Environmental
Product **D**eclaration

date of issue:
29.06.2021

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Practitioner of the LCA	ift Rosenheim GmbH Theodor-Gietl-Straße 7-9 D-83026 Rosenheim
Declaration holder	Guardian Europe S.à r.l. 19 rue du Puits Romain L-8070 Bertrange
Declaration code	EPD-GFEV-GB-19.2
Designation of the declared product	Uncoated flat glass, laminated safety glass and coated flat glass – hereinafter Glass
Scope	Uncoated Flat glass, Laminated Safety Glass and Coated Flat Glass for processing into Insulating Glass Units (IGUs) and for use as glass for building and other works (e.g. bus passenger compartments, sound insulation panels, etc.).
Basis	This EPD was prepared on the basis of EN ISO 14025:2011 and DIN EN 15804:2012+A2:2019. In addition, the “ift General guideline for elaboration of Type III Environmental Product Declarations” applies. The Declaration is based on the PCR Documents EN 17074 ”PCR for flat glas products”, “Part A” PCR-A-0.2:2018 and “Flat glass in building” PCR-FG-1.4:2016.
Validity	Publication date: 29.06.2021 / Last revision: 29.06.2021 / Next revision: 29.06.2026 This verified company Environmental Product Declaration applies solely to the specified products and is valid for a period of five years from the date of publication in accordance with DIN EN 15804.
LCA basis	The LCA was prepared in accordance with EN ISO 14040 and DIN EN ISO 14044. The base data include both data collected from five production sites of Guardian Europe S.à r.l. and the generic data derived from the "GaBi 10" database. LCA calculations were based on the "cradle to gate" life cycle including all upstream processes (e.g. raw materials extraction, etc.).
Notes on publication	The "Conditions and Guidance on the Use of ift Test Documents" apply. The declaration holder assumes full liability for the underlying data, certificates and verifications.

Christian Kehrer Director of ift Certification and Surveillance Body	Dr. Torsten Mielecke Chairman of commitee of experts ift EPD and PCR	Patrick Wortner External Verifier

Production sites of Guardian Glass –Europe and Russia–			
Site	**Uncoated flat glass**	**Laminated safety glass**	**Coated flat glass**
Guardian Flachglas – *Germany*	x	x	x
Guardian Oroshaza – *Hungary*	x	x	x
Guardian Bascharage – *Luxembourg*	x		x
Guardian Dudelange – *Luxembourg*	x	x	
Guardian Industries Poland – *Poland*	x	x	x
Guardian Llodio Uno – *Spain*	x		
Guardian Navarra – *Spain*	x	x	x
Guardian Industries UK – *UK*	x	x	x
Guardian Steklo Ryazan – *Russia*	x		x
Guardian Steklo Rostov - *Russia*	x		x

1. General product information

product definition

This EPD relates to the product group Flat glass and applies to:

1 m² and 1 mm Glass
of Guardian Glass produced at the above listed production sites

The LCA was prepared using the declared unit:

1 m² area and 1 mm thickness

The functional unit is declared as follows:

Considered product	Area	Thickness	Grammage	Density
Uncoated flat glass	1 m²	4,33 mm	10,80 kg/m²	2,5 kg/m³
Laminated safety glass	1 m²	7,78 mm	19,46 kg/m²	2,5 kg/m³
Coated flat glass	1 m²	4,97 mm	12,42 kg/m²	2,5 kg/m³

Table 1: Product groups

The average unit is declared as follows:
Directly used material flows are determined using produced batch-masses (kg) and assigned to the declared unit. All other inputs and outputs in the production were scaled to the declared unit in their entirety, since no direct assignment to the average size is possible. The reference period is the year 2018.
The “average” glass pane used in modeling is a calculated average pane thickness and area and does not represent a specific product manufactured by Guardian Glass.

Product description

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.

Uncoated Flat Glass is a clear, flat soda lime silicate glass with parallel surfaces. It is manufactured using the float-glass method. This EPD is valid for the following Guardian Glass flat glass products:

- Guardian ExtraClear™
- Guardian UltraClear™

Laminated Safety Glass (LSG) consists of at least two sheets of flat glass (coated and/or uncoated) lying one on top of the other, with one or several layers of a tear-resistant, toughened film, usually polyvinyl butyral (PVB), bonding the panes of glass togehter. This EPD is valid for the following Guardian Glass laminated products:

- LamiGlass® ExtraClear & UltraClear (Standard)
- LamiGlass® Acoustic
- LamiGlass® Colored
- LamiGlass® Structural (XT)
- UltraClear® LamiGlass™ Neutral
- LamiGlass® Transwhite
- AntiReflective Lami
- Dielectric Mirror Lami
- Low Emissivity Lami (ClimaGuard®)
- Low Emissivity & Solar Control Lami (SunGuard® HP, SN, SNX)
- Solar Control Lami (Guardian Sun SunGuard® HD & Solar)

Coated flat glass can be colourless or coloured, depending on the coating used. The coating can also modify the radiation (thermal insulation and/or solar control) properties of the flat glass. This multi-layer coating is produced in a vacuum using magnetron sputtering. This EPD is valid for the following Guardian Glass coated products:

- ClimaGuard® Residential Glass
- SunGuard® Architectural Glass
  - Covers all SunGuard low-e products and includes product series: HD, HP, SN, SNX, Solar & RD
- Guardian Technical Glass
  - Covers all products in the following Technical Glass product series: Anti-Reflective Glass, Clarity, ThermaGuard & Dielectric Mirrror
- Guardian Automotive Glass: IRR

For a detailed product description, refer to the manufacturer specifications or the product specifications of the respective offer / quotation.

Product manufacture

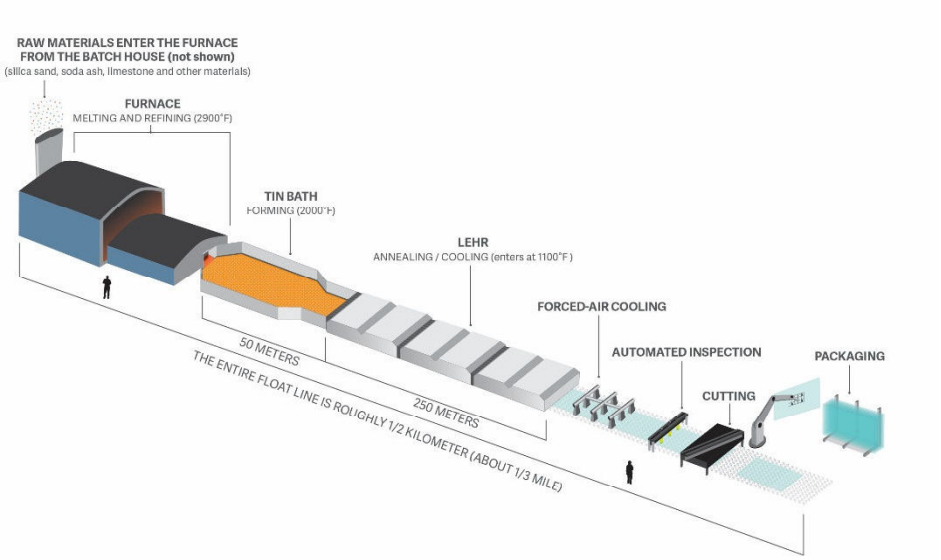


Figure 1: Uncoated Flat glass

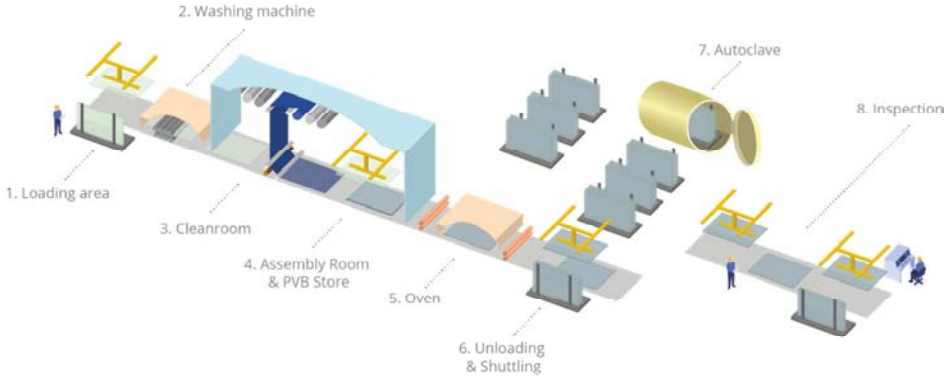


Figure 2: Laminated Safety Glass

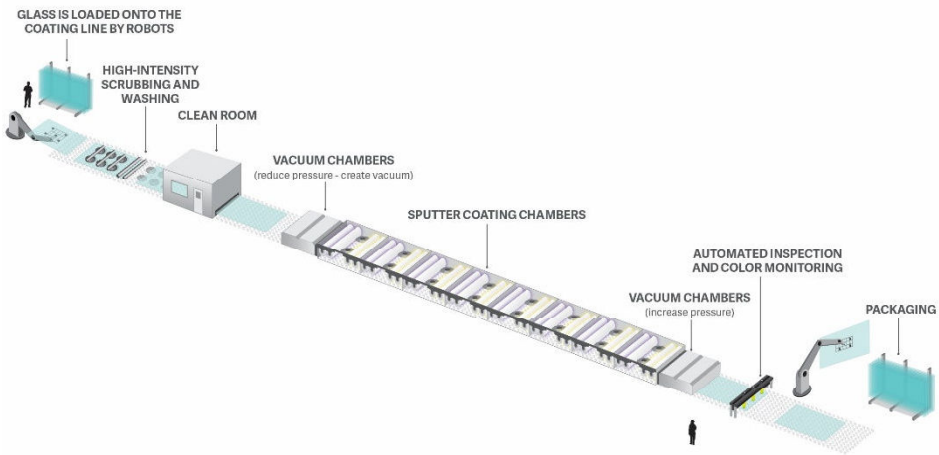


Figure 3: Coated Flat glass

Flat 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. Recycled glass, or cullet, is utilized to reduce process emissions and consumption of virgin raw materials, extend the life of the equipment and save energy. 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. Evaluated over multiple years of operation, each ton of glass produced in the European facilities (EU and UK) contains on average a range of 20 – 24 % glass cullet. This ratio can vary from site to site and over time, depending on cullet availability.

The flat glass product is then processed by either coating, laminating and/or heat treating depending on application needs. These processed glass products are similar in composition to uncoated flat glass but include slight additions of trace elements to achieve required optical properties.

Application

Guardian Glass products are designed for a variety of interior and exterior commercial, residential, technical, transportation and specialty glass applications as outlined in the product description section above. Guardian Glass typically supplies flat, coated and laminated safety 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. The glass makeup is typically specified by architects, glazing contractors, window manufacturers and other design professionals.

Verifications

The following verifications are held:

- Uncoated flat glass: Product quality according to EN 572-9
- Laminated safety glass: Product quality according to ISO 12543 as well as EN 14449
- Coated flat glass: Product quality according to EN 1096-4
- Guardian Industries UK: Responsible sourcing of construction products according to BES 6001
- All products: Cradle to Cradle™-certified at Bronze Level, versio 3.1, valid until 23.12.2021 (European production only, to be renewed)

Further and each current documentation (including other national permits) is available at www.guardianglass.com.

Management systems

The following management systems are held:

- Quality management system according to DIN EN ISO 9001:2015 (all sites)
- Energy management system according to DIN EN ISO 50001:2018 (Guardian Flachglas, Guardian Navarra)
- Environmental management system according to DIN EN ISO 14001:2015 (Guardian Dudelange, Guardian Bascharage, Guardian Oroshaza, Guardian Llodio Uno, Guardian Insutries UK, Guardian Navarra, Guardian Industries Poland)
- Occupational health and safety management system according to BS OHSAS 18001:2007 (Guardian Insutries UK)
- Occupational health and safety management system according to DIN ISO 45001:2018 (Guardian Navarra)

Additional information

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.

For additional verification of applicability or conformity, refer to the CE marking and the documents accompanying the product, if applicable.

The Glass displays the required performance characteristics relating to building physics; see: http://cemarking.eu.guardian.com/CeMarking/Default.aspx

2. Materials used

Primary materials

The primary materials used can be found in the Life Cycle Assessment (LCA) (see Section 6).

Declarable substances

The product contains no substances from the REACH candidate list (declaration dated September 2020).

All relevant safety data sheets are available from Guardian Europe S.à r.l..

3. Construction process stage

Processing recommendations, installation

Observe the manufacturer's instructions for interim storage, processing, assembly / installation and information on compatibility.

4. Use stage

Emissions to the environment

No emissions to indoor air, water and soil are known. There may be VOC emissions.
No VOC emissions for uncoated and coated flat glass
For laminated safety glass, VOC emissions from standard and acoustic PVB are very low (total VOC below 1,000 µg/m^3). Following the ISO 16000 testing, the LSG is classified as A+ according to the labelling French Decree.
Certificates can be requested from the manufacturer.

Labeling of product:
Conentration of the 10 VOC below are inferior of A conentrations:

Labelling	C	B	A	A+
Formaldehyde	>120	<120	<60	<10
Acetaldehyde	>400	<400	<300	<200
Toluene	>600	<600	<450	<300
Tetrachloroethylene	>500	<500	<350	<250
Xylenes (m-, o-, p-)	>400	<400	<300	<200
1,2,4-Trimethylbenzene	>2000	<2000	<1500	<1000
1,4-Dichlorobenzene	>120	<120	<90	<60
Éthylbenzene	>1500	<1500	<1000	<750
2-Butoxyethanol	>2000	<2000	<1500	<1000
Styrene	>500	<500	<350	<250
Total VOC	>2000	<2000	<1500	<1000

* Information representative of the indoor air emissions of volatile substances posing an inhalation toxicity risk on a scale from C (high emissions) to A+ (very low emissions)

Reference service life (RSL)

For this EPD the following applies:
The reference service life (RSL) can not be determined for a "cradle-to-gate" EPD with the modules C1-C4 and module D (A1-A3 + C + D) as reference in-use conditions are not specified.
The RSL of Glass of the Guardian Europe S.à r.l. is not specified.

Guardian Glass products Limited Warranties are available here: www.guardianglass.com.
Processing and the quality of end products remain the full responsibility of the processor or its customers.

5. End of life stage

Possible end-of-life stages

The Glass is shipped to central collection points. There the products are usually shredded and sorted into their original constitutents. The end-of-life stage depends on the site where the products are used and is therefore subject to local regulations. Observe the locally applicable regulatory requirements.

In this EPD, the end-of-life modules are according to EN 17074. This proposes a European default scenario in which 70 % goes to landfill and 30 % is recycled.

Disposal methods

The LCA includes the average disposal routes.

All life cycle scenarios are detailed in the Annex.

6. Life Cycle Assessment (LCA)

Environmental product declarations are based on Life Cycle Analyses (LCAs) which use material and energy flows for the calculation and subsequent representation of environmental impacts.

Such LCAs were developed as the basis for the Glass. The LCAs are in conformity with DIN EN 15804 and the international standards DIN EN ISO 14040, DIN EN ISO 14044, ISO 21930 and EN ISO 14025.

The LCA is representative of the products presented in the declaration and the specified reference period.

6.1. Definition of goal and scope

Goal

The goal of the LCA is to demonstrate the environmental impacts of the products. In accordance with DIN EN 15804, the environmental impacts covered by this Environmental Product Declaration are presented for the entire product life cycle in the form of basic information. No other additional environmental impacts are specified.

Data quality, data availability, and geographical and time-related system boundaries

The specific data originate exclusively from the fiscal year 2018. They were collected on-site at the plants located in PL-42-200 Częstochowa, DE-06766 Bitterfeld-Wolfen, ES-31500 Tudela, RU-346353 Krasny Sulin and RU-390011 Ryazan by the manufacturer and originate in parts from company records and partly from values directly obtained by measurement. Validity of the data was checked by the ift Rosenheim.

The generic data originate from the "Professional Datenbank und "Baustoff Datenbank" (professional database and building materials database) from the software "GaBi 10". The last update of both databases was in 2021. Data from before this date originate also from these databases and are not more than ten years old. No other generic data were used for the calculation.

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 flat glass production.
Data gaps were either filled with comparable data or conservative assumptions, or the data were cut off in compliance with the 1 % rule.

The life cycle was modelled using the sustainability software tool “GaBi ts” for the development of Life Cycle Assessments.

Scope / System boundaries

The system boundaries refer to the supply of raw materials and purchased parts, the manufacture and the end-of-life stage of Glass.
Additional specific data from one pre-supplier was used: Sodium Ash - Bulk (EPD registration number: S-P-01129). Otherwise, no additional data from pre-suppliers / subcontractors or other sites were taken into consideration.

Cut-off criteria

All company data collected, i.e. all commodities/input and raw materials used, the thermal energy and electricity consumption, were taken into consideration.

The boundaries cover only the production-relevant data. Building sections / parts of facilities that are not relevant to the manufacture of the products were excluded. Also capital goods, infrastructure, personnel-related activities, waste treatment facilities, etc are not included in EPD.

The transport distances of the pre-products were taken into consideration as a function of 100 % of the mass of the products.
If transport distances to the plants under consideration were not known exactly, they were included with the help of an estimated value.

The criteria for the exclusion of inputs and outputs as set out in DIN EN 15804 are fulfilled. Based on the data analysis, it can be assumed that the total negligible processes per life cycle stage does not exceed 1 % of the mass / the primary energy. This way the total of negligible processes does not exceed 5 % of the energy and mass input. The life cycle calculation also includes material and energy flows that account for less than 1 %.

6.2. Inventory analysis

Goal	All material and energy flows are described below. The processes covered are presented as input and output parameters and refer to the declared / functional units.
Life cycle stages	The Annex shows the included life cycle of the Glass. The product stage “A1 – A3”, construction process stage “A4 – A5”, end-of-life stage “C1 – C4” and benefits and loads beyond the system boundaries “D” are considered.
Benefits	The below benefits have been defined as per DIN EN 15804: • Benefits from recycling
Allocation of co-products	During the manufacture no allocations occur.
Allocations for reuse, recycling and recovery	If products are reused / recycled and recovered during product stage (cullet), they are fed directly back into the production process. The system boundaries were set following their disposal, when the end of their waste status has been reached.
Allocations beyond life cycle boundaries	Use of recycled materials in the manufacturing process was based on the current market-specific situation. In parallel to this, a recycling potential was taken into consideration that reflects the economic value of the product after recycling (recyclate). Secondary material that enters the Glass as input is calculated without loads. The system boundary of the recycled material was set during collection.
Secondary material	The use of secondary materials in the module A3 was considered. Secondary material is used.

Inputs

The LCA includes the following production-relevant inputs per 1 m² and 1 mm Glass:

Energy

The electricity mix is based on the following regional mix (see Table 2):

Electricity mix	Share in %		
	PG1	PG2	PG3
Electricity mix EU-28	59,1	66,5	100,0
Electricity mix RU	40,9	33,5	0,0

Table 2: Electricity mix (Regions)

The electricity mix Russia (RU) is based on the "Electricity mix Russia" (see Table 3):

Electricity disclosure	Share in %
Hydropower	15,0
Other renewable Energy	<0,1
Coal / natural gas	0,0
Hard coal / Lignite	63,5
Other fossil fuels	0,0
Nuclear energy	21,5

Table 3: Electricity mix Russia

The input material gas is based on the following regional mix (see Table 4):

Natural gas mix	Share in %	
	PG1	PG3
Natural gas mix EU-28	92,1	100,0
Natural gas mix Poland	7,9	0,0

Table 4: Natural gas mix (Regions)

A portion of the process heat is used for space heating. This can, however, not be quantified, hence a "worst case" figure was taken into account for the product.

Water

The water consumed per m² and mm by the individual process steps for the manufacture is 2.31 l for uncoated FG, 3.29 l for coated FG and 1.05 l for VSG.
The consumption of fresh water specified in Section 6.3 originates (among others) from the process chains of the pre-products and by process water for cooling.

Raw material / Pre-products:
The table below shows the use of raw materials / pre-products in %:

Nr.	Material	Mass in %	
		FG	LSG
1	Siliceous sand	46,5	42,5
2	Recycled flat glass	19,0*	17,4
3	Sodium	14,3	13,1
4	Dolomite	13,5	12,3
5	Limestone	3,3	3,0
6	Feldspar	1,5	1,4
7	PVB	-	8,5
8	Other	1,9	1,7

Table 5: Representation of individual materials in % per declared unit
*23 % cullet in glass.

Ancillary materials and consumables
0.52 kg for uncoated FG, 0.38 g for coated FG and 0.04 g for VSG of ancillary materials and consumables are required per m² and mm.

Product packaging
The amounts used for product packaging are as follows:

Nr.	Material	Mass in kg		
		Uncoated FG	Coated FG	LSG
1	Foil	5,69E-04	6,98E-04	2,76E-06
2	Wood	2,42E-02	2,88E-02	7,19E-04
3	Carton	1,08E-03	1,04E-03	3,16E-04

Table 6: Representation of packaging in kg per declared unit

Biogenic carbon content
The biogenic carbon content reflects the proportion of renewable raw materials used in a product and its packaging (e.g. wood, cardboard, biogenic plastics).
Only the biogenic carbon content of the associated packaging is indicated, as the total mass of biogenic carbon-containing substances is less than 5 % of the total mass of the product and the associated packaging According to EN 16449, the following quantities of biogenic carbon for packaging accumulate:

Nr.	Component	Content in kg C		
		Uncoated FG	Coated FG	LSG
1	In the associated packaging	-1,33E-02	-1,33E-02	-4,62E-04

Table 7: Biogenic carbon content of the packaging at the factory gate

Outputs

The LCA includes the following production-relevant outputs per 1 m² and 1 **mm** Glass:

Waste
Secondary raw materials were included in the benefits.
See Section 6.3 Impact assessment.

Waste water
1.13 l for uncoated FG, 1.04 l for coated FG and 0.28 l for VSG l waste water per m² and mm is produced for the manufacture.

6.3. Impact assessment

Goal

The impact assessment covers inputs and outputs. The impact categories applied are listed below:

Impact categories

The models for impact assessment were applied as described in DIN EN 15804-A2.
The impact categories presented in the EPD are as follows:

- Depletion of abiotic resources - minerals and metals;
- Depletion of abiotic resources - fossil fuels;
- Acidification;
- Ozone depletion,
- Climate change – total;
- Climate change – fossil;
- Climate change – biogenic;
- Climate change – land use and land use change;
- Eutrophication aquatic freschwater;
- Eutrophication aquatic marine;
- Eutrophication terrestrial;
- Photochemical ozone formation;
- Water use.

Resource use

The models for impact assessment were applied as described in DIN EN 15804-A2.
The parameters describing resource use presented in the EPD are as follows:

- Renewable primary energy as energy source;
- Renewable primary energy for material use;
- Total use of renewable primary energy;
- Non renewable primary energy as energy source;
- Non renewable primary energy for material use;
- Total use of non renewable primary energy;
- Use of secondary material;
- Renewable secondary fuels;
- Non renewable secondary fuels;
- Use of fresh water.

Waste

The waste generated during the production of 1 m² and 1 mm Glass is evaluated and shown separately for the fractions trade wastes, special wastes and radioactive wastes.
Since waste handling is modelled within the system boundaries, the amounts shown refer to the deposited wastes. A portion of the waste indicated is generated during the manufacture of the pre-products.
Radioactive waste is not generated during the manufacturing of Guardian glass, but associated with the upstream generation of nuclear electricity.

The models for impact assessment were applied as described in DIN EN 15804-A2.
The waste categories and parameters describing output flows presented in the EPD are as follows:

- Hazardous waste disposed;
- Non hazardous waste disposed;
- Radioactive waste disposed;
- Components for re-use;
- Materials for recycling;

- Materials for energy recovery;
- Exported electrical energy;
- Exported thermal energy.

Additional environmental impact indicators

The models for impact assessment were applied as described in DIN EN 15804-A2. The additional impact categories presented in the EPD are as follows:

- Particulate Matter emissions;
- Ionizing radiation, human health;
- Eco-toxicity (freshwater);
- Human toxicity, cancer effects;
- Human toxicity, non-cancer effects;
- Land use related impacts/Soil quality.

Results per 1 m² and 1 mm uncoated Flat glass

	Unit	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Core environmental indicators																		
GWP-t	kg CO_2-eq.	0.66	3.57E-02	2.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.68E-02	2.06E-03	2.58E-02	-0.37
GWP-f	kg CO_2-eq.	0.67	3.56E-02	2.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.67E-02	2.04E-03	2.65E-02	-0.37
GWP-b	kg CO_2-eq..	-2.59E-02	-1.48E-04	1.29E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	-2.13E-05	1.73E-05	-7.69E-04	-8.79E-04
GWP-l	kg CO_2-eq.	6.61E-04	3.07E-04	1.46E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.37E-04	2.89E-06	7.78E-05	-1.23E-04
ODP	kg CFC-11-eq.	3.10E-10	4.80E-18	1.57E-15	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	2.13E-18	4.88E-17	1.03E-16	-1.27E-15
AP	mol H^+-eq.	4.55E-03	6.72E-05	3.55E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.44E-05	4.24E-06	1.88E-04	-2.48E-03
EP-fw	kg P-eq.	8.47E-07	1.11E-07	3.73E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	4.96E-08	5.47E-09	4.44E-08	-2.04E-07
EP-m	kg N-eq.	1.04E-03	2.76E-05	4.31E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.46E-05	1.01E-06	4.89E-05	-7.11E-04
EP-t	mol N-eq.	1.63E-02	3.14E-04	4.74E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.66E-04	1.06E-05	5.38E-04	-8.09E-03
POCP	kg NMVOC-eq.	2.30E-03	5.97E-05	1.41E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.08E-05	2.74E-06	1.48E-04	-1.43E-03
ADPF*²	MJ	8.34	0.50	25.60	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
ADPE*²	kg Sb-eq.	1.34E-07	2.86E-09	9.04E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.27E-09	6.00E-10	2.50E-09	-2.88E-08
WDP*²	m^3 world-eq. deprived	0.11	3.26E-04	2.36E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.45E-04	3.27E-04	2.84E-03	-1.99E-02
Use of ressources																		
PERE	MJ	0.67	2.79E-02	0.64	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.24E-02	1.67E-02	4.73E-02	-0.44
PERM	MJ	0.41	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
PERT	MJ	1.07	2.79E-02	0.64	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.24E-02	1.67E-02	4.73E-02	-0.44
PENRE	MJ	8.28	0.50	25.70	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	5.93E-02	0.40	-5.53
PENRM	MJ	8.70E-02	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	-2.30E-02	-5.30E-02	0.00
PENRT	MJ	8.37	0.50	25.70	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
SM	kg	0.00	0.00	0.58	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
RSF	MJ	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
NRSF	MJ	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
FW	m^3	3.21E-03	3.19E-05	1.10E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.42E-05	1.63E-05	8.66E-05	-7.01E-04
Waste categories																		
HWD	kg	4.98E-09	2.52E-11	2.31E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.12E-11	9.6E-12	3.73E-11	-9.95E-10
NHWD	kg	0.10	7.43E-05	1.08E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.31E-05	2.57E-05	1.75	-4.80E-02
RWD	kg	1.98E-04	6.05E-07	2.62E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	2.69E-07	5.40E-06	3.68E-06	-1.32E-04
Output material flows																		
CRU	kg	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
MFR	kg	0.00	0.00	4.40E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.75	0.00	0.00
MER	kg	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
EEE	MJ	0.00	0.00	8.28E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
EET	MJ	0.00	0.00	1.21E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00

Legend:
GWP-t – global warming potential - total **GWP-f** – global warming potential fossil fuels **GWP-b** – global warming potential - biogenic **GWP-l** – global warming potential - land use and land use change **ODP** – ozone depletion potential **AP** - acidification potential **EP-fw** - eutrophication potential - aquatic freshwater **EP-m** - eutrophication potential - aquatic marine **EP-t** - feutrophication potential - terrestrial **POCP** - photochemical ozone formation potential **ADPF*²** - abiotic depletion potential – fossil resources **ADPE*²** - abiotic depletion potential – minerals&metals **WDP*²** – Water (user) deprivation potential **PERE** - Use of renewable primary energy **PERM** - use of renewable primary energy resources **PERT** - total use of renewable primary energy resources **PENRE** - use of non-renewable primary energy **PENRM** - use of non-renewable primary energy resources **PENRT** - 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 **FW** - net use of fresh water **HWD** - hazardous waste disposed **NHWD** - non-hazardous waste disposed **RWD** - radioactive waste disposed **CRU** - components for re-use **MFR** - materials for recycling **MER** - materials for energy recovery **EEE** - exported electrical energy **EET** - exported thermal energy

Results per 1 m² and 1 mm uncoated Flat glass																	
	Unit	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Additional environmental indicators																		
PM	Disease incidence	1.85E-07	3.8E-10	2.56E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.87E-10	3.58E-11	2.34E-09	-1.46E-08
IRP*1	kBq U235-Äqv.	3.10E-02	8.66E-05	3.59E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.85E-05	8.87E-04	3.87E-04	-2.13E-02
ETP-fw*2	CTUe	94	0.36	0.99	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.61E-01	1.53E-02	0.20	-6.65
HTP-c*2	CTUh	5.9E-11	7.29E-12	1.88E-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.24E-12	4.32E-13	2.95E-11	-3.65E-11
HTP-nc*2	CTUh	1.68E-08	3.94E-10	8.24E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.77E-10	1.63E-11	3.26E-09	-3.61E-09
SQP*2	dimensionless	4.72	0.17	0.40	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	7.63E-02	1.15E-02	7.09E-02	-0.33

Legend:
PM – particulate matter emissions potential **IRP*1** – ionizing radiation potential – human health **ETP-fw*2** - Eco-toxicity potential – freshwater **HTP-c*2** - Human toxicity potential – cancer effects **HTP-nc*2** - Human toxicity potential – non-cancer effects **SQP*2** – soil quality potential

Disclaimers:

*1 This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

*2 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 per 1 m² and 1 mm coated Flat glass

	Unit	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Core environmental indicators																		
GWP-t	kg CO_2-eq.	2.78	6.55E-04	0.60	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.68E-02	2.06E-03	2.58E-02	-0.37
GWP-f	kg CO_2-eq.	2.78	6.51E-04	0.58	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.67E-02	2.04E-03	2.65E-02	-0.37
GWP-b	kg CO_2-eq..	-1.90E-02	-8.31E-07	1.76E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	-2.13E-05	1.73E-05	-7.69E-04	-8.79E-04
GWP-l	kg CO_2-eq.	1.13E-03	5.33E-06	1.24E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.37E-04	2.89E-06	7.78E-05	-1.23E-04
ODP	kg CFC-11-eq.	2.99E-10	8.32E-20	2.01E-15	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	2.13E-18	4.88E-17	1.03E-16	-1.27E-15
AP	mol H^+-eq.	8.46E-03	1.22E-06	3.83E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.44E-05	4.24E-06	1.88E-04	-2.48E-03
EP-fw	kg P-eq.	1.38E-06	1.93E-09	1.20E-06	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	4.96E-08	5.47E-09	4.44E-08	-2.04E-07
EP-m	kg N-eq.	1.54E-03	5.05E-07	9.29E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.46E-05	1.01E-06	4.89E-05	-7.11E-04
EP-t	mol N-eq.	2.19E-02	5.74E-06	9.39E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.66E-04	1.06E-05	5.38E-04	-8.09E-03
POCP	kg NMVOC-eq.	3.88E-03	1.08E-06	2.49E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.08E-05	2.74E-06	1.48E-04	-1.43E-03
ADPF*²	MJ	35.30	8.67E-03	2.46	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
ADPE*²	kg Sb-eq.	2.35E-07	4.96E-11	2.52E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.27E-09	6.00E-10	2.50E-09	-2.88E-08
WDP*²	m³ world-eq. deprived	0.27	5.66E-06	-2.98E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.45E-04	3.27E-04	2.84E-03	-1.99E-02
Use of ressources																		
PERE	MJ	1.36	4.84E-04	0.75	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.24E-02	1.67E-02	4.73E-02	-0.44
PERM	MJ	0.48	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
PERT	MJ	1.84	4.84E-04	0.75	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.24E-02	1.67E-02	4.73E-02	-0.44
PENRE	MJ	35.39	8.68E-03	2.46	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
PENRM	MJ	1.43E-02	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
PENRT	MJ	35.40	8.68E-03	2.46	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
SM	kg	0.59	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
RSF	MJ	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
NRSF	MJ	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
FW	m³	7.74E-03	5.54E-07	1.27E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.42E-05	1.63E-05	8.66E-05	-7.01E-04
Waste categories																		
HWD	kg	2.37E-04	4.37E-13	9.38E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.12E-11	9.6E-12	3.73E-11	-9.95E-10
NHWD	kg	0.12	1.29E-06	2.07E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.31E-05	2.57E-05	1.75	-4.80E-02
RWD	kg	4.72E-04	1.05E-08	3.10E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	2.69E-07	5.40E-06	3.68E-06	-1.32E-04
Output material flows																		
CRU	kg	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
MFR	kg	3.79E-03	0.00	6.04E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.75	0.00	0.00
MER	kg	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
EEE	MJ	7.72E-03	0.00	4.97E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
EET	MJ	0.00	0.00	1.21E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00

Legend:
GWP-t – global warming potential - total **GWP-f** – global warming potential fossil fuels **GWP-b** – global warming potential - biogenic **GWP-l** – global warming potential - land use and land use change **ODP** – ozone depletion potential **AP** - acidification potential **EP-fw** - eutrophication potential - aquatic freshwater **EP-m** - eutrophication potential - aquatic marine **EP-t** - feutrophication potential - terrestrial **POCP** - photochemical ozone formation potential **ADPF*²** - abiotic depletion potential – fossil resources **ADPE*²** - abiotic depletion potential – minerals&metals **WDP*²** – Water (user) deprivation potential **PERE** - Use of renewable primary energy **PERM** - use of renewable primary energy resources **PERT** - total use of renewable primary energy resources **PENRE** - use of non-renewable primary energy **PENRM** - use of non-renewable primary energy resources **PENRT** - 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 **FW** - net use of fresh water **HWD** - hazardous waste disposed **NHWD** - non-hazardous waste disposed **RWD** - radioactive waste disposed **CRU** - components for re-use **MFR** - materials for recycling **MER** - materials for energy recovery **EEE** - exported electrical energy **EET** - exported thermal energy

Results per 1 m² and 1 mm coated Flat glass																	
	Unit	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Additional environmental indicators																		
PM	Disease incidence	2.17E-07	6.83E-12	3.16E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.87E-10	3.58E-11	2.34E-09	-1.46E-08
IRP*1	kBq U235-Äqv.	6.87E-02	1.50E-06	4.41E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.85E-05	8.87E-04	3.87E-04	-2.13E-02
ETP-fw*2	CTUe	97.60	6.27E-03	1.09	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.16	1.53E-02	0.20	-6.65
HTP-c*2	CTUh	2.6E-10	1.26E-13	7.98E-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.24E-12	4.32E-13	2.95E-11	-3.65E-11
HTP-nc*2	CTUh	2.60E-08	6.86E-12	9.26E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.77E-10	1.63E-11	3.26E-09	-3.61E-09
SQP*2	dimensionless	6.07	2.98E-03	0.48	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	7.63E-02	1.15E-02	7.09E-02	-0.33

Legend:
PM – particulate matter emissions potential **IRP*1** – ionizing radiation potential – human health **ETP-fw*2** - Eco-toxicity potential – freshwater **HTP-c*2** - Human toxicity potential – cancer effects **HTP-nc*2** - Human toxicity potential – non-cancer effects **SQP*2** – soil quality potential

Disclaimers:

*1 This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

*2 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 per 1 m² and 1 mm Laminated safety glass																		
	Unit	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Core environmental indicators																		
GWP-t	kg CO_2-eq.	3.88	4.51E-03	0.59	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.68E-02	2.06E-03	2.58E-02	-0.37
GWP-f	kg CO_2-eq.	3.85	4.48E-03	0.58	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.67E-02	2.04E-03	2.65E-02	-0.37
GWP-b	kg CO_2-eq..	1.05E-02	-5.72E-06	1.03E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	-2.13E-05	1.73E-05	-7.69E-04	-8.79E-04
GWP-l	kg CO_2-eq.	9.94E-04	3.67E-05	9.29E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.37E-04	2.89E-06	7.78E-05	-1.23E-04
ODP	kg CFC-11-eq.	1.64E-08	5.73E-19	1.56E-15	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	2.13E-18	4.88E-17	1.03E-16	-1.27E-15
AP	mol H^+-eq.	1.02E-02	8.37E-06	1.48E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.44E-05	4.24E-06	1.88E-04	-2.48E-03
EP-fw	kg P-eq.	1.72E-06	1.33E-08	3.54E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	4.96E-08	5.47E-09	4.44E-08	-2.04E-07
EP-m	kg N-eq.	1.87E-03	3.48E-06	3.82E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.46E-05	1.01E-06	4.89E-05	-7.11E-04
EP-t	mol N-eq.	2.48E-02	3.95E-05	3.97E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.66E-04	1.06E-05	5.38E-04	-8.09E-03
POCP	kg NMVOC-eq.	6.38E-03	7.46E-06	1.03E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.08E-05	2.74E-06	1.48E-04	-1.43E-03
ADPF*²	MJ	57.40	5.97E-02	1.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
ADPE*²	kg Sb-eq.	2.09E-07	3.42E-10	2.02E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.27E-09	6.00E-10	2.50E-09	-2.88E-08
WDP*²	m³ world-eq. deprived	0.19	3.90E-05	-1.49E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.45E-04	3.27E-04	2.84E-03	-1.99E-02
Use of ressources																		
PERE	MJ	1.39	3.33E-03	0.54	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.24E-02	1.67E-02	4.73E-02	-0.44
PERM	MJ	1.66E-02	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
PERT	MJ	1.41	3.33E-03	0.54	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.24E-02	1.67E-02	4.73E-02	-0.44
PENRE	MJ	53.04	0.06	1.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	1.35	3.41	-5.53
PENRM	MJ	4.36	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	-1.31	-3.05	0.00
PENRT	MJ	57.40	5.98E-02	1.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.22	3.63E-02	0.35	-5.53
SM	kg	0.53	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
RSF	MJ	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
NRSF	MJ	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
FW	m³	5.73E-03	3.82E-06	2.43E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.42E-05	1.63E-05	8.66E-05	-7.01E-04
Waste categories																		
HWD	kg	2.12E-04	3.01E-12	2.57E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.12E-11	9.6E-12	3.73E-11	-9.95E-10
NHWD	kg	0.10	8.88E-06	1.30E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.31E-05	2.57E-05	1.75	-4.80E-02
RWD	kg	2.12E-04	3.01E-12	2.57E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	2.69E-07	5.40E-06	3.68E-06	-1.32E-04
Output material flows																		
CRU	kg	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
MFR	kg	3.39E-03	0.00	1.28E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.75	0.00	0.00
MER	kg	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
EEE	MJ	6.90E-03	0.00	8.94E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
EET	MJ	1.02E-02	0.00	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00

Legend:
GWP-t – global warming potential - total **GWP-f** – global warming potential fossil fuels **GWP-b** – global warming potential - biogenic **GWP-l** – global warming potential - land use and land use change **ODP** – ozone depletion potential **AP** - acidification potential **EP-fw** - eutrophication potential - aquatic freshwater **EP-m** - eutrophication potential - aquatic marine **EP-t** - feutrophication potential - terrestrial **POCP** - photochemical ozone formation potential **ADPF*²** - abiotic depletion potential – fossil resources **ADPE*²** - abiotic depletion potential – minerals&metals **WDP*²** – Water (user) deprivation potential **PERE** - Use of renewable primary energy **PERM** - use of renewable primary energy resources **PERT** - total use of renewable primary energy resources **PENRE** - use of non-renewable primary energy **PENRM** - use of non-renewable primary energy resources **PENRT** - 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 **FW** - net use of fresh water **HWD** - hazardous waste disposed **NHWD** - non-hazardous waste disposed **RWD** - radioactive waste disposed **CRU** - components for re-use **MFR** - materials for recycling **MER** - materials for energy recovery **EEE** - exported electrical energy **EET** - exported thermal energy

Results per 1 m² and 1 mm Laminated safety glass																	
	Unit	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Additional environmental indicators																		
PM	Disease incidence	2.07E-07	4.71E-11	1.25E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.87E-10	3.58E-11	2.34E-09	-1.46E-08
IRP*1	kBq U235-Äqv.	8.61E-02	1.04E-05	2.83E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.85E-05	8.87E-04	3.87E-04	-2.13E-02
ETP-fw*2	CTUe	89.60	4.32E-02	0.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.16	1.53E-02	0.20	-6.65
HTP-c*2	CTUh	3.48E-10	8.71E-13	1.67E-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	3.24E-12	4.32E-13	2.95E-11	-3.65E-11
HTP-nc*2	CTUh	2.48E-08	4.72E-11	7.12E-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	1.77E-10	1.63E-11	3.26E-09	-3.61E-09
SQP*2	dimensionless	1.34	2.05E-02	0.37	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	7.63E-02	1.15E-02	7.09E-02	-0.33

Legend:
PM – particulate matter emissions potential **IRP*1** – ionizing radiation potential – human health **ETP-fw*2** - Eco-toxicity potential – freshwater **HTP-c*2** - Human toxicity potential – cancer effects **HTP-nc*2** - Human toxicity potential – non-cancer effects **SQP*2** – soil quality potential

Disclaimers:

*1 This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

*2 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.

6.4. Interpretation, LCA presentation and critical verification

Evaluation

The environmental impacts of Flat Glass, Coated flat glass and Laminated safety glass differ from each other. This is primarily due to differences in the amount of energy used for the production processes and the respective and pre-products and raw materials used. For this reason three separate tables are used to show the environmental impacts of the different products.

The environmental impacts during the manufacture of flat glass result mainly from the use of soda ash and its upstream processess, as well as from the use of energy (especially natural gas). The use of sodium sulphate, nitrogen and caustic soda and their respective upstream chains also have an impact on the environment.
For coated flat glass and laminated safety glass, the environmental impacts result primarily from the use of flat glass and its upstream processes. The use of electricity is subordinate, but worth mentioning for both types of glass.
With regard to laminated safety glass, the use of PVB and its upstream chains further contributes strongly to the environmentla impacts.

Because the products are used in a very wide range of applications, the use phase was not taken into consideration in this EPD.

For scneario C4 consumptions arising from the physical pre-treatment and management of the disposal site are expected. Due to the high proportion of landfill according to EN 17074, the influence of landfilling of the glass on the environmental impacts is also significant.
When recycling the products, the amount of benefits that can be offseted for the glass in scenario D varies.

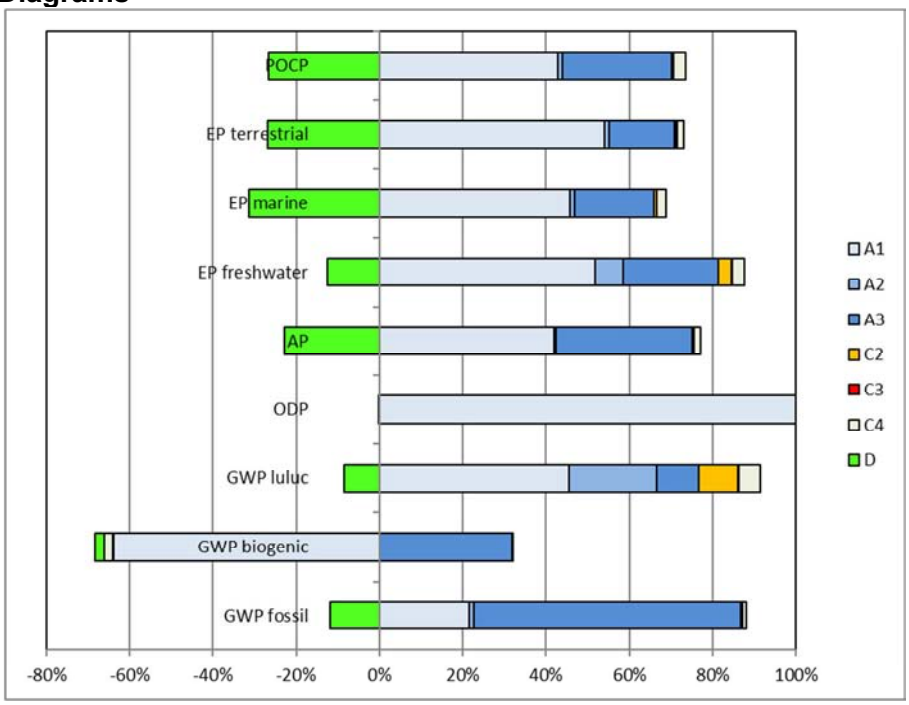
Compared to the EPD five years ago, the LCA results differ. Some reasons are methodological changes in the modelling, some others reflecting changes of production. The sources of the differences are listed below:

- Consideration of CO_2 emissions from production
- Update of glass data (esp. soda ash and PVB data)
- Extension to include Russian plants and Russian electricity mix
- Adaptation of energy data (electricity, natural gas, regional source)
- Adaption of soda ash data (synthetic and antural soda)
- Methodology - change in calculation of average values (weighting)
- Methodology - Consideration of the end-of-life stage and benefits and loads beyond the system boundaries
- Application of more appropriate GaBi data sets (esp.PVB)
- Adaptation of background data in GaBi (version update)

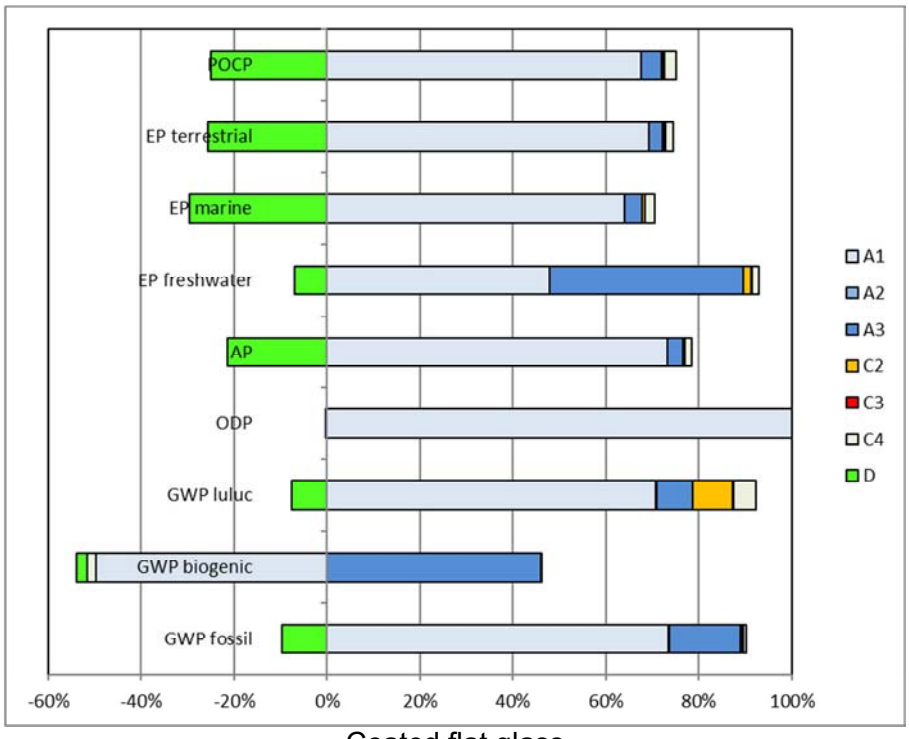
The breakdown of the main environmental impacts is shown in the diagram below.

The chart below shows the allocation of the main environmental impacts.
The values obtained from the LCA calculation are suitable for building certification.

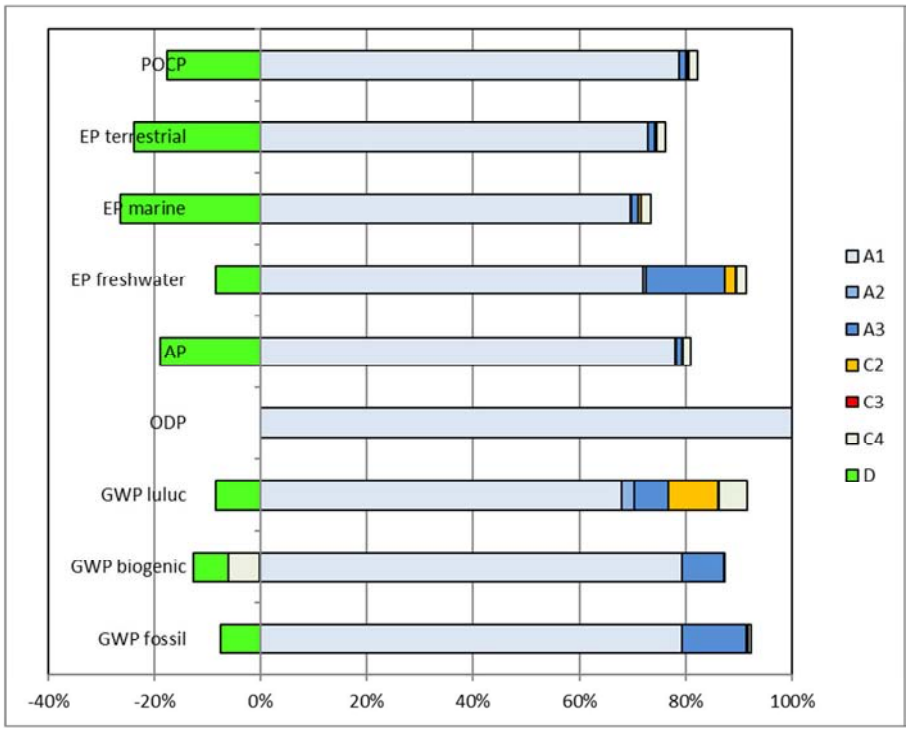
Diagrams



Uncoated flat glass



Coated flat glass



Laminated safety glass

Figure 4: Percentaged shares of modules in selected environmental impact categories

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.

Report

The LCA report underlying this EPD was developed according to the requirements of DIN EN ISO 14040 and DIN EN ISO 14044 as well as DIN EN 15804 and DIN EN ISO 14025. It is not addressed to third parties for reasons of confidentiality. It is deposited with the ift Rosenheim. The results and conclusions reported to the target group are complete, correct, without bias and transparent. The results of the study are not designed to be used for comparative statements intended for publication.

Critical review

The critical review of the LCA and the report took place in the course of verification of the EPD by the external verifier Patrick Wortner, MBA and Eng., Dipl.-Ing. (FH).

General information regarding the EPD

Comparability

This EPD was prepared in accordance with DIN EN 15804 and is therefore only comparable to those EPDs that also comply with the requirements set out in DIN EN 15804.
Any comparison must refer to the building context and the same boundary conditions of the various life cycle stages.
For comparing EPDs of construction products, the rules set out in DIN EN 15804 (Clause 5.3) apply.

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.

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

Communication

The communications format of this EPD meets the requirements of EN 15942:2011 and is therefore the basis for B2B communication. Only the nomenclature has been changed according to DIN EN 15804.

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.

Verification

Verification of the Environmental Product Declaration is documented in accordance with the "Richtlinie zur Erstellung von Typ III Umweltproduktdeklarationen" (Guidance on preparing Type III Environmental Product Declarations) in accordance with the requirements set out in DIN EN ISO 14025.

This Declaration is based on the ift PCR documents EN 17074 "PCR for flat glas products", “Part A” PCR-A-0.2:2018 an “Flat glass in building” PCR-FG-1.4:2016.

The European standard EN 15804 serves as the core PCR [a)]
Independent verification of the Declaration and statement according to EN ISO 14025:2010 ☐ internal ☒ external
Independent third party verifier: [b)] Patrick Wortner
[a)] Product category rules [b)] Optional for business-to-business communication, mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4)

Revisions of this document

No.	Date	Note	LCA-Practitioner	Verifier/s
1	25.06.2021	External verification	Zwick	Wortner

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Annex

Description of life cycle scenarios for Glass

Product stage			Con-struction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacture	Transport	Construction / Installation pro-cess	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport	Waste processing	Disposal	Reuse Recovery Recycling potential
✓	✓	✓	—	—	—	—	—	—	—	—	—	✓	✓	✓	✓	✓

The scenarios were based on information provided by the manufacturer. The scenarios were furthermore based on EN 17074.

Note: The standard scenarios selected are presented in bold type. They were also used for calculating the indicators in the summary table.

✓ Included in the LCA
— Not included in the LCA

A5 Construction/Installation – not considered, informative module

No.	Usage scenario	Description
A5	Disposal packaging	Output substances following waste treatment on site.

Environmental impacts occur in the selected scenario, resulting from the use of packaging material.

The amounts used for product packaging calculated in A1-A3, are as follows:

	Mass in kg		
Material	Float glass	Coated flat glass	Laminated safety glass
Foil	5.69E-04	6.98E-04	2.76E-06
Plastic cans	1.77E-05	1.13E-05	2.05E-05
Wood	2.42E-02	2.88E-02	7.19E-04
Carton	1.08E-03	1.04E-03	3.16E-04

C1 Deconstruction

No.	Usage scenario	Description
C1	Deconstruction	Based on EN 17074 (9.8.4 End-of-life stage (C1 to C4)) Glass 30 % dismantling, 70 % residues (disposed) Further deconstruction rates are possible, give adequate reasons.

No relevant inputs or outputs apply to the selected scenario. Energy consumption during deconstruction can be neglected. Resulting efforts are marginal.

Since this is the only scenario, the results are shown in the summary table.

In case of deviating consumption, the removal of the products forms part of the site management and is covered at the building level.

C2 Transport

No.	Usage scenario	Description
C2	Transport	Transport to the recycling facility using 34-40 t truck (Euro 0-6 Mix), Diesel, 27 t payload, 35.6 % capacity used, 74 km distance

Since this is the only scenario, the results are shown in the summary table.

C3 Waste management

No.	Usage scenario	Description
C3	Disposal	Based on EN 17074 (9.8.4 End-of-life stage (C1 to C4)). Share for recirculation of materials: • Glass 30 % in melt • Rest in landfill sites

As the products are placed on the worldwide market, the disposal scenario is based on average European data sets.

The below table presents the disposal processes and their percentage by mass / weight. The calculation is based on the above mentioned shares in percent related to the declared unit of the product system.

C3 disposal	unit	C3
Collection process, collected separately	kg	0.75
Collection process, collected as mixed construction waste	kg	1.75
Recovery system, for re-use	kg	0.00
Recovery system, for recycling	kg	0.75
Recovery system, for energy recovery	kg	0.00
Disposal	kg	1.75

Since this is the only scenario, the results are shown in the overall table.

C4 Disposal

No.	Usage scenario	Description
C4	Disposal	The non-measurable quantities and losses of the re-use / recycling chain (C1 and C3) are modelled as “disposed” (EU-28).

The consumption of scenario C4 results from physical pre-treatment, waste recycling and operating of the disposal site. The benefits obtained here from the substitution of primary material production are allocated to module D, e.g. electricity and heat from waste incineration.

Since this is the only scenario, the results are shown in the overall table.

D Benefits and loads beyond the system boundaries

No.	Usage scenario	Description
D	Recycling potential	Glass recyclate from C3 excluding the glass shards used in A3 replaces 60 % of container glass; Benefits from waste incineration: electricity replaces EU-28 electricity mix; thermal energy replaces thermal energy from EU-28 natural gas

The values in module D result from the deconstruction at the end of the service life.

Since this is the only scenario, the results are shown in the overall table.

Imprint

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Notes
This EPD is mainly based on the work and findings of the Institut für Fenstertechnik e.V., Rosenheim (ift Rosenheim) and specifically on the ift-Guideline NA-01/3 - Guidance on preparing Type III Environmental Product Declarations.

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