Environmental Product Declaration (EPD)

Declaration code: M-EPD-FEV-GB-002000

Note: The original was prepared based on the model EPD glass. The model EPD obtains validity through the transfer to the manufacturer by the ift.

Bundesverband Flachglas e.V.

Glass

Flat glass, toughened safety glass and laminated safety glass

Basis:

DIN EN ISO 14025
EN15804

Model EPD
Environmental Product
Declaration

Publication date:
18.12.2017

Next revision:
18.12.2022

www.ift-rosenheim.de/issued-epd

ift Rosenheim GmbH
Theodor-Gietl-Str. 7-9
D-83026 Rosenheim

Kontakt
Tel.: +49 8031 261-0
Fax: +49 8031 261-290
www.ift-rosenheim.de

Environmental Product Declaration (EPD)

Declaration code: M-EPD-FEV-GB-002000

Programme operator	ift Rosenheim GmbH Theodor Gietl Straße 7-9 83026 Rosenheim
Practitioner of the LCA	ift Rosenheim GmbH Theodor Gietl Straße 7-9 83026 Rosenheim
Declaration holder	Bundesverband Flachglas e.V. Müllheimerstraße 1 53840 Troisdorf Note: Declaration holders can be found on page 3.
Declaration code	M-EPD-FEV-GB-002000
Designation of declared product	Flat glass, toughened safety glass and laminated safety glass FG, TSG, LSG
Scope	Flat glass (FG), toughened safety glass (TSG) and laminated safety glass (LSG) for processing into insulating glass units and for use as glass for buildings (in the building envelope and for finishing of works / structures).
Basis	This model EPD was prepared on the basis of EN ISO 14025:2011 and EN 15804:2012+A1:2013. In addition, the “Allgemeiner Leitfaden zur Erstellung von Typ II Umweltproduktdeklarationen” (Guidance on preparing Type III Environmental Product Declarations) applies. The Declaration is based on the PCR Documents “Flachglas” (Flat Glass) PCR-FG-1.3:2016 and “PCR Teil A” (Part A) PCR-A-0.1:2018.
Validity	Publication date: 18.12.2017 / Last revision: 27.08.2019 / Next revision: 18.12.2022 This verified Environmental Product Declaration applies solely to the specified products and is valid for a period of 5 years from the date of publication in accordance with DIN EN 15804.
LCA basis	The LCA was prepared in accordance with DIN EN ISO 14040 and DIN EN ISO 14044. The base data include both the data collected at the Bundesverband Flachglas e.V. production site and the generic data derived from the “Gabi ts” database. LCA calculations were based on the “cradle to gate with options” life cycle including all upstream processes (e.g. raw material extraction, etc.).
Notes	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.

Prof. Ulrich Sieberath Director of Institute	Patrick Wortner External verifier

Declaration holder

The currently valid EPDs are published in accordance with the following list at www.ift-service.de/epd:

- M-EPD-FEV-002001
  Semcoglas Holding GmbH
  Langebrügger Straße 10
  26655 Westerstede
- M-EPD-FEV-002002
  Q4Glass ABJ Investors Sp. z.o.o. Sp. k.
  BoWiD 10
  75-209 Koszalin
- M-EPD-FEV-002003
  arcon Flachglas-Veredelung GmbH & Co. KG
  Industriestraße 10
  91555 Feuchtwangen
- M-EPD-FEV-002004
  Pilkington Deutschland AG
  Hegerstraße
  45966 Gladbeck
- M-EPD-FEV-002005
  EUROGLAS GmbH
  Dammühlenweg 60
  39340 Haldensleben
- M-EPD-FEV-002006
  Hero-Glas Veredelungs GmbH
  Industriestraße 1
  26906 Dersum
- M-EPD-FEV-002007
  Glas Tech S.A.
  Rabowicka Straße 17
  62-020 Swarzedz
- M-EPD-FEV-002008
  Opolglass Sp. z.o.o.
  ul. Skladowa 6
  45-125 Opole
- M-EPD-FEV-002009
  thermopor glas GmbH
  Am Buschfeld 9
  52399 Merzenich
- M-EPD-FEV-002011
  Scheuten Glas Nederland Base Glass Unit
  Magalhaesweg 10
  5928 LN Venlo
- M-EPD-FEV-002012
  Scheuten Glas Nederland Glass Tech Unit
  Magalhaesweg 6
  5928 LN Venlo
- M-EPD-FEV-002013
  Glas Trösch GmbH
  Rentheborgen 6 – 9
  86720 Nördlingen
- M-EPD-FEV-002014
  Flachglas Wernberg GmbH
  Nürnberger Straße 140
  92533 Wernberg-Köblitz
- M-EPD-FEV-002015
  OKALUX GmbH
  Am Jöspershecklein 1
  97828 Marktheidenfeld-Altfeld
- M-EPD-FEV-002016
  Brakeler Thermo-Glas GmbH
  Industriestraße 38
  33034 Brakel
- M-EPD-FEV-GB-002017
  Pilkington IGP SP. Z o.o.
  Portowa 24
  27-600 Sandomierz
- M-EPD-FEV-GB-002018
  PRESS GLASS SA
  ul. Kopalniana 9
  42-262 Poczesna
- M-EPD-FEV-002019
  Isophon glas GmbH
  An der Breite 18
  34346 Hann. Münden
- M-EPD-FEV-002020
  sedak GmbH & Co. KG
  Einsteinring 1
  86368 Gersthofen

1 General product information

Product definition

The EPD relates to the product group “flat glass” and applies to:

1 m² area and 1 mm glass thickness

Flat glass, toughened safety glass and laminated safety glass

The declared unit relates to the product and end-of-life stages of 1 m² area and 1 mm thickness of flat glass (FG), toughened safety glass (TSG) or laminated safety glass (LSG).

The average unit is declared as follows:
Directly used material flows are determined using average area (1 m²) or produced masses (kg) and assigned to the declared unit. All other inputs and outputs in the manufacture were scaled to the declared unit as a whole, since no direct assignment to the average size is possible. The reference period is 2016.

Product description

Flat glass (FG) refers to both uncoated and coated float glass. Float glass is a clear, flat soda lime silicate glass with parallel, fire-polished surfaces, in some cases bearing metal-oxide-based coatings to modify the radiation (thermal insulation and/or solar control) properties of the glass.

Toughened safety glass (TSG) consists of a single pane that has been specially heat-treated to give the glass increased impact resistance. If the glass breaks under exposure to a high load, it disintegrates into very small fragments without forming sharp edges.

Laminated safety glass (LSG) consists of at least two glass panes lying one on top of the other, with one or several layers of a tear-resistant, viscoelastic film positioned between the panes, which consist of polyvinyl butyral (PVB).

Cutting/characteristics: Flat glass is generally supplied in stock sizes of 600 x 321 cm. It is cut and processed into toughened safety glass or laminated safety glass on a project-specific basis.

For a detailed product description refer to the manufacturer specifications at www.glas-ist-gut.de or the product specifications of the respective offer/quotation.

Product manufacture

Soda lime silicate glass (float glass):

The raw materials are introduced as a mixture into the furnace where they are melted at a temperature of approx. 1,560 °C, genera lly using gas as an energy resource.

The glass is shaped by distributing the mass of liquid glass over a bath of molten tin. The glass sheet is then cooled evenly and cut to size.

Coated glass is float glass that has been coated with a metal-oxide-based coating using various processes (sputtering, evaporation, pyrolytic processes). The coating is a few atom layers thick.

In the manufacture of ESG, float glass is heated to its transition temperature (min. 640 °C) and then rapidly cooled. This causes the su rfaces of the glass to cool and

contract faster than the remaining material. This creates additional compressive strength in the surfaces that makes the resulting glass tougher.

For the manufacture of VSG, a PVB film is placed between the panes of glass and these are pressed together in an autoclave under the action of heat and pressure.

The manufacturing processes described are applicable to all manufacturing sites of all manufacturers in Europe, because no production processes are used for the manufacture of FG, ESG and VSG that differ significantly from the above.

Application

Flat glass, toughened safety glass and laminated safety glass for processing into insulating glass units and for use as glass for buildings (in the building envelope and for finishing of works / structures).

Additional information

For detailed structural characteristics refer to the CE marking, declaration of performance, documents accompanying the product or the product data sheets.

	Flat glass	Toughened safety glass	Laminated safety glass
Strength	EN 572	EN 12150	EN 14449
Failure pattern	---	EN 12150	EN 14449
Residual loadbearing capacity	no	no	yes

2 Materials used

Primary materials

The main components of float glass are the naturally occurring raw materials sand (silicon carbonate, 58%), soda (sodium carbonate, 18%), dolomite (15%), lime (calcium carbonate, 5%) and sulphate (1%).

Further base materials used can be found in the Life Cycle Assessment (see chapter 6).

Explanation of materials:

- Flat glass: Soda lime silicate glass
- Coated flat glass: Soda lime silica glass + metal oxide
- TSG: Soda lime silicate glass
- LSG: Soda lime silicate glass + PVB film

Declarable substances

REACH conformity is requested upon transfer to the manufacturers.

All relevant safety data sheets are available from Bundesverband Flachglas e.V..

3 Construction process stage

Processing recommendations, installation

Flat glass (i.e. uncoated and, in some cases, coated float glass) can be processed into toughened safety glass, laminated safety glass and insulating glass units. It can also be used separately; depending on the application, other processes such as cutting, polishing or drilling may be applied.

Toughened safety glass can be processed into laminated safety glass and insulating glass units. It can also be used separately; depending on the application, other processes such as cutting, polishing or drilling may be applied prior to the thermal toughening process

Laminated safety glass can be processed into insulating glass units. It can also be used separately; depending on the application, other processes such as cutting, polishing or drilling may be applied.

The instructions for installation, operation, maintenance and disassembly must be noted. See www.glas-ist-gut.de for more information.

4 Use stage

Emissions to the environment

No further emissions to water and soil are known. The emissions to indoor air are within the official limits. Sound emissions do not exceed the statutory limits. There are no known VOC emissions.

Due to the wide range of possible applications and designs, the use stage is not taken into account in the calculation.

Reference service life (RSL)

RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer. The RSL shall refer to the declared technical and functional performance of the product within a building. It shall be established in accordance with any specific rules given in European product standards and shall take into account ISO 15686-1, -2, -7 and -8. Where European product standards provide guidance on deriving the RSL, such guidance shall have priority.

If the reference service life can´t be determined acoording to ISO 15686, the BBSR table „Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach BNB“ can be used. For further information visit www.nachhaltigesbauen.de

The reference service life (RSL) can be determined for a "cradle to gate - with options" EPD only if all the modules A1- A3 and B1-B5 are specified;
The service life of the FG, TSG, LSG from Bundesverband Flachglas e.V. is optionally specified at 30 years according to BBSR-Tabelle (glazing).

The service life depends on the characteristics of the product and the terms of use. The features described in the EPD are applied, in particular the following:

- Outdoor conditions: Weather conditions can have a negative effect on the service life.
- Indoor conditions: There are no known impacts that have a negative effect on the service life.

The reference service life is for the features, which are reported in this EPD or the relevant references for this purpose.

The RSL does not reflect the actual life time, which is usually determined by the service life and the redevelopment of a building. It represents no statement about service life, guarantee of performance or promise of guarantee.

5 End-of-life stage

Possible end-of-life stages

FG, TSG and LSG are not specifically designed for reuse, although reuse is by all means possible.

Flat glass, if sorted into its original pure components, can be reintroduced into the manufacturing process. Offcuts from glass cutting can be sorted into their original pure components and reintroduced into the float glass process (as per VDI 2243).

According to prEN 17074, FG, TSG, LSG are collected up to 30%, shipped to central collection points and recycled, for example for the production of container glass, insulating wool, sandpaper or glass bricks, flat glass.

All production waste generated during production and manufacture is internally recycled.

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.

Disposal routes

The average disposal routes were taken into account in the LCA.
Approximately 70% of the glass share and 100% of the glass-free materials are disposed of at a construction waste landfill.

Waste code glass waste:

- 170202, 170204, 170902 for glass from construction and demolition waste
- 190401, 191205 for glass from waste treatment plants

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.

As the basis for this, an LCA was prepared for FG, TSG, LSG. The LCA was developed in accordance with EN 15804 and the requirements set out by 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 FG, TSG, LSG. In accordance with 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. Apart from these, no other environmental impacts have been specified.

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

The specific data originate from the fiscal year 2013. The production-specific data of flat glass manufacture are taken form data collected at various typical, European manufacturer plants and statistics from 2013. In 2016, these data were verified for currentness by member companies of the Bundesverband Flachglas e.V. (German Flat Glass Association). The average values determined are based on the volumes produced by the plants. For the manufacture of TSG and LSG, typical industrial data were collected on the basis of an annual average (2016) for plants of members of the Bundesverband Flachglas e.V. The quantity data for raw materials, energy, ancillary materials used are annual averages. The data originates partly from company records and partly from values directly obtained by measurement. Data were additionally collected by the **ift** Rosenheim in 2017 to verify representativeness.

The generic data originates from the GaBi ts software, "Professional Datenbank und Baustoff Datenbank" (professional database and building materials database). The last update of both databases was in 2018. Data from before this date originate also from this databases and are not more than 4 years old. No other generic data were used for the calculation.

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 8” for the development of Life Cycle Assessments.

Scope / System boundaries

The system boundaries refer to the supply of raw materials and purchased parts, manufacture and end-of-life stage of FG, TSG, LSG (cradle to gate - with options). No additional data from pre-suppliers/subcontractors or other sites were taken into consideration.

Due to the wide range of possible applications and designs, the use stage is not taken into account in the calculation.

Cut-off criteria

All company data collected, i.e. all commodities/input and raw materials used, the thermal energy, the electricity consumption and all results of the available emission measurements from the plants were taken into consideration.

The boundaries cover only the product-relevant data. Building sections/parts of facilities that are not relevant to the manufacture of the products, were excluded.

The transport distances of the pre-products were taken into consideration as a function of 100% of the mass of the products. The transport mix is consisted as follows and is derived from the research project "EPDs for transparent components":

- Lorry, 26 - 28 t gross weight / 18.4 t payload, Euro 6, freight, 85% utilization, 100 km;
- Road train, 28 - 34 t gross weight / 22 t payload, Euro 6, 50% utilization, 50 km;
- Freight train, electric and diesel-operated, D 60%, E 51% utilization, 50 km;
- Sea ship consumption mix, 50 km

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

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.

The models of the unit processes used for the LCA have been documented in a transparent manner.

Life cycle stages

The Annex shows the entire life cycle of FG, TSG, LSG. Product stage “A1 – A3”, end-of-life stage “C3 – C4” and benefits and loads beyond the system boundaries

Benefits

"D" are considered.
The below benefits have been defined as per EN 15804:

- Benefits from recycling

Allocation procedures Allocation of co-products

During the manufacture of FG, TSG, LSG no allocations occur.

Allocations for re-use, recycling and recovery

Allocations for the use of recycled materials/secondary raw materials can be found in the GaBi database documentation.

Allocations beyond life cycle boundaries

If FG, TSG, LSG is reused / recycled during the product stage (rejects), the elements are shredded, as necessary, and then sorted into their original pure components. The system boundaries for the manufacture of FG, TSG, LSG were set following their disposal, with termination of their waste characteristics.

Secondary material

The use of secondary materials in Module A3 was considered. A small proportion of secondary material is used across industry boundaries.

Inputs

Energy:

The electricity mix is based on "Strommix Europa" (European electricity mix). Gas is based on "Erdgas Europa" (European natural gas).

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:

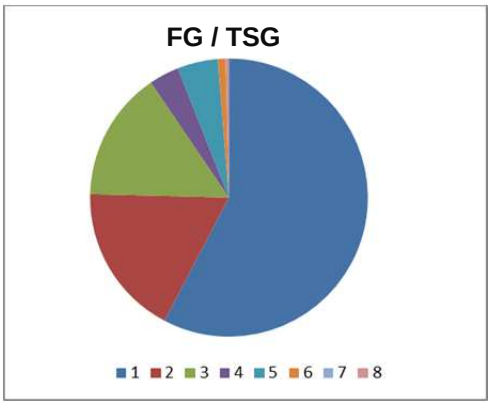
The water consumed by the individual process steps for the manufacture of FG, TSG, LSG is 3.6 l (FG) or 3.8 l (TSG) or 47.3 l (LSG) per m² element.

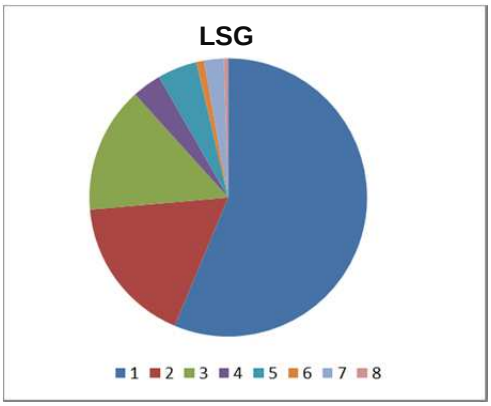
The consumption of fresh water specified in Section 6.3 originates (among others) from the upstream processes of the pre-products.

Raw material/Pre-products:

The main non-renewable material resources used are siliceous sand and waste rock.

The chart below shows the use of raw materials/pre-products per cent.





		Mass in %		
Nr.	Material	FG	TSG	LSG
1	Sand	57.7	57.7	56.3
2	Soda	17.7	17.7	17.3
3	Dolomite	15.1	15.1	14.7
4	Broken glass	3.5	3.5	3.4
5	Chalk	4.7	4.7	4.6
6	Sulphate	0.9	0.9	0.9
7	PVB-film	-	-	2.3
8	Other	< 1.0	< 1.0	< 1.0

Sand, dolomite and limestone are direct ingredients in the manufacture of the flat glass. Waste rock is the commercially worthless mass of stone obtained during the mining of ores and energy resources such as coal, etc.

Product package:

Due to their very marginal share (<1 %), no packaging materials were accounted.

Outputs

The LCA includes the following production-relevant outputs per 1 m² FG, TSG, LSG:

Waste:

See Section 6.3 - Impact assessment.

Waste water

The manufacture of FG, TSG, LSG produces 1,9 l (FG) or 3,8 l (TSG) or 47,3 l (LSG) waste water per 1 m².

6.3 Impact assessment

Goal

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

Impact categories

The models for impact assessment were applied as described in EN 15804-A1.
The impact categories presented in the EPD are as follows:

- Depletion of abiotic resources (fossil fuels);
- Depletion of abiotic resources (elements);
- Acidification of soil and water;
- Ozone depletion;
- Global warming;
- Eutrophication;
- Photochemical ozone creation.

Waste

The waste generated during the production of 1 m² of FG, TSG, LSG is evaluated and shown separately for each of the three main fractions, namely 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.

Results per 1 m² and 1 mm of FG, TSG, LSG (Part 1)		Flat glass				Toughened safety glass				Laminated safety glass			
Environmental impacts	**Unit**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**
Global warming potential (GWP)	kg CO_2 equiv.	2.43	4.32E-02	2.79E-02	-0.39	3.46	4.32E-02	2.79E-02	-0.39	7.93	4.28E-02	2.88E-02	-0.39
Depletion potential of stratospheric layer (ODP)	kg R11 equiv.	7.23E-13	1.92E-13	6.32E-15	-2.27E-13	5.12E-12	1.92E-13	6.32E-15	-2.27E-13	7.60E-09	1.90E-13	6.53E-15	-2.25E-13
Acidification potential of soil and water (AP)	kg CO_2 equiv.	1.43E-02	1.23E-04	1.65E-04	-2.13E-03	3.25E-02	1.23E-04	1.65E-04	-2.13E-03	4.91E-02	1.22E-04	1.70E-04	-2.11E-03
Eutrophication potential (EP)	kg PO_4^{3-} equiv.	1.49E-03	1.15E-05	2.28E-05	-2.74E-04	2.83E-03	1.15E-05	2.28E-05	-2.74E-04	4.26E-03	1.14E-05	2.35E-05	-2.71E-04
Formation potential of tropospheric ozone (POCP)	kg C_2H_4 equiv.	8.18E-04	7.68E-06	1.28E-05	2.98E-04	1.70E-03	7.68E-06	1.28E-05	2.98E-04	2.93E-03	7.61E-06	1.32E-05	2.96E-04
Abiotic depletion potential - non-fossil resources (ADP - elements)	kg Sb equiv.	2.24E-05	2.30E-08	1.07E-08	-8.43E-07	2.35E-05	2.30E-08	1.07E-08	-8.43E-07	6.08E-05	2.28E-08	1.10E-08	-8.36E-07
Abiotic depletion potential - fossil fuels (ADP - fossil resources)	MJ	44.37	0.46	0.36	-5.29	55.63	0.46	0.36	-5.29	106.95	0.46	0.37	-5.24
Use of resources	**Unit**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**
Use of renewable primary energy - excluding renewable primary energy resources used as raw materials	MJ	0.60	0.30	4.63E-02	-0.38	7.39	0.30	4.63E-02	-0.38	30.73	0.29	4.78E-02	-0.38
Use of renewable primary energy resources used as raw materials (material use)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total use of renewable primary energy resources (primary energy and renewable primary energy resources used as raw materials) (energy + material use)	MJ	0.60	0.30	4.63E-02	-0.38	7.39	0.30	4.63E-02	-0.38	30.73	0.29	4.78E-02	-0.38
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials.	MJ	44.80	0.79	0.37	-5.69	63.59	0.79	0.37	-5.69	139.77	0.78	1.83	-5.64
Use of non-renewable primary energy resources used as raw materials (material use)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	0.00	-1.44	0.00
Total use of non-renewable primary energy resources (primary energy and non-renewable primary energy resources used as raw materials) (energy + material use)	MJ	44.80	0.79	0.37	-5.69	63.59	0.79	0.37	-5.69	141.21	0.78	0.39	-5.64
Use of secondary materials	kg	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.12	0.00	0.00	0.00

Results per 1 m² and 1 mm of FG, TSG, LSG (Part 2)		Flat glass				Toughened safety glass				Laminated safety glass			
Use of resources	**Unit**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**
Use of renewable secondary fuels	MJ	2.39E-21	0.00	5.66E-24	-2.44E-22	2.45E-21	0.00	5.66E-24	-2.44E-22	2.84E-21	0.00	5.85E-24	-2.42E-22
Use of non-renewable secondary fuels	MJ	2.81E-20	1.17E-30	6.65E-23	-2.87E-21	2.88E-20	1.17E-30	6.65E-23	-2.87E-21	3.34E-20	1.16E-30	6.87E-23	-2.84E-21
Use of net fresh water	m^3	5.53E-03	4.04E-04	7.14E-05	-8.20E-04	1.69E-02	4.04E-04	7.14E-05	-8.20E-04	5.17E-02	4.01E-04	7.37E-05	-8.12E-04
Waste categories	**Unit**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	8.24E-08	3.70E-10	6.43E-09	-5.95E-09	9.28E-08	3.70E-10	6.43E-09	-5.95E-09	1.42E-07	3.67E-10	6.64E-09	-5.89E-09
Non-hazardous waste disposed (municipal waste)	kg	2.58	5.56E-04	1.75	-5.23E-02	2.66	5.56E-04	1.75	-5.23E-02	3.23	5.51E-04	1.81	-5.19E-02
Radioactive waste	kg	1.71E-04	1.31E-04	5.42E-06	-1.59E-04	3.16E-03	1.31E-04	5.42E-06	-1.59E-04	1.35E-02	1.30E-04	5.59E-06	-1.57E-04
Output material flows	**Unit**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**	**A1-A3**	**C3**	**C4**	**D**
Components for re-use	kg	0.00	0.00	0.00	-	0.00	0.00	0.00	-	0.00	0.00	0.00	-
Materials for recycling	kg	0.00	0.75	0.00	-	6.30E-02	0.75	0.00	-	0.38	0.74	0.00	-
Materials for energy recovery	kg	0.00	0.00	0.00	-	0.00	0.00	0.00	-	0.00	0.00	0.00	-
Exported energy (electricity)	MJ	0.00	0.00	0.00	-	0.00	0.00	0.00	-	0.29	0.00	0.00	-
Exported energy (thermal energy)	MJ	0.00	0.00	0.00	-	0.00	0.00	0.00	-	0.53	0.00	0.00	-

6.4 Interpretation, LCA presentation and critical review

Evaluation

Some of the environmental effects differ considerably. The differences arise on the one hand from changed background data in the GaBi ts software and through the use of more suitable data sets. On the other hand, the reduced energy consumption in the manufacture of flat glass leads to differences between the assessments from 2012 and 2018. With regard to toughened safety glass and laminated safety glass, the increased quantity of flat glass also plays a role.

The environmental effects of FG, TSG, LSG arise in the range of production, mainly due to the discharging emissions as well as from the use of soda or its precursors in flat glass.

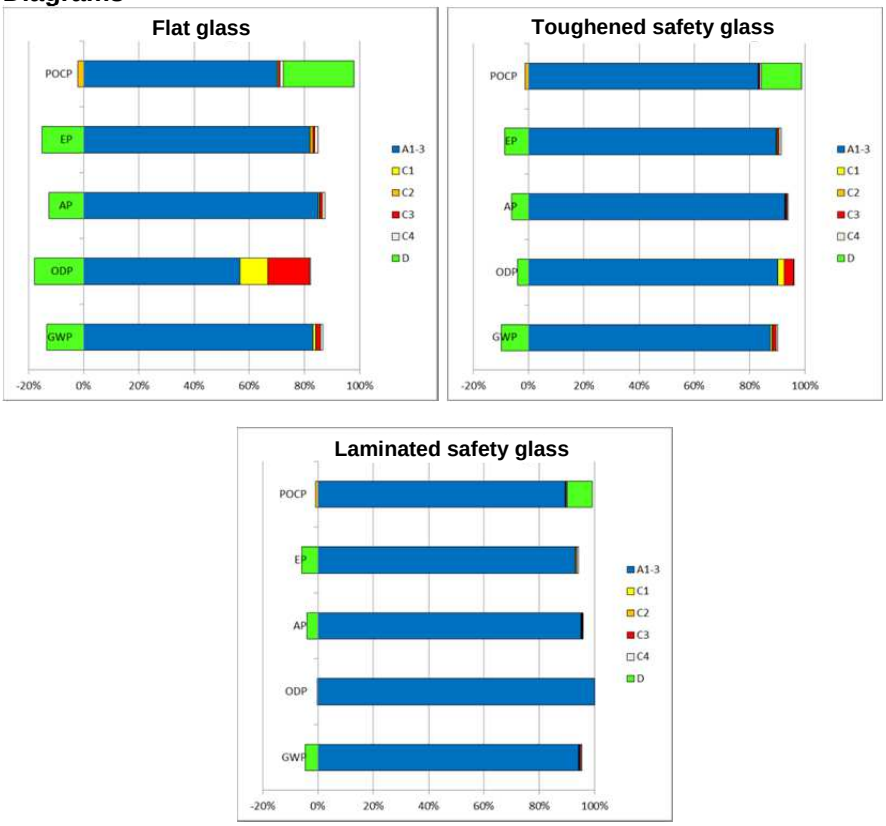
In scenario C4, only marginal expenditures for the physical pretreatment and the landfill operation are to be expected.

During the recycling of the glasses, approximately one-tenth of the environmental impact of manufacturing can be credited to Scenario D.

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

The values obtained from the LCA calculation are suitable for the certification of buildings, as necessary.

Diagrams



Report

The LCA underlying this EPD was developed according to the requirements set out in DIN EN ISO 14040 and DIN EN ISO 14044 as well as EN 15804 and EN ISO 14025. It is not addressed to third parties for confidentiality reasons. 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).

7 General information regarding the EPD

Comparability

This EPD was prepared in accordance with EN 15804 and is therefore only comparable to those EPDs that also comply with the requirements set out in 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 EN 15804 (Clause 5.3) apply.

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 EN 15804.

Verification

Verification of the Environmental Product Declaration is documented in accordance with the ift "Richtlinie zur Erstellung von Typ III Umweltproduktdeklarationen" (Guidance on preparing Type III Environmental Product Declarations) in accordance with the requirements set out in EN ISO 14025.
This Declaration is based on the ift PCR documents “PCR Teil A” (Part A) PCR-A-0.2:2018 and “Flachglas” (Flat glass) PCR-FG-1.3:2016.

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:	Practitioner of the LCA	Verifier/s
1	18.12.2017	First internal verification and approval	Stich	Stöhr
2	06.08.2018	Review	Zwick	Stöhr
3	12.02.2019	External verification	Zwick	Wortner
4	17.07.2019	Review	Zwick	Wortner

Bibliography

[1] Ökologische Bilanzierung von Baustoffen und Gebäuden – Wege zu einer ganzheitlichen Bilanzierung.
Hrsg.: Eyerer, P.; Reinhardt, H.-W.
Birkhäuser Verlag, Basel, 2000

[2] Leitfaden Nachhaltiges Bauen.
Hrsg.: Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit
Berlin, 2016

[3] GaBi 8: Software und Datenbank zur Ganzheitlichen Bilanzierung.
Hrsg.: IKP Universität Stuttgart und PE Europe GmbH
Leinfelden-Echterdingen, 2017

[4] „Ökobilanzen (LCA)“.
Klöpffer, W.; Grahl, B.
Wiley-VCH-Verlag, Weinheim, 2009

[5] EN 15804:2012+A1:2013
Nachhaltigkeit von Bauwerken – Umweltdeklarationen für Produkte – Regeln für Produktkategorien.
Beuth Verlag GmbH, Berlin

[6] EN 15942:2012-01
Nachhaltigkeit von Bauwerken – Umweltproduktdeklarationen – Kommunikationsformate zwischen Unternehmen
Beuth Verlag GmbH, Berlin

[7] ISO 21930:2017-7
Hochbau – Nachhaltiges Bauen – Umweltproduktdeklarationen von Bauprodukten
Beuth Verlag GmbH, Berlin

[8] EN ISO 14025:2011-10
Umweltkennzeichnungen und -deklarationen Typ III Umweltdeklarationen – Grundsätze und Verfahren.
Beuth Verlag GmbH, Berlin

[9] EN ISO 16000-9:2006-08
Innenraumluftverunreinigungen – Teil 9: Bestimmung der Emissionen von flüchtigen organischen Verbindungen aus Bauprodukten und Einrichtungsgegenständen – Emissionsprüfkammer-Verfahren.
Beuth Verlag GmbH, Berlin

[10] EN ISO 16000-11:2006-06
Innenraumluftverunreinigungen – Teil 11: Bestimmung der Emissionen von flüchtigen organischen Verbindungen aus Bauprodukten und Einrichtungsgegenständen – Probenahme, Lagerung der Proben und Vorbereitung der Prüfstücke.
Beuth Verlag GmbH, Berlin

[11] DIN ISO 16000-6:2012-11
Innenraumluftverunreinigungen – Teil 6: Bestimmung von VOC in der Innenraumluft und in Prüfkammern, Probenahme auf TENAX TA®, thermische Desorption und Gaschromatografie mit MS/FID.
Beuth Verlag GmbH, Berlin

[12] DIN EN ISO 14040:2018-05
Umweltmanagement – Ökobilanz – Grundsätze und Rahmenbedingungen.
Beuth Verlag GmbH, Berlin

[13] DIN EN ISO 14044:2006-10
Umweltmanagement – Ökobilanz – Anforderungen und Anleitungen.
Beuth Verlag GmbH, Berlin

[14] DIN EN 12457-1:2003-01
Charakterisierung von Abfällen – Auslaugung; Übereinstimmungsuntersuchung für die Auslaugung von körnigen Abfällen und Schlämmen – Teil 1: Einstufiges Schüttelverfahren mit einem Flüssigkeits-/Feststoffverhältnis von 2 l/kg und einer Korngröße unter 4 mm (ohne oder mit Korngrößenreduzierung).
Beuth Verlag GmbH, Berlin

[15] DIN EN 12457-2:2003-01
Charakterisierung von Abfällen – Auslaugung; Übereinstimmungsuntersuchung für die Auslaugung von körnigen Abfällen und Schlämmen – Teil 2: Einstufiges Schüttelverfahren mit einem Flüssigkeits-/Feststoffverhältnis von 10 l/kg und einer Korngröße unter 4 mm (ohne oder mit Korngrößenreduzierung).
Beuth Verlag GmbH, Berlin

[16] DIN EN 12457-3:2003-01
Charakterisierung von Abfällen – Auslaugung; Übereinstimmungsuntersuchung für die Auslaugung von körnigen Abfällen und Schlämmen – Teil 3: Zweistufiges Schüttelverfahren mit einem Flüssigkeits/Feststoffverhältnis von 2 l/kg und 8 l/kg für Materialien mit hohem Feststoffgehalt und einer Korngröße unter 4 mm (ohne oder mit Korngrößenreduzierung).
Beuth Verlag GmbH, Berlin

[17] DIN EN 12457-4:2003-01
Charakterisierung von Abfällen – Auslaugung; Übereinstimmungsuntersuchung für die Auslaugung von körnigen Abfällen und Schlämmen – Teil 4: Einstufiges Schüttelverfahren mit einem Flüssigkeits-/Feststoffverhältnis von 10 l/kg für Materialien mit einer Korngröße unter 10 mm (ohne oder mit Korngrößenreduzierung).
Beuth Verlag GmbH, Berlin

[18] DIN EN 13501-1:2010-01
Klassifizierung von Bauprodukten und Bauarten zu ihrem Brandverhalten –
Teil 1: Klassifizierung mit den Ergebnissen aus den Prüfungen zum Brandverhalten von Bauprodukten.
Beuth Verlag GmbH, Berlin

[19] EN 572-1
Glas im Bauwesen – Basiserzeugnisse aus Kalk-Natronsilicatglas – Teil 1: Definitionen und

allgemeine physikalische und mechanische Eigenschaften;
Beuth Verlag GmbH, Berlin

[20] EN 12150-1:2000-6
Glas im Bauwesen – Thermisch vorgespanntes Kalknatron-Einscheibensicherheitsglas – Teil 1: Definitionen und Beschreibung;
Beuth Verlag GmbH, Berlin

[21] EN 18631-1:2011
Glas im Bauwesen – Teilvorgespanntes Kalknatronglas – Teil 1: Definition und Beschreibung;
Beuth Verlag GmbH, Berlin

[22] EN 14449:2005
Glas im Bauwesen – Verbundglas und Verbund-Sicherheitsglas –
Konformitätsbewertung/Produktnorm
Beuth Verlag GmbH, Berlin

[23] ift QM332
Zertifizierungsprogramm für Verbund und Verbundsicherheitsglas (VSG) nach EN 14449
ift Rosenheim, Rosenheim

[24] ift QM333
Zertifizierungsprogramm für thermisch vorgespanntes Kalknatron-Einscheiben-Sicherheitsglas (ESG) nach EN 12150-2
ift Rosenheim, Rosenheim

[25] ift QM334
Zertifizierungsprogramm für heißgelagertes thermisch vorgespanntes Kalknatron-Einscheiben-Sicherheitsglas (ESG-H) nach EN 14179-2
ift Rosenheim, Rosenheim

[26] ift QM335
Zertifizierungsprogramm für teilvorgespanntes Kalknatronglas (TVG) nach EN 1863-2
ift Rosenheim, Rosenheim

[27] DIN 4102-1:1998-05
Brandverhalten von Baustoffen und Bauteilen – Teil 1: Baustoffe; Begriffe, Anforderungen und Prüfungen.
Beuth Verlag GmbH, Berlin

[28] OENORM S 5200:2009-04-01
Radioaktivität in Baumaterialien.
Beuth Verlag GmbH, Berlin

[29] OENORM EN 14405:2017-05-15
Charakterisierung von Abfällen – Auslaugungsverhalten – Perkolationsprüfung im Aufwärtsstrom (unter festgelegten Bedingungen).
Beuth Verlag GmbH, Berlin

[30] VDI 2243:2002-07
Recyclingorientierte Produktentwicklung.
Beuth Verlag GmbH, Berlin

[31] Richtlinie 2009/2/EG der Kommission zur 31. Anpassung der Richtlinie 67/548/EWG des Rates zur Angleichung der Rechts- und Verwaltungsvorschriften für die Einstufung, Verpackung und Kennzeichnung gefährlicher Stoffe an den technischen Fortschritt
(15. Januar 2009)

[32] ift-Richtlinie NA-01/3
Allgemeiner Leitfaden zur Erstellung von Typ III Umweltproduktdeklarationen.
ift Rosenheim, November 2015

[33] Arbeitsschutzgesetz – ArbSchG
Gesetz über die Durchführung von Maßnahmen des Arbeitsschutzes zur Verbesserung der Sicherheit und des Gesundheitsschutzes der Beschäftigten bei der Arbeit, 2015 (BGBl. I S. 160, 270)

[34] Bundesimmissionsschutzgesetz – BImSchG
Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnlichen Vorgängen, 2017 (BGBl. I S. 3830)

[35] Chemikaliengesetz – ChemG
Gesetz zum Schutz vor gefährlichen Stoffen
Unterteilt sich in Chemikaliengesetzt und eine Reihe von Verordnungen; hier relevant: Gesetz zum Schutz vor gefährlichen Stoffen, 2. Juli 2008 (BGBl. I S.1146)

[36] Chemikalien-Verbotsverordnung – ChemVerbotsV
Verordnung über Verbote und Beschränkungen des Inverkehrbringens gefährlicher Stoffe, Zubereitungen und Erzeugnisse nach dem Chemikaliengesetz, 2017 (BGBl. I S. 1328)

[37] Gefahrstoffverordnung – GefStoffV
Verordnung zum Schutz vor Gefahrstoffen, 23. Dezember 2017 (BGBl. I S. 3758)

[38] „PCR Teil A: Allgemeine Produktkategorieregeln für Umweltproduktdeklarationen nach EN ISO 14025 und EN 15804“.
ift Rosenheim, Januar 2018

[39] „PCR Flachglas. Product Category Rules nach ISO 14025 und EN 15804“.
ift Rosenheim, November 2016

[40] Forschungsvorhaben „EPDs für transparente Bauelemente“.
ift Rosenheim, 2011

[41] FprEN 17074:2018 D
Glas im Bauwesen - Umweltproduktdeklaration - Produktkategorieregeln für Flachglasprodukte
Beuth Verlag, GmbH, Berlin

8 Annex

Description of life cycle scenarios for FG, TSG, LSG

Product stage			Con-struction 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	Use	Inspection, maintenance, cleaning	Repair	Exchange / Replacement	Improvement / Modernisation	Operational energy use	Operational water use	Deconstruction	Transport	Waste management	Disposal	Re-use Recovery Recycling potential
✓	✓	✓	—	—	—	—	—	—	—	—	—	✓	✓	✓	✓	✓

The scenarios were based on information provided by the manufacturer. The scenarios were furthermore based on the research project “EPDs for transparent building components” [40].

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

C1 Deconstruction

No.	Scenario	Description
C1	Deconstruction	In dependence on prEN 17074 (9.8.4 Disposal phase (C1 to C4)). Residues (landfill) 70% for glass; Residues (landfill) glass-free materials 100%; Rest in the recovery. Further dismantling rates possible, appropriately substantiates

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

Results per 1 m² and 1 mm of FG, TSG, LSG		FG	TSG	LSG
Environmental impacts	**Unit**	**C1**	**C1**	**C1**
Global warming potential (GWP)	kg CO_2 equiv.	2.88E-02	2.88E-02	2.94E-02
Depletion potential of stratospheric layer (ODP)	kg R11 equiv.	1.28E-13	1.28E-13	1.31E-13
Acidification potential of soil and water (AP)	kg CO_2 equiv.	8.18E-05	8.18E-05	8.35E-05
Eutrophication potential (EP)	kg PO_4^{3-} equiv.	7.67E-06	7.67E-06	7.82E-06
Formation potential of tropospheric ozone (POCP)	kg C_2H_4 equiv.	5.12E-06	5.12E-06	5.23E-06
Abiotic depletion potential - non-fossil resources (ADP - elements)	kg Sb equiv.	1.53E-08	1.53E-08	1.56E-08
Abiotic depletion potential - fossil fuels (ADP - fossil resources)	MJ	0.31	0.31	0.31
Use of resources	**Unit**	**C1**	**C1**	**C1**
Use of renewable primary energy - excluding renewable primary energy resources used as raw materials	MJ	0.20	0.20	0.20
Use of renewable primary energy resources used as raw materials (material use)	MJ	0.00	0.00	0.00
Total use of renewable primary energy resources (primary energy and renewable primary energy resources used as raw materials) (energy + material use)	MJ	0.20	0.20	0.20
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials.	MJ	0.53	0.53	0.54
Use of non-renewable primary energy resources used as raw materials (material use)	MJ	0.00	0.00	0.00
Total use of non-renewable primary energy resources (primary energy and non-renewable primary energy resources used as raw materials) (energy + material use)	MJ	0.53	0.53	0.54
Use of secondary materials	kg	0.00	0.00	0.00
Use of renewable secondary fuels	**Unit**	0.00	0.00	0.00
Use of non-renewable secondary fuels	MJ	7.82E-31	7.82E-31	7.98E-31
Use of net fresh water	MJ	2.69E-04	2.69E-04	2.75E-04
Waste categories	m^3	**C1**	**C1**	**C1**
Hazardous waste disposed	**Unit**	2.47E-10	2.47E-10	2.52E-10
Non-hazardous waste disposed (municipal waste)	kg	3.71E-04	3.71E-04	3.78E-04
Radioactive waste	kg	8.72E-05	8.72E-05	8.89E-05

Output material flows	kg	C1	C1	C1
Components for re-use	Unit	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	0.00	0.00	0.00
Exported energy (electricity)	kg	0.00	0.00	0.00
Exported energy (thermal energy)	MJ	0.00	0.00	0.00

C2 Transport

No.	Scenario	Description
C2	Transport	Transport to collecting point using 28 - 34 t truck, 50 % capacity used, 50 km distance

Results per 1 m² and 1 mm of FG, TSG, LSG		FG	TSG:	LSG:
Environmental impacts	**Unit**	**C2**	**C2**	**C2**
Global warming potential (GWP)	kg CO_2 equiv.	9.45E-03	9.45E-03	9.63E-03
Depletion potential of stratospheric layer (ODP)	kg R11 equiv.	2.61E-16	2.61E-16	2.66E-16
Acidification potential of soil and water (AP)	kg CO_2 equiv.	5.54E-05	5.54E-05	5.65E-05
Eutrophication potential (EP)	kg PO_4^{3-} equiv.	1.42E-05	1.42E-05	1.45E-05
Formation potential of tropospheric ozone (POCP)	kg C_2H_4 equiv.	-2.48E-05	-2.48E-05	-2.53E-05
Abiotic depletion potential - non-fossil resources (ADP - elements)	kg Sb equiv.	7.84E-10	7.84E-10	8.00E-10
Abiotic depletion potential - fossil fuels (ADP - fossil resources)	MJ	0.13	0.13	0.13
Use of resources	**Unit**	**C2**	**C2**	**C2**
Use of renewable primary energy - excluding renewable primary energy resources used as raw materials	MJ	7.19E-03	7.19E-03	7.34E-03
Use of renewable primary energy resources used as raw materials (material use)	MJ	0.00	0.00	0.00
Total use of renewable primary energy resources (primary energy and renewable primary energy resources used as raw materials) (energy + material use)	MJ	7.19E-03	7.19E-03	7.34E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials.	MJ	0.13	0.13	0.13
Use of non-renewable primary energy resources used as raw materials (material use)	MJ	0.00	0.00	0.00
Total use of non-renewable primary energy resources (primary energy and non-renewable primary energy resources used as raw materials) (energy + material use)	MJ	0.13	0.13	0.13
Use of secondary materials	kg	0.00	0.00	0.00
Use of renewable secondary fuels	MJ	7.04E-31	7.04E-31	7.18E-31
Use of non-renewable secondary fuels	MJ	1.07E-29	1.07E-29	1.09E-29
Use of net fresh water	m^3	1.33E-05	1.33E-05	1.35E-05
Waste categories	**Unit**	**C2**	**C2**	**C2**
Hazardous waste disposed	kg	7.54E-09	7.54E-09	7.69E-09

Non-hazardous waste disposed (municipal waste)	kg	1.09E-05	1.09E-05	1.11E-05
Radioactive waste	kg	1.78E-07	1.78E-07	1.82E-07
Output material flows	**Unit**	**C2**	**C2**	**C2**
Components for re-use	kg	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	0.00	0.00	0.00
Exported energy (electricity)	MJ	0.00	0.00	0.00
Exported energy (thermal energy)	MJ	0.00	0.00	0.00

C3 Waste management

No.	Scenario	Description
C3	Disposal	In dependence on prEN 17074 (9.8.4 Disposal phase (C1 to C4)). Share for the return of materials: Glass 100% in melting, glass-free materials 100% in landfill.

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

C3 Disposal		**C3.1**		
	Unit	**FG**	**ESG:**	**VSG:**
Collection process, collected separately	kg	0.75	0.75	0.74
Collection process, collected as mixed construction waste	kg	1.75	1.75	1.81
Recovery system, for re-use	kg	0.00	0.00	0.00
Recovery system, for recycling	kg	0.75	0.75	0.74
Recovery system, for energy recovery	kg	0.00	0.00	0.00
Disposal	kg	1.75	1.75	1.81

Values that cannot be shown or are inexistent or marginal are expressed as [-].

C4 Disposal

No.	Scenario	Description
C4	Disposal	The non-measurable quantities and losses of the re-use/recycling chain (C1 and C3) are modelled as “disposed”. The consumption is marginal and cannot be quantified.

The consumption of scenario C4 results from physical pre-treatment, waste recycling and management 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.	**Scenario**	**Description**
D	Recycling potential	Glass recyclate from C3 excluding the recyclate used in A3 replaces 60 % of container glass;
The values in module D result from de-construction at the end of service life.		

Imprint

Practitioner of the LCA
ift Rosenheim GmbH
Theodor Gietl Straße 7-9
83026 Rosenheim

Programme operator
ift Rosenheim GmbH
Theodor-Gietl-Str. 7-9
D-83026 Rosenheim
Phone: +49 (0) 80 31/261-0
Fax: +49 (0) 80 31/261 290
Email: info@ift-rosenheim.de
www.ift-rosenheim.de

Supported by
Bundesverband Flachglas e.V.
Müllheimerstraße
D-53840 Troisdorf

Declaration holder
Bundesverband Flachglas e.V.
Müllheimerstraße 1
53840 Troisdorf

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-Richtlinie NA-01/3 Allgemeiner Leitfaden zur Erstellung von Typ III Umweltproduktdeklarationen. (Guideline NA.01/3 - Guidance on preparing Type III Environmental Product Declarations)

Layout
ift Rosenheim GmbH - 2015

Photographs (front page)
BF Flachglas e.V.

ift Rosenheim GmbH
Theodor-Gietl-Str. 7-9
D-83026 Rosenheim
Phone: +49 (0) 80 31/261-0
Fax: +49 (0) 80 31/261-290
Email: info@ift-rosenheim.de
www.ift-rosenheim.de