Date: August 1, 2023

LAMBERTS
est. 1887

Glasfabrik Lamberts GmbH & Co. KG
Egerstraße 197, 95632
Wunsiedel, Germany
Phone: +49 9232 6050

BENDHEIM

S.A. Bendheim Ltd
82 Totowa, Road
Wayne, New Jersey, 07470
Phone: 800 221 7379

LAMBERTS EcoGlass since 1996

LINIT U-profiled (channel) glass EPD

Glasfabrik Lamberts GmbH & Co. KG and S.A Bendheim LTD have a long-standing & successful partnership for over 75 years. Bendheim is the exclusive North American representative for Lamberts LINIT U-profiled (channel) glass.

This EPD for LINIT U-profiled (channel) glass covers the North American market. The data contained is in accordance with the applicable PCR and the worldwide ISO 14025 & EN 15804 standards.

Lamberts is certified with the following management systems standards: quality management ISO 9001:2015, energy management ISO 50001:2018, and environmental management ISO 14001:2015.

Please find attached:

- Lamberts Environmental Product Declaration (EPD), Declaration Code: EPD-LPG-GB-28.1, certified by ift Rosenheim Institute.
- Short report on ecological comparison "Transport scenarios in A4" for LINIT U-profiled (channel) glass, certified by ift Rosenheim Institute.

Christoph Lamberts
General Manager
Glasfabrik Lamberts GmbH & Co. KG

Donald A. Jayson
President
S.A. Bendheim Ltd

Environmental Product Declaration

Declaration Code: EPD-LPG-GB-28.1

Glasfabrik Lamberts GmbH & Co. KG

Cast glass

Patterned, solar, wired glasses and LINIT U-profiled (channel shaped) glass made by Glasfabrik Lamberts GmbH & Co. KG

Basis:

DIN EN ISO 14025
EN15804

Company EPD
Environmental
Product **D**eclaration

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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

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Programme operator	ift Rosenheim GmbH Theodor-Gietl-Straße 7-9 D-83026 Rosenheim
Practitioner of the LCA	ift Rosenheim GmbH Theodor-Gietl-Straße 7-9 D-83026 Rosenheim
Declaration holder	Glasfabrik Lamberts GmbH & Co. KG Egerstraße 197 D-95632 Wunsiedel Holenbrunn www.lamberts.info
Declaration code	EPD-LPG-GB-28.1
Designation of declared product	Cast glass Patterned, solar, wired and LINIT U-profiled glasses made by Glasfabrik Lamberts GmbH & Co. KG
Scope	Architecture and façade construction
Basis	This EPD was prepared on the basis of EN ISO 14025:2011 and DIN EN 15804:2012+A2:2019. In addition, the “Allgemeiner Leitfaden zur Erstellung von Typ III Umweltproduktdeklarationen” (Guidance on preparing Type III Environmental Product Declarations) applies. The Declaration is based on the PCR documents EN 17074 “PCR for flat glass products”, “PCR Part A” PCR-A-0.3:2018 and “Flat glass in building” PCR-FG-2.0:2021.
Validity	Publication date: 12.12.2022 / Last revision: 12.12.2022 / Next revision: 12 December 2027 This verified Company Environmental Product Declaration (company EPD) 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 DIN EN ISO 14040 and DIN EN ISO 14044. The base data include both the data collected at the production site of Glasfabrik Lamberts GmbH & Co. KG and the generic data derived from the "GaBi 10“ data base. LCA calculations were carried out for the included “cradle to grave” life cycle including all upstream chains (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.

Christian Kehrer Head of Certification and Surveillance Body	Dr. Torsten Mielecke Chairman of Expert Committee ift-EPD and PCR	Patrick Wortner External verifier

1 General product information

Product definitioffn

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

1 m² surface area and 1 mm thickness of cast glass from Glasfabrik Lamberts GmbH & Co. KG

The LCA was prepared using the declared unit:

1 m² surface area and 1 mm thickness

The functional unit is obtained by summing up:

Assessed reference product*	Surface area	Glass thickness	Weight per unit area
LINIT U-profiled glass refined P23/60/7	1 m²	7 mm	25.81 kg/m²
LINIT U-profiled glass P23/60/7	1 m²	7 mm	25.40 kg/m²
Wired glass	1 m²	6 mm	15.00 kg/m²

* The calculated results (page 14 ff.) for the reference products listed in Table 1 are scalable for additional profiles of deviating dimensions (see conversion table, page 19)

Table 1: Functional unit per reference product

The average unit is declared as follows:
Directly used material flows are determined using the masses produced (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 2021.

The validity of the EPD is restricted to the following models:

Product groups (PG)		
PG 1 LINIT U-profiled glass refined	PG 2 LINIT U-profiled glass	PG 3 Flat glass (Patterned, solar, wired glasses)
LINIT U-profiled glass refined (theoretical glass channel covering all refinements of the channels listed below)	**LINIT U-profiled glass**	**Wired glass**
LINIT U-profiled glass enamelled TCH/TC		Patterned glass
LINIT U-profiled glass sandblasted TSH/TS/S		Solar glass
LINIT U-profiled glass toughened TH/T		

*Bold = reference product (the reference product in the product groups is the one with the worst environmental impacts)

Table 2: Product groups

Product description

The production of all glass units made by Lamberts is based on the rolled glass process in accordance with EN 572.

All glass units feature at least one, sometimes two patterned glass surface(s).
Patterned glass and LINIT U-profiled glass are available as standard green and low iron glass melts, solar glass only as low iron glass melt and wired glass only as standard green glass melt.

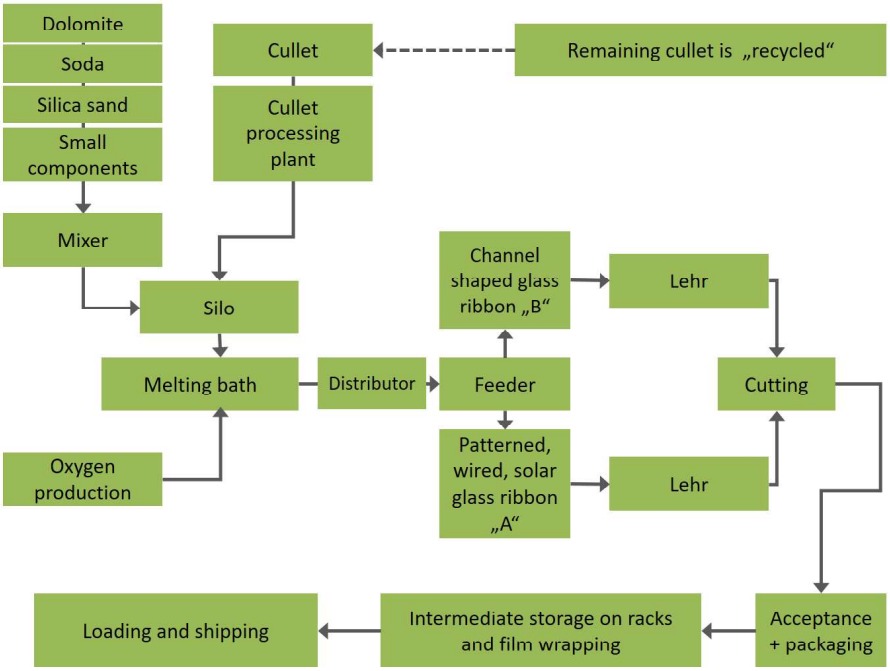
Lamberts LINIT U-profiled glass
The "U-shaped" cast glass channels are installed as single, double or multiple glazing units to the façade. Glass thicknesses range between 6 mm and 7 mm, web widths between 100 mm and 600 mm, flange heights between 20 mm and 80 mm. One channel may have a length of up to 7.50 m.
The glass can be provided with wire inlays and can be thermally toughened, colour-enamelled or even sandblasted as part of the refinement process. Coated glass was not considered.

Patterned glass
The great variety of surface patterns produces changing and surprising plays of light. Excellent light diffusion and daylighting of the interior, accompanied by privacy protection, has been one of its most significant characteristics known for more than 150 years.
Larger glazing dimensions are produced in glass thicknesses between 3 mm and 12 mm and, depending on pattern and thickness, can be additionally finished (thermal toughening, enamelling, lamination).

Solar glass
Solar glass is patterned glass for optimising the energy coming into the building, and produced from low iron melt. They are produced in thicknesses between 2 mm and 6 mm. Most of the glass is further processed into thermally toughened safety glass.

For a detailed product description refer to the manufacturer specifications at www.lamberts.info or the product specifications of the respective offer/quotation.

Product manufacture



Scope

Lamberts cast glass, be it flat glass or "U"-shaped channel glass, is used by architects and designers to enhance both the aesthetics of a building and the lighting effects produced by the glass surfaces, and to improve also various technical functions of the façades .
Lamberts architectural design glass is used in the interior and exterior of buildings.

Lamberts LINIT U-profiled glass is mainly installed in large-scale façades. The range of projects includes production halls and warehouses, office and residential buildings, parking garages and stadiums, theatres and museums.

Lamberts patterned glass is mainly used for interior applications (doors, tables, furniture, luminaires, showers, insulating glass windows, etc.) and in aesthetically sophisticated façades.
Wired glass with or without pattern is used mainly for industrial façades, roofs and interior glass doors.
Solar glass is used mainly for photovoltaics, by the collector industry and for greenhouses.

Management systems

The following management systems are in place:

- Quality management as per ISO 9001:2015
- Energy management as per ISO 50001:2018
- Environmental management as per ISO 14001:2015

Additional information

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

2 Materials used

Primary materials

The primary materials used are listed in the LCA (see Section 7).

Declarable substances

The product contains no substances from the REACH candidate list (declaration dated 22 June 2022).

All relevant safety data sheets are available from Glasfabrik Lamberts GmbH & Co. KG.

3 Construction process stage

Processing recommendations, installation

Observe the instructions for mounting/installation, operation, maintenance and disassembly, provided by the manufacturer. See www.lamberts.info.

4 Use stage

Emissions to the environment

No emissions to indoor air, water and soil are known. There may be VOC emissions.

Reference service life (RSL)

The RSL information was provided by the manufacturer. The RSL shall be specified under defined reference in-use conditions and shall refer to the declared technical and functional performance of the product within the building. It shall be established in accordance with any specific rules given in European product standards, or, if not available, in a c-PCR. It shall also take into account ISO 15686-1, -2, -7 and -8. Where European product standards or a c-PCR provide guidance on deriving the RSL, such guidance shall have priority.
If it is not possible to determine the service life as the RSL in accordance with ISO 15686, the BBSR table “Nutzungsdauer von Bauteilen zur Lebenszyklusanalyse nach BNB” (service life of building components for life cycle assessment in accordance with the sustainable construction evaluation system) can be used. For further information and explanations refer to www.nachhaltigesbauen.de.

For this EPD the following applies:
A reference service life (RSL) must be stated for the “cradle to grave” EPD and module D (A + B + C + D).
A 30-year service life has been specified for cast glass made by Glasfabrik Lamberts GmbH & Co. KG in accordance with EN 17074.

Based on the manufacturer’s practical experience values, the cast glass made by Glasfabrik Lamberts GmbH & Co. KG has an estimated service life of ≥ 70 years.

The service life is dependent on the characteristics of the product and in-use conditions.

The service life applies solely to the characteristics specified in this EPD or the corresponding references.

The reference service life (RSL) does not reflect the actual life span, which is usually determined by the service life and the refurbishment of a building. It does not provide any indication of durability, nor does it constitute a warranty with regard to the product's performance characteristics, nor any kind of guarantee.

5 End-of-life stage

Possible end-of-life stages

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

This EPD shows the end-of-life modules in accordance with EN 17074. Specific glass parts are recycled. Residual fractions are sent to landfill.

Disposal routes

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 assessments (LCAs) which use material and energy flows for the calculation and subsequent representation of environmental impacts.

As a basis for this, Life Cycle Assessments (LCAs) have been prepared for cast glass. The LCAs are in conformity with the requirements set out in 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. 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 exclusively from the 2021 fiscal year. They were collected on-site at the plant located in Wunsiedel 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 “GaBi 10” software professional and building materials databases. The last update of both databases was in 2022. Data from before this date originate also from these 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 “GaBi” sustainability software tool for the development of life cycle assessments.

Scope / system boundaries

The system boundaries refer to the supply of raw materials and purchased parts, manufacture/production, use and end-of-life stage of cast glass.
No additional data from pre-suppliers/subcontractors or other sites were taken into consideration.

Cut-off criteria

All the data that the company records, i.e. all commodities/input and raw materials used, the thermal energy used and electricity consumption, 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 distances not recorded by the company are covered by the life cycle assessment in the assumed transport mix.

The transport mix is composed as follows and originates from the research project "EPDs für transparente Bauelemente" (EPDs for transparent building components).

- Truck, 26 – 28 t total weight / 18.4 t payload, Euro 6, freight, 85% capacity used, 100 km;
- Truck-trailer, 28 – 34 t total weight / 22 t payload, Euro 6, 50% capacity used, 50 km;
- Freight train, electrical and diesel driven; D 60%, E 51% capacity used, 50 km
- Seagoing vessel, consumption mix, 50 km.

The criteria for the exclusion of inputs and outputs as set out in DIN EN 15804 are fulfilled. From the data analysis it can be assumed that the total of negligible processes per life cycle stage does not exceed 1% of the mass/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 entire life cycle of cast glass. The product stage "A1 – A3", construction process stage" A4 – A5", use stage "B1 – B7", end-of-life stage "C1 – C4" and the 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 • Benefits (thermal and electrical) from incineration
Allocation of co-products	The manufacture of the product does not give rise to any allocations.
Allocations for re-use, recycling and recovery	If the products are re-used/recycled and recovered during the product stage (rejects), the components are shredded, if necessary and then sorted into their single constituents. This is done by various process plants, e.g. magnetic separators. The system boundaries were set following their disposal, reaching the end-of-waste status.
Allocations beyond life cycle boundaries	Use of recycled materials in the manufacturing process was based on the current market-specific situation. A recycling potential that reflects the economic value of the product after recycling (recyclate) was also taken into account. The secondary material included as inputs in the cast glass is calculated as input without loads. No benefits are allocated to module D, but consumption is allocated to modules C3 and C4 (worst case scenario). The system boundary set for the recycled material refers to collection.
Secondary material	The use of secondary material in module A3 by Glasfabrik Lamberts GmbH & Co. kg was considered. Secondary material is used.
Inputs	The LCA includes the following production-relevant inputs per 1 m² surface area and 1 mm thickness: **Energy** The gas input material is based on “Erdgas Mix Deutschland (natural gas mix, Germany)”. Diesel is based on “Diesel Mix Deutschland”. Electricity is based on “Strom aus Wasserkraft Deutschland“ (Ökostrom) (hydropower - green power, Germany). 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 individual manufacturing process steps do not include water consumption, because water consumption was excluded from the assessment. The consumption of fresh water specified in Section 6.3 originates from the upstream processes of the pre-products (amongst other things).

Raw material / pre-products
The chart below shows the share of raw materials/pre-products in %.

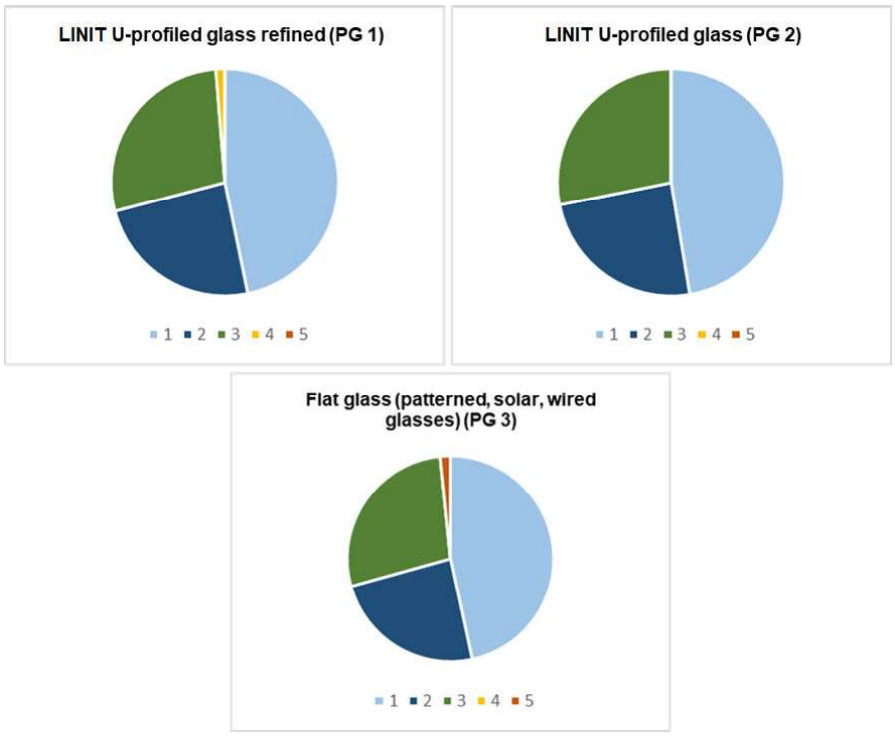


Figure 1: Percentage of individual materials per declared unit

No.	Material	Mass in %		
		PG 1	PG 1	PG 1
1	Batch	46.77	47.38	46.62
2	In-house cullet	24.13	24.45	24.06
3	Flat glass recyclate	27.81	28.17	27.72
4	Ceramic coating	1.28	0.00	0.00
5	Wire	0.00	0.00	1.60

Table 3: Percentage of individual materials per declared unit

Ancillary materials and consumables
The ancillary materials and consumables used per 1 m² surface area and 1 mm thickness of cast glass amount to 1.43 g (PG 1), 1.35 g (PG 2) and 0.93 g (PG 3):

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

No.	Material	Mass in g per PG		
		PG 1	PG 2	PG 3
1	Films and protective covers	0.06	0.06	0.04
2	PET-tape	0.23	0.23	0.16

Table 4: Weight in g of packaging per declared unit

Biogenic carbon content
The biogenic carbon content is ignored and not specified, as the total mass of substances containing biogenic carbon is less than 5% of the total mass of the product and associated packaging, and the mass of substances containing biogenic carbon in the packaging is less than 5% of the total mass of the packaging.

Outputs

The LCA includes the following production-relevant outputs per 1 m² surface area and 1 mm thickness:

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

Waste water
The water consumption for manufacture was treated as an excluded process, so there are no data on waste water.

6.3 Impact assessment

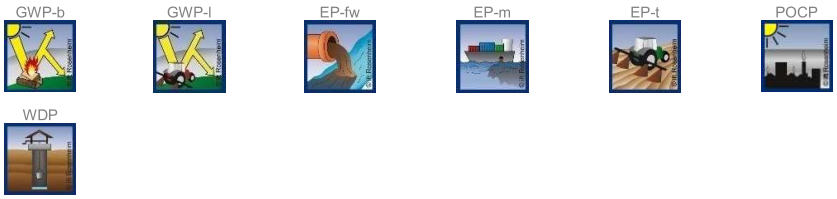
Goal

The impact assessment covers both inputs and outputs. The impact categories applied are stated 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:

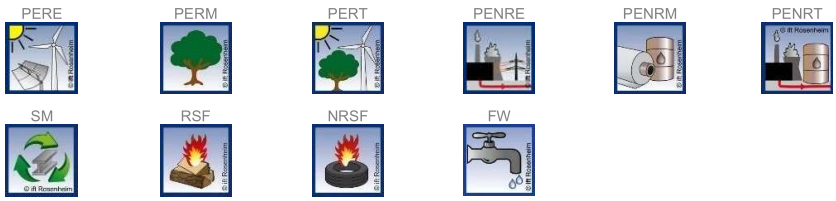
- depletion of abiotic resources – minerals and metals;
- depletion of abiotic resources– fossil fuels;
- acidification;
- ozone depletion;
- climate change– total;
- climate change– fossil;
- climate change– biogenic;
- climate change – land use and land use change;
- eutrophication aquatic fresh water;
- eutrophication aquatic marine;
- eutrophication terrestrial;
- photochemical ozone creation;
- water use.



Use of resources

The models for impact assessment were applied as described in DIN EN 15804-A2.
The following indicators for the use of resources are shown in the EPD:

- renewable primary energy as energy resource;
- renewable primary energy for material use;
- total use of renewable primary energy;
- non-renewable primary energy as energy resource;
- renewable primary energy for material use;
- total use of non-renewable primary energy;
- use of secondary materials;
- use of renewable secondary fuels;
- use of non-renewable secondary fuels;
- net use of fresh water resources.



Waste

The waste generated during the production of 1 m² surface area and 1 mm thickness of cast 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.

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

- hazardous waste disposed;
- non-hazardous waste disposed;
- radioactive waste
- components for further use;
- materials for recycling;
- materials for energy recovery;
- exported electrical energy;
- exported thermal energy.

EEE 

EET 

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;
- ionising radiation, human health;
- eco-toxicity (fresh water);
- human toxicity - carcinogenic effect;
- human toxicity - non-carcinogenic effect;
- land use related impacts / soil quality.

PM 

IRP 

ETP-fw 

HTP-c 

HTP-nc 

SQP 

Results per 1 m² surface area and 1 mm thickness of LINIT U-profiled glass refined																
	Unit	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Core indicators																
GWP-t	kg CO_2 eq.	1.27	3.88E-02	7.38E-04	0.00	4.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.78E-03	5.74E-02	3.76E-02	-0.32
GWP-f	kg CO_2 eq.	1.26	3.86E-02	7.38E-04	0.00	4.17E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.77E-03	5.69E-02	3.87E-02	-0.31
GWP-b	kg CO_2 eq.	1.01E-02	-5.30E-05	5.04E-08	0.00	3.40E-05	0.00	0.00	0.00	0.00	0.00	0.00	-3.81E-06	5.12E-04	-1.15E-03	-7.54E-04
GWP-l	kg CO_2 eq.	7.24E-04	2.14E-04	1.59E-09	0.00	3.31E-07	0.00	0.00	0.00	0.00	0.00	0.00	1.54E-05	1.20E-05	7.14E-05	-3.56E-05
ODP	kg CFC -11 eq.	6.84E-12	2.30E-15	7.30E-17	0.00	7.27E-15	0.00	0.00	0.00	0.00	0.00	0.00	1.65E-16	8.32E-13	9.09E-14	-6.24E-13
AP	mol H^+ eq.	8.63E-03	4.91E-05	1.03E-07	0.00	5.23E-06	0.00	0.00	0.00	0.00	0.00	0.00	3.21E-06	1.25E-04	2.74E-04	-2.10E-03
EP-fw	kg P eq.	2.39E-06	1.15E-07	1.63E-11	0.00	2.09E-08	0.00	0.00	0.00	0.00	0.00	0.00	8.23E-09	1.66E-07	6.55E-08	-1.76E-07
EP-m	kg N eq.	2.68E-03	1.80E-05	2.11E-08	0.00	1.73E-06	0.00	0.00	0.00	0.00	0.00	0.00	1.12E-06	2.80E-05	7.01E-05	-5.97E-04
EP-t	mol N eq.	3.45E-02	2.09E-04	4.87E-07	0.00	1.77E-05	0.00	0.00	0.00	0.00	0.00	0.00	1.32E-05	2.94E-04	7.70E-04	-6.80E-03
POCP	kg NMVOC eq.	6.52E-03	4.35E-05	5.63E-08	0.00	7.87E-06	0.00	0.00	0.00	0.00	0.00	0.00	2.81E-06	7.57E-05	2.13E-04	-1.18E-03
ADPF*²	MJ	42.79	0.51	1.25E-04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	3.69E-02	1.03	0.51	-4.64
ADPE*²	kg Sb eq.	5.66E-07	3.21E-09	1.79E-12	0.00	5.13E-10	0.00	0.00	0.00	0.00	0.00	0.00	2.31E-10	1.55E-08	3.96E-09	-2.29E-08
WDP*²	m^3 world eq. deprived	5.04E-04	3.43E-04	6.59E-05	0.00	9.17E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.47E-05	1.29E-02	4.23E-03	-1.93E-02
Use of resources																
PERE	MJ	34.83	2.92E-02	3.41E-05	0.00	1.37E-04	0.00	0.00	0.00	0.00	0.00	0.00	2.10E-03	0.57	7.60E-02	-0.43
PERM	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	0.00	0.00	0.00
PERT	MJ	34.83	2.92E-02	3.41E-05	0.00	4.10E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.10E-03	0.57	7.60E-02	-0.43
PENRE	MJ	42.79	0.51	1.26E-04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	3.70E-02	1.03	0.51	-4.64
PENRM	MJ	6.11E-03	0.00	-6.11E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	MJ	42.79	0.51	1.26E-04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	3.70E-02	1.03	0.51	-4.64
SM	kg	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	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	0.00	0.00	0.00
NRSF	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	0.00	0.00	0.00
FW	m^3	3.77E-02	3.30E-05	1.55E-06	0.00	2.24E-04	0.00	0.00	0.00	0.00	0.00	0.00	2.37E-06	5.46E-04	1.28E-04	-6.43E-04
Waste categories																
HWD	kg	1.27E-08	2.46E-12	1.30E-14	0.00	1.20E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.77E-13	8.93E-11	2.60E-11	-6.82E-10
NHWD	kg	6.43E-02	7.37E-05	3.38E-06	0.00	5.43E-05	0.00	0.00	0.00	0.00	0.00	0.00	5.30E-06	7.77E-04	2.59	-4.14E-02
RWD	kg	3.52E-04	6.33E-07	3.77E-09	0.00	7.67E-07	0.00	0.00	0.00	0.00	0.00	0.00	4.55E-08	1.65E-04	5.64E-06	-1.15E-04
Output material flows																
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	kg	2.63E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	MJ	5.80E-03	0.00	1.02E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	MJ	1.35E-02	0.00	2.37E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key:
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** - eutrophication 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 surface area and 1 mm thickness of LINIT U-profiled glass refined															
	Unit	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Additional environmental impact indicators																
PM	Disease incidence	1.50E-07	2.82E-10	6.03E-13	0.00	3.63E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.92E-11	1.03E-09	3.37E-09	-1.18E-08
IRP*1	kBq U235 eq.	3.54E-02	9.28E-05	3.74E-07	0.00	1.11E-04	0.00	0.00	0.00	0.00	0.00	0.00	6.67E-06	2.79E-02	6.27E-04	-1.93E-02
ETP-fw*2	CTUe	98.22	0.36	5.10E-05	0.00	5.20E-02	0.00	0.00	0.00	0.00	0.00	0.00	2.56E-02	0.45	0.28	-5.70
HTP-c*2	CTUh	1.29E-09	7.18E-12	4.33E-15	0.00	1.37E-12	0.00	0.00	0.00	0.00	0.00	0.00	5.16E-13	1.30E-11	4.33E-11	-3.14E-11
HTP-nc*2	CTUh	3.34E-08	3.78E-10	1.48E-13	0.00	6.73E-11	0.00	0.00	0.00	0.00	0.00	0.00	2.71E-11	4.75E-10	4.79E-09	-3.09E-09
SQP*2	dimensionless	2.88	0.18	3.82E-05	0.00	2.83E-03	0.00	0.00	0.00	0.00	0.00	0.00	1.27E-02	0.37	0.11	-0.30

Key:
PM – particulate matter emissions potential **IRP*1** – ionising 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 ionising 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 ionising radiation from the soil, from radon and from some building 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 surface area and 1 mm thickness of LINIT U-profiled glass																
	Unit	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Core indicators																
GWP-t	kg CO_2 eq.	1.19	3.82E-02	7.38E-04	0.00	4.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.74E-03	5.65E-02	3.70E-02	-0.31
GWP-f	kg CO_2 eq.	1.18	3.80E-02	7.38E-04	0.00	4.17E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.72E-03	5.60E-02	3.81E-02	-0.31
GWP-b	kg CO_2 eq.	9.82E-03	-5.22E-05	5.04E-08	0.00	3.40E-05	0.00	0.00	0.00	0.00	0.00	0.00	-3.75E-06	5.04E-04	-1.13E-03	-7.42E-04
GWP-l	kg CO_2 eq.	6.54E-04	2.11E-04	1.59E-09	0.00	3.31E-07	0.00	0.00	0.00	0.00	0.00	0.00	1.51E-05	1.18E-05	7.02E-05	-3.51E-05
ODP	kg CFC -11 eq.	6.56E-12	2.26E-15	7.30E-17	0.00	7.27E-15	0.00	0.00	0.00	0.00	0.00	0.00	1.63E-16	8.19E-13	8.94E-14	-6.14E-13
AP	mol H^+ eq.	8.26E-03	4.83E-05	1.03E-07	0.00	5.23E-06	0.00	0.00	0.00	0.00	0.00	0.00	3.16E-06	1.23E-04	2.70E-04	-2.07E-03
EP-fw	kg P eq.	2.27E-06	1.13E-07	1.63E-11	0.00	2.09E-08	0.00	0.00	0.00	0.00	0.00	0.00	8.11E-09	1.63E-07	6.45E-08	-1.74E-07
EP-m	kg N eq.	2.59E-03	1.77E-05	2.11E-08	0.00	1.73E-06	0.00	0.00	0.00	0.00	0.00	0.00	1.11E-06	2.76E-05	6.90E-05	-5.87E-04
EP-t	mol N eq.	3.33E-02	2.06E-04	4.87E-07	0.00	1.77E-05	0.00	0.00	0.00	0.00	0.00	0.00	1.30E-05	2.89E-04	7.58E-04	-6.70E-03
POCP	kg NMVOC eq.	6.31E-03	4.28E-05	5.63E-08	0.00	7.87E-06	0.00	0.00	0.00	0.00	0.00	0.00	2.77E-06	7.45E-05	2.10E-04	-1.17E-03
ADPF*²	MJ	42.09	0.51	1.25E-04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	3.63E-02	1.02	0.50	-4.57
ADPE*²	kg Sb eq.	4.02E-07	3.16E-09	1.79E-12	0.00	5.13E-10	0.00	0.00	0.00	0.00	0.00	0.00	2.27E-10	1.53E-08	3.90E-09	-2.26E-08
WDP*²	m^3 world eq. deprived	-4.71E-02	3.38E-04	6.59E-05	0.00	9.17E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.43E-05	1.27E-02	4.16E-03	-1.90E-02
Use of resources																
PERE	MJ	7.23	2.87E-02	3.41E-05	0.00	1.37E-04	0.00	0.00	0.00	0.00	0.00	0.00	2.06E-03	0.56	7.48E-02	-0.42
PERM	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	0.00	0.00	0.00
PERT	MJ	7.23	2.87E-02	3.41E-05	0.00	4.10E-03	0.00	0.00	0.00	0.00	0.00	0.00	2.06E-03	0.56	7.48E-02	-0.42
PENRE	MJ	42.09	0.51	1.26E-04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	3.64E-02	1.02	0.50	-4.57
PENRM	MJ	6.11E-03	0.00	-6.11E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	MJ	42.09	0.51	1.26E-04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	3.64E-02	1.02	0.50	-4.57
SM	kg	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	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	0.00	0.00	0.00
NRSF	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	0.00	0.00	0.00
FW	m^3	8.99E-03	3.24E-05	1.55E-06	0.00	2.24E-04	0.00	0.00	0.00	0.00	0.00	0.00	2.33E-06	5.37E-04	1.26E-04	-6.33E-04
Waste categories																
HWD	kg	1.07E-08	2.42E-12	1.30E-14	0.00	1.20E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.74E-13	8.79E-11	2.56E-11	-6.72E-10
NHWD	kg	5.61E-02	7.25E-05	3.38E-06	0.00	5.43E-05	0.00	0.00	0.00	0.00	0.00	0.00	5.21E-06	7.65E-04	2.55	-4.07E-02
RWD	kg	3.42E-04	6.23E-07	3.77E-09	0.00	7.67E-07	0.00	0.00	0.00	0.00	0.00	0.00	4.48E-08	1.62E-04	5.55E-06	-1.14E-04
Output material flows																
CRU	kg	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	kg	2.63E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	MJ	5.80E-03	0.00	1.02E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	MJ	1.35E-02	0.00	2.37E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key:
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** - eutrophication 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 surface area and 1 mm thickness of LINIT U-profiled glass															
	Unit	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Additional environmental impact indicators																
PM	Disease incidence	6.49E-08	2.78E-10	6.03E-13	0.00	3.63E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.89E-11	1.02E-09	3.32E-09	-1.17E-08
IRP*1	kBq U235 eq.	3.42E-02	9.14E-05	3.74E-07	0.00	1.11E-04	0.00	0.00	0.00	0.00	0.00	0.00	6.57E-06	2.75E-02	6.17E-04	-1.90E-02
ETP-fw*2	CTUe	93.95	0.35	5.10E-05	0.00	5.20E-02	0.00	0.00	0.00	0.00	0.00	0.00	2.52E-02	0.45	0.28	-5.62
HTP-c*2	CTUh	3.50E-10	7.07E-12	4.33E-15	0.00	1.37E-12	0.00	0.00	0.00	0.00	0.00	0.00	5.08E-13	1.28E-11	4.26E-11	-3.09E-11
HTP-nc*2	CTUh	3.19E-08	3.72E-10	1.48E-13	0.00	6.73E-11	0.00	0.00	0.00	0.00	0.00	0.00	2.66E-11	4.67E-10	4.72E-09	-3.04E-09
SQP*2	dimensionless	2.80	0.17	3.82E-05	0.00	2.83E-03	0.00	0.00	0.00	0.00	0.00	0.00	1.25E-02	0.37	0.10	-0.30

Key:
PM – particulate matter emissions potential **IRP*1** – ionising 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 ionising 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 ionising radiation from the soil, from radon and from some building 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 surface area and 1 mm thickness of flat glass (patterned, solar, wired glasses)																
	Unit	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Core indicators																
GWP-t	kg CO_2 eq.	0.94	2.62E-02	5.07E-04	0.00	4.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	1.88E-03	3.88E-02	2.54E-02	-0.22
GWP-f	kg CO_2 eq.	0.94	2.61E-02	5.07E-04	0.00	4.17E-03	0.00	0.00	0.00	0.00	0.00	0.00	1.87E-03	3.84E-02	2.61E-02	-0.22
GWP-b	kg CO_2 eq.	6.72E-03	-3.58E-05	3.46E-08	0.00	3.40E-05	0.00	0.00	0.00	0.00	0.00	0.00	-2.57E-06	3.46E-04	-7.74E-04	-5.35E-04
GWP-l	kg CO_2 eq.	4.87E-04	1.45E-04	1.09E-09	0.00	3.31E-07	0.00	0.00	0.00	0.00	0.00	0.00	1.04E-05	8.12E-06	4.82E-05	-2.60E-05
ODP	kg CFC -11 eq.	4.45E-12	1.55E-15	5.02E-17	0.00	7.27E-15	0.00	0.00	0.00	0.00	0.00	0.00	1.12E-16	5.62E-13	6.14E-14	-4.71E-13
AP	mol H^+ eq.	6.04E-03	3.31E-05	7.05E-08	0.00	5.23E-06	0.00	0.00	0.00	0.00	0.00	0.00	2.17E-06	8.43E-05	1.85E-04	-1.41E-03
EP-fw	kg P eq.	1.62E-06	7.74E-08	1.12E-11	0.00	2.09E-08	0.00	0.00	0.00	0.00	0.00	0.00	5.56E-09	1.12E-07	4.43E-08	-1.32E-07
EP-m	kg N eq.	1.85E-03	1.21E-05	1.45E-08	0.00	1.73E-06	0.00	0.00	0.00	0.00	0.00	0.00	7.60E-07	1.89E-05	4.73E-05	-4.00E-04
EP-t	mol N eq.	2.35E-02	1.41E-04	3.35E-07	0.00	1.77E-05	0.00	0.00	0.00	0.00	0.00	0.00	8.90E-06	1.98E-04	5.20E-04	-4.56E-03
POCP	kg NMVOC eq.	4.57E-03	2.94E-05	3.87E-08	0.00	7.87E-06	0.00	0.00	0.00	0.00	0.00	0.00	1.90E-06	5.11E-05	1.44E-04	-8.02E-04
ADPF*²	MJ	30.27	0.35	8.62E-05	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.49E-02	0.70	0.34	-3.17
ADPE*²	kg Sb eq.	3.37E-07	2.17E-09	1.23E-12	0.00	5.13E-10	0.00	0.00	0.00	0.00	0.00	0.00	1.56E-10	1.05E-08	2.68E-09	-1.68E-08
WDP*²	m^3 world eq. deprived	-1.87E-02	2.32E-04	4.53E-05	0.00	9.17E-03	0.00	0.00	0.00	0.00	0.00	0.00	1.67E-05	8.74E-03	2.86E-03	-1.27E-02
Use of resources																
PERE	MJ	5.01	1.97E-02	2.34E-05	0.00	1.37E-04	0.00	0.00	0.00	0.00	0.00	0.00	1.42E-03	0.39	5.13E-02	-0.31
PERM	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	0.00	0.00	0.00
PERT	MJ	5.01	1.97E-02	2.34E-05	0.00	4.10E-03	0.00	0.00	0.00	0.00	0.00	0.00	1.42E-03	0.39	5.13E-02	-0.31
PENRE	MJ	30.27	0.35	8.62E-05	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.50E-02	0.70	0.34	-3.17
PENRM	MJ	4.19E-03	0.00	-4.19E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	MJ	30.27	0.35	8.62E-05	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.50E-02	0.70	0.34	-3.17
SM	kg	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	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	0.00	0.00	0.00
NRSF	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	0.00	0.00	0.00
FW	m^3	6.57E-03	2.23E-05	1.06E-06	0.00	2.24E-04	0.00	0.00	0.00	0.00	0.00	0.00	1.60E-06	3.69E-04	8.67E-05	-4.46E-04
Waste categories																
HWD	kg	-2.54E-09	1.66E-12	8.94E-15	0.00	1.20E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.20E-13	6.03E-11	1.76E-11	-4.59E-10
NHWD	kg	4.46E-02	4.98E-05	2.32E-06	0.00	5.43E-05	0.00	0.00	0.00	0.00	0.00	0.00	3.58E-06	5.25E-04	1.75	-2.75E-02
RWD	kg	2.33E-04	4.28E-07	2.59E-09	0.00	7.67E-07	0.00	0.00	0.00	0.00	0.00	0.00	3.07E-08	1.11E-04	3.81E-06	-7.94E-05
Output material flows																
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	kg	1.07E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	MJ	3.98E-03	0.00	6.99E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	MJ	9.25E-03	0.00	1.63E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key:
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** - eutrophication 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 surface area and 1 mm thickness of flat glass (patterned, solar, wired glasses)															
	Unit	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Additional environmental impact indicators																
PM	Disease incidence	5.00E-08	1.90E-10	4.14E-13	0.00	3.63E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.30E-11	6.99E-10	2.28E-09	-8.13E-09
IRP*1	kBq U235 eq.	2.40E-02	6.27E-05	2.57E-07	0.00	1.11E-04	0.00	0.00	0.00	0.00	0.00	0.00	4.51E-06	1.89E-02	4.24E-04	-1.31E-02
ETP-fw*2	CTUe	64.74	0.24	3.50E-05	0.00	5.20E-02	0.00	0.00	0.00	0.00	0.00	0.00	1.73E-02	0.31	0.19	-3.80
HTP-c*2	CTUh	2.91E-10	4.85E-12	2.98E-15	0.00	1.37E-12	0.00	0.00	0.00	0.00	0.00	0.00	3.48E-13	8.77E-12	2.92E-11	-2.93E-11
HTP-nc*2	CTUh	2.40E-08	2.55E-10	1.02E-13	0.00	6.73E-11	0.00	0.00	0.00	0.00	0.00	0.00	1.83E-11	3.21E-10	3.24E-09	-2.22E-09
SQP*2	dimensionless	1.99	0.12	2.62E-05	0.00	2.83E-03	0.00	0.00	0.00	0.00	0.00	0.00	8.57E-03	0.25	7.12E-02	-0.22

Key:
PM – particulate matter emissions potential **IRP*1** – ionising 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 ionising 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 ionising radiation from the soil, from radon and from some building 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

Conversion table

The cast glass calculations were based on the declared product P23/60/7. The environmental impacts of the other channel glass units can be calculated using the following equation and factors:

P xxx/yy/z = z * (P 23/60/7) * factor

Profile	Dimensions [mm]	kg/m²	Factor	Profile	Dimensions [mm]	kg/m²	Factor
P 15	150/41/6	21.3	**0.98**	P 15/60/7	150/60/7	29.3	**1.15**
P 23	232/41/6	19.4	**0.89**	P 18/60/7	180/60/7	27.2	**1.07**
P 26	262/41/6	18.7	**0.86**	P 23/60/7	232/60/7	25.4	**1.00**
P 33	331/41/6	17.8	**0.82**	P 23/80/7	232/80/7	28.9	**1.14**
P 50	498/41/6	16.9	**0.78**	P 26/60/7	262/60/7	24.0	**0.94**
				P 26/80/7	262/80/7	27.0	**1.06**
				P 33/60/7	331/60/7	23.0	**0.91**
				P 40/60/7	400/60/7	21.8	**0.86**

6.4 Interpretation, LCA presentation and critical review

Evaluation

The product groups
- LINIT U-profiled glass refined (PG 1)
- LINIT U-profiled glass (PG 2)
- Flat glass (patterned, solar and wired glasses) (PG 3)

differ to varying degrees in their environmental impacts. The differences are due to the variations in the pre-products and raw materials and the amounts used. The differences between PG and PG 2 are due to the surface finishing assessments of PG 1. The differences between PG 2 and PG 3 are due to less material used per declared PG 3 unit and the wire used. Comparably better environmental impacts would be expected for PG 3 due to the much lower product weight.

The environmental impacts during the manufacture of all product groups are mainly due to the use of soda and their upstream chains. The modelled one-off replacement during the specified 30-year RSL also produces a major part of the environmental impacts during the entire life cycle.
In addition, the use of oxygen for oxygen-supported incineration and of natural gas plays a minor role with respect to the environmental impacts. The use of steel wire in PG 3 only contributes to the environmental impacts to a small extent.
During the use stage, environmental impacts are due soley to cleaning. As 0.2 l cleaning solution is required for cleaning per declared unit per year in accordance with EN 17074, the environmental impacts during the use stage are identical for all product groups.
For scenario C4 only marginal consumptions arising from the physical pre-treatment and management of the disposal site are expected. Allocation to individual products is almost impossible for site disposal.
In terms of product recycling, for the glass about 8.00% (PG 1), 8.19% (PG 2) and 7.43% (PG 3) of the environmental impacts can be assigned as benefits in scenario D. For wire in PG 3, the benefits amount to 0.29% of the environmental impacts.

Some LCA results differ from the results presented in the EPD prepared five years ago. This is partly due to methodological changes in modelling and partly reflects production changes. The reasons for the differences are listed below:

1. Recording emissions from production
2. Updating glass data
3. Use of other, more suitable GaBi datasets
4. Adjustment of background data in GaBi (version update)
5. Updating modelling basis due to revision from EN 15804:A1 to EN 15804:A2
6. Extension of assessed lifecycle modules

The charts below show the allocation of the main environmental impacts.

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

Charts

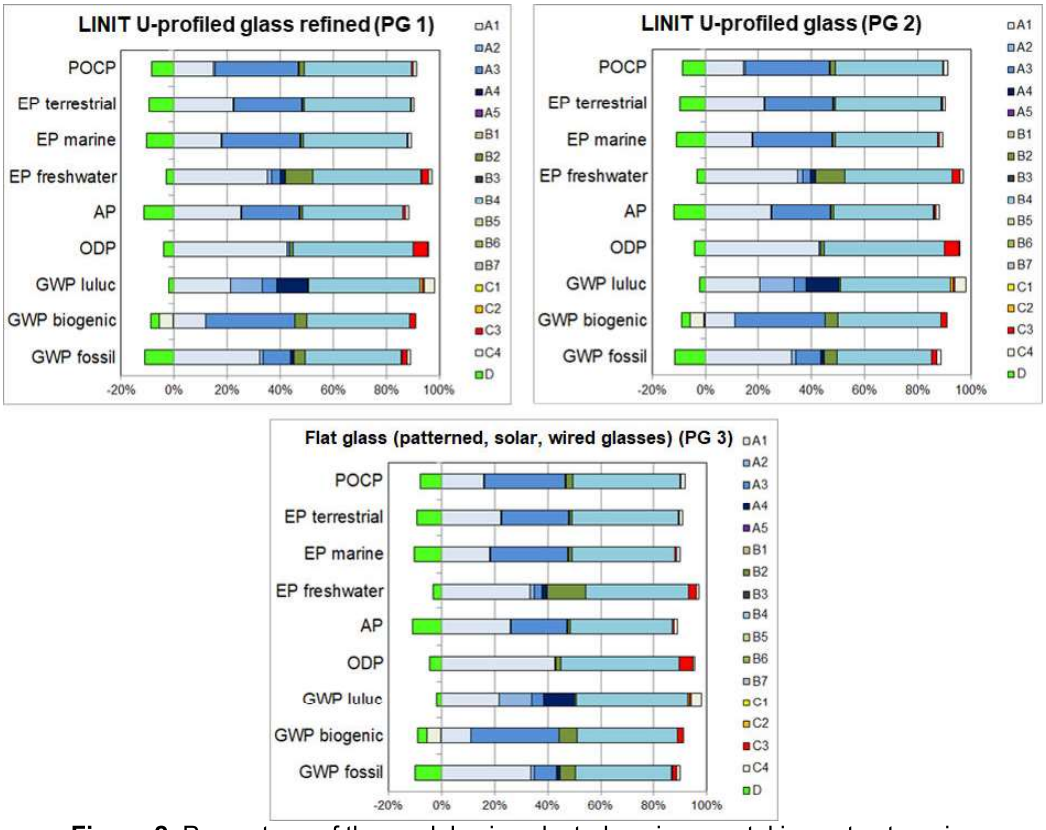


Figure 2: Percentage of the modules in selected environmental impact categories

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 of the report took place in the course of verification of the EPD and were carried out by Patrick Wortner, MBA and Eng., Dipl.-Ing, an external verifier.

7 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.

The detailed results of the products were summarised on the basis of conservative assumptions and differ from the average results. The establishment of the product groups and the resulting variations are documented in the background report.

Communication

The communications format of this EPD meets the requirements of EN 15942:2012 and is therefore the basis for B2B communication. Only the nomenclature has been changed according to EN 15804. The nomenclature was selected in accordance with DIN 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 DIN EN ISO 14025.

The Declaration is based on the PCR documents EN 17074 “PCR for flat glass product)”, “PCR Part A” PCR-A-0.3:2018 and “Flat glass in building” PCR-FG-2.0:2021.

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
1	12.12.2022	External Verification	Pscherer	Wortner

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9 Annex

Description of life cycle scenarios for cast glass

Product stage			Con-struction stage		Use stage*							End-of-life stage				Benefits and loads from 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 process	Use	Maintenance	Repair	Replacement	Modification/refurbishment	Operational energy use	Operational water use	Deconstruction/demolition	Transport	Waste processing	Disposal	Re-use Recovery Recycling potential
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

* For the declared B modules, the calculation of the results included the specified RSL related to one year.

Calculation of the scenarios included the defined RSL (see 4 Use stage).

The scenarios were based on information provided by the manufacturer. The scenarios were furthermore based on EN 14074 and the research project "EPDs for transparent building components” (1).

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

A4 Transport to the construction site

A4	**Large-scale project**	**40 t truck (Euro 0-6 mix), diesel, 27 t payload, 100% capacity used, approx. 150 km to construction site and empty return trip.**

A4 Transport to the construction site	Transport weight [kg/1 m² surface area and 1 mm thickness]	Density [kg/m³]
PG1	3.70	2500
PG2	3.64	2500
PG3	2.50	2500

Since only one scenario is used, the results are shown in the relevant summary table.

A5 Construction/Installation

No.	Scenario	Description
A5	**With ancillary elements**	**As set out in standard EN 17074, the ancillary elements to install the glass/glass products in the building have not been taken into account.**

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

Ancillary materials, consumables, use of energy and water, use of other resources, material losses, direct emissions as well as waste materials during installation are negligible.

It is assumed that the packaging material in the module construction / installation is sent to waste handling. Waste is only thermally recycled in line with the conservative approach. Benefits from A5 are specified in module D. Benefits from waste incineration: electricity replaces electricity mix (EU 28); thermal energy replaces thermal energy from natural gas (EU 28). Transport to the recycling plants has not been taken into account.

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

B1 Use – not relevant

Refer to Section 4 Use stage - Emissions to the environment. No emissions to indoor air environment are known.

B2 Inspection, maintenance, cleaning

B2.1 Cleaning

No.	Scenario	Description
B2.1	**Rarely manual**	**as per EN 17074: Use of 0.2 l cleaning solution (0.2 l water with 0.01 l detergent) per square metre of glass per year.**

Ancillary materials, consumables, use of energy and water, material losses and waste as well as transport distances during cleaning are negligible.

Since only one scenario is used, the results are shown in the relevant summary table.

B2.2 Maintenance – not relevant

In accordance with EN 17074, no maintenance is required for cast glass

B3 Repair – not relevant

In accordance with EN 17074, repair of glass products installed in the building is included in the service life of the glass products, therefore this module has not been included.

For updated information refer to the respective instructions for assembly/installation, operation and maintenance from Glasfabrik Lamberts GmbH & Co. KG.

B4 Exchange / Replacement

No.	Scenario	Description
B4.1	**No replacement**	**No replacement provided according to EN 17074.**
B4.2	Normal use, heavy use and extraordinary use	One replacement over a 30 year period (RSL)*

* Assumptions for evaluation of possible environmental impacts; statements made do not constitute any guaranty or warranty of performance.

The statements made in this EPD are only informative to allow evaluation at the building level.

It is assumed that no replacement will be necessary during the 30-year RSL according to EN 17074 and the assumed 50-year building service life.
The results refer to one year based on the RSL.

For updated information refer to the respective instructions for assembly/installation, operation and maintenance from Glasfabrik Lamberts GmbH & Co. KG.

Ancillary materials, consumables, use of energy and water, material losses, waste as well as transport distances during installation are negligible.

LINIT U-profiled glass refined			
B4 Exchange / Replacement	**Unit**	**B4.1**	B4.2
Core indicators			
GWP-t	kg CO_2 eq.	**0.00**	3.50E-02
GWP-f	kg CO_2 eq.	**0.00**	3.47E-02
GWP-b	kg CO_2 eq.	**0.00**	2.91E-04
GWP-l	kg CO_2 eq.	**0.00**	2.62E-05
ODP	kg CFC -11 eq.	**0.00**	2.38E-13
AP	mol H^+ eq.	**0.00**	2.31E-04
EP-fw	kg P eq.	**0.00**	8.17E-08
EP-m	kg N eq.	**0.00**	7.30E-05
EP-t	mol N eq.	**0.00**	9.57E-04
POCP	kg NMVOC eq.	**0.00**	1.88E-04
ADPF	MJ	**0.00**	1.32
ADPE	kg Sb eq.	**0.00**	1.88E-08
WDP	m^3 world eq. deprived	**0.00**	-4.90E-05

Use of resources			
PERE	MJ	**0.00**	3.89E-02
PERM	MJ	**0.00**	0.00
PERT	MJ	**0.00**	1.17
PENRE	MJ	**0.00**	1.32
PENRM	MJ	**0.00**	0.00
PENRT	MJ	**0.00**	1.32
SM	kg	**0.00**	4.20E-02
RSF	MJ	**0.00**	0.00
NRSF	MJ	**0.00**	0.00
FW	m^3	**0.00**	1.26E-03
Waste categories			
HWD	kg	**0.00**	4.03E-10
NHWD	kg	**0.00**	8.73E-02
RWD	kg	**0.00**	1.36E-05
Output material flows			
CRU	kg	**0.00**	0.00
MFR	kg	**0.00**	3.70E-02
MER	kg	**0.00**	0.00
EEE	MJ	**0.00**	2.27E-04
EET	MJ	**0.00**	5.27E-04
Additional environmental impact indicators			
PM	Disease incidence	**0.00**	4.73E-09
IRP	kBq U235 eq.	**0.00**	1.49E-03
ETPfw	CTUe	**0.00**	3.11
HTPc	CTUh	**0.00**	4.40E-11
HTP-nc	CTUh	**0.00**	1.18E-09
SQP	dimensionless	**0.00**	0.10
LINIT U-profiled glass			
B4 Exchange / Replacement	**Unit**	**B4.1**	B4.2
Core indicators			
GWP-t	kg CO_2 eq.	**0.00**	3.25E-02
GWP-f	kg CO_2 eq.	**0.00**	3.22E-02
GWP-b	kg CO_2 eq.	**0.00**	2.82E-04
GWP-l	kg CO_2 eq.	**0.00**	2.39E-05
ODP	kg CFC -11 eq.	**0.00**	2.28E-13
AP	mol H^+ eq.	**0.00**	2.20E-04
EP-fw	kg P eq.	**0.00**	7.77E-08
EP-m	kg N eq.	**0.00**	7.03E-05
EP-t	mol N eq.	**0.00**	9.23E-04
POCP	kg NMVOC eq.	**0.00**	1.81E-04
ADPF	MJ	**0.00**	1.30
ADPE	kg Sb eq.	**0.00**	1.33E-08
WDP	m^3 world eq. deprived	**0.00**	-1.64E-03
Use of resources			
PERE	MJ	**0.00**	8.28E-03
PERM	MJ	**0.00**	0.00
PERT	MJ	**0.00**	0.25
PENRE	MJ	**0.00**	1.30
PENRM	MJ	**0.00**	0.00
PENRT	MJ	**0.00**	1.30
SM	kg	**0.00**	4.20E-02
RSF	MJ	**0.00**	0.00
NRSF	MJ	**0.00**	0.00
FW	m^3	**0.00**	3.01E-04

Waste categories			
HWD	kg	**0.00**	3.37E-10
NHWD	kg	**0.00**	8.57E-02
RWD	kg	**0.00**	1.32E-05
Output material flows			
CRU	kg	**0.00**	0.00
MFR	kg	**0.00**	3.67E-02
MER	kg	**0.00**	0.00
EEE	MJ	**0.00**	2.27E-04
EET	MJ	**0.00**	5.27E-04
Additional environmental impact indicators			
PM	Disease incidence	**0.00**	1.92E-09
IRP	kBq U235 eq.	**0.00**	1.44E-03
ETPfw	CTUe	**0.00**	2.97
HTPc	CTUh	**0.00**	1.25E-11
HTP-nc	CTUh	**0.00**	1.14E-09
SQP	dimensionless	**0.00**	9.93E-02
Flat glass (patterned, solar, wired glasses)			
B4 Exchange / Replacement	**Unit**	**B4.1**	B4.2
Core indicators			
GWP-t	kg CO_2 eq.	**0.00**	2.64E-02
GWP-f	kg CO_2 eq.	**0.00**	2.62E-02
GWP-b	kg CO_2 eq.	**0.00**	1.92E-04
GWP-l	kg CO_2 eq.	**0.00**	1.76E-05
ODP	kg CFC-11 eq.	**0.00**	1.53E-13
AP	mol H^+ eq.	**0.00**	1.63E-04
EP-fw	kg P eq.	**0.00**	5.50E-08
EP-m	kg N eq.	**0.00**	5.07E-05
EP-t	mol N eq.	**0.00**	6.57E-04
POCP	kg NMVOC eq.	**0.00**	1.32E-04
ADPF	MJ	**0.00**	0.94
ADPE	kg Sb eq.	**0.00**	1.11E-08
WDP	m^3 world eq. deprived	**0.00**	-6.60E-04
Use of resources			
PERE	MJ	**0.00**	5.71E-03
PERM	MJ	**0.00**	0.00
PERT	MJ	**0.00**	0.17
PENRE	MJ	**0.00**	0.94
PENRM	MJ	**0.00**	0.00
PENRT	MJ	**0.00**	0.94
SM	kg	**0.00**	2.88E-02
RSF	MJ	**0.00**	0.00
NRSF	MJ	**0.00**	0.00
FW	m^3	**0.00**	2.19E-04
Waste categories			
HWD	kg	**0.00**	-9.73E-11
NHWD	kg	**0.00**	5.90E-02
RWD	kg	**0.00**	8.97E-06
Output material flows			
CRU	kg	**0.00**	0.00
MFR	kg	**0.00**	2.54E-02
MER	kg	**0.00**	0.00
EEE	MJ	**0.00**	1.56E-04
EET	MJ	**0.00**	3.63E-04

Additional environmental impact indicators			
PM	Disease incidence	**0.00**	1.49E-09
IRP	kBq U235 eq.	**0.00**	1.01E-03
ETPfw	CTUe	**0.00**	2.05
HTPc	CTUh	**0.00**	1.00E-11
HTP-nc	CTUh	**0.00**	8.43E-10
SQP	dimensionless	**0.00**	7.00E-02

B5 Improvement / modernisation – not relevant
According to EN 17047, the elements are not included in the improvement / modernisation activities for buildings.

For updated information refer to the respective instructions for assembly/installation, operation and maintenance from Glasfabrik Lamberts GmbH & Co. KG.

Ancillary materials, consumables, use of energy and water, material losses, waste as well as transport distances during replacement are negligible.

B6 Operational energy use – not relevant

There is no energy used during normal use.

B7 Operational water use – not relevant

There is no water consumption when used as intended. Water consumption for cleaning is stated in module B2.1.

C1 Deconstruction

No.	Scenario	Description
C1	**Deconstruction**	**As per EN 17074 (9.8.4 End-of-life stage (C1 to C4): Glass 30% deconstruction, 70 % residues (land-filling)** **Further deconstruction rates are possible, give adequate reasons.**

No relevant inputs or outputs apply to the scenario selected. The energy consumed for deconstruction is negligible. Any arising consumption is marginal.

Since only one scenario is used, 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.	Scenario	Description
C2	Transport	Transport to collection point using 40 t truck (Euro 0-6 mix), diesel, 27 t payload, 80% capacity used, 50 km

Since only one scenario is used, the results are shown in the relevant summary table.

C3 Waste management

No.	Scenario	Description
C3	Disposal	As per EN 17074 (9.8.4 End-of-life stage C1 to C4). Share for recirculation of materials: • 100% glass in melt

Electricity consumption of incineration plant 0.5 MJ/kg.

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

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

C3 Disposal	Unit	PG 1	PG 2	PG 3
Collection process, collected separately	kg	1.11	1.09	0.75
Collection process, collected as mixed construction waste	kg	2.59	2.55	1.75
Recovery system, for re-use	kg	0.00	0.00	0.00
Recovery system, for recycling	kg	1.11	1.09	0.75
Recovery system, for energy recovery	kg	0.00	0.00	0.00
Disposal	kg	2.59	2.55	1.75

The 100% scenarios differ from current average recycling (C3.1). The evaluation of the individual scenarios is presented in the underlying report.

Since only one scenario is used, the results are shown in the relevant summary table.

C4 Disposal		
No.	**Scenario**	**Description**
C4	**Disposal**	**The non-recordable amounts and losses within the re-use/recycling chain (C1 and C3) are modelled as “disposed” (EU-28).**
The consumption in 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 only one scenario is used, the results are shown in the relevant summary table.		
D Benefits and loads from beyond the system boundaries		
No.	**Scenario**	**Description**
D1	**Recycling potential (current market situation)**	**Glass recyclate from C3 excluding the glass cullet used in A3 replaces 60% of container glass.**
The values in module D result from recycling of the packaging material in module A5 and from deconstruction at the end of service life. The 100% scenarios differ from current average recycling (D1). The evaluation of the individual scenarios is presented in the underlying report. Since only one scenario is used, the results are shown in the relevant summary table.		

Imprint

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

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

Declaration holder
Glasfabrik Lamberts GmbH & Co. KG
Egerstraße 197
D-95632 Wunsiedel Holenbrunn

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)

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Glasfabrik Lamberts GmbH & Co. KG

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

Short report on the ecological comparison "Transport scenarios in A4" for Cast glass: Patterned glass, solar glass, wired glass and LINIT U-profiled glass of Glasfabrik Lamberts GmbH & Co. KG

June 2023

Client: Glasfabrik Lamberts GmbH & Co. KG
Egerstraße 197
95632 Wunsiedel
www.lamberts.info

Contractor: **ift** Rosenheim GmbH
Theodor-Gietl-Straße 7-9
83026 Rosenheim
www.ift-rosenheim.de

Creator: Katharina Pscherer, M.Sc.
pscherer@ift-rosenheim.de

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List of acronyms used

ADPE	Abiotic depletion potential – non-fossil resources
ADPF	Abiotic depletion potential – fossil resources
AP	Acidification potential
EP-fw	Eutrophication potential - aquatic freshwater
EP-m	Eutrophication potential - aquatic marine
EP-t	Eutrophication potential – terrestrial
EPD	Environmental Product Declaration
GWP-b	Global warming potential - biogenic
GWP-f	Global warming potential fossil fuels
GWP-l	Global warming potential - land use and land use change
GWP-t	Global warming potential – total
HWD	Hazardous waste disposed
ODP	Ozone depletion potential
PERT	Total use of renewable primary energy resources
PENRT	Total use of non-renewable primary energy resources
POCP	Photochemical ozone formation potential
RSL	Reference Service Life
WDP	Water (user) deprivation potential

1 General Aspects, Starting Point and Motivation

Sustainable construction has developed into an essential tool for the construction industry. The specific requirements associated with sustainable construction come from politicians/standards, the environment/society, and the property market. Benefits of sustainable construction include higher property values, a better environmental image, protection of our natural resources, etc. To enable the sustainability of buildings to be evaluated, environmental product declarations must be produced for construction products, describing their environmental impacts for the life cycle under consideration. Environmental product declarations are based on life cycle assessments (LCAs) which use material and energy flows for the calculation and subsequent representation of environmental impacts.

2 Goal of Study

The ecological comparison of transport scenarios in A4 is used to map the environmental impact in the environmental impact category "climate change (GWP)" for different transport routes ex works to the downstream customer.
The basis of the ecological comparison is the EPD "Cast Glass" (EPD-LPG-GB-28.1) and the products balanced therein

- LINIT channel shaped glass refined,
- LINIT channel shaped glass and
- Flat glass (patterned glass, solar glass, wired glass).

The ecological comparison considers complementary transport scenarios to the existing EPD for different delivery locations. The consideration begins for the respective transport scenario ex works in 95632 Wunsiedel and ends in various destinations in the US. The modelling of the individual transport scenarios is defined in terms of means of transport, payload, utilization and transport kilometers etc. and converted to the declared unit of 1 m² surface area and 1 mm thickness.
The environmental impacts are evaluated according to DIN EN 15804:2012+A2:2019.

An evaluation according to DIN EN 15804:2012+A2:2019 includes the following indicators:

- 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;
- Total use of renewable primary energy;
- Total use of non-renewable primary energy;
- Eutrophication freshwater;
- Eutrophication salt water;
- Eutrophication land;
- Photochemical ozone creation;
- Water use.

For the ecological comparison of the transport scenarios in A4, the evaluation is limited to the environmental impact indicator "climate change (GWP)".

The results of the study are not intended for use in comparative statements intended for publication with products other than those included in the study and, in particular, with competing products.
Further, the publication of individual values of this study should be refrained from.

3 Global warming potential

Due to the greenhouse effect the average surface temperature of the Earth is approx. 33 Kelvin higher than without this effect. Long-wave solar radiation meets the Earth's surface and is reflected as short-wave radiation. This solar radiation is partially reflected again by the atmosphere and trapped in the atmosphere. This causes a temperature increase that is promoted mainly by the trace gases carbon dioxide and water vapor. Other climate-relevant gases include methane, ozone or certain persistent synthetic chemicals that are also likely to contribute to the greenhouse effect.

Illustration 1 Total global warming potential

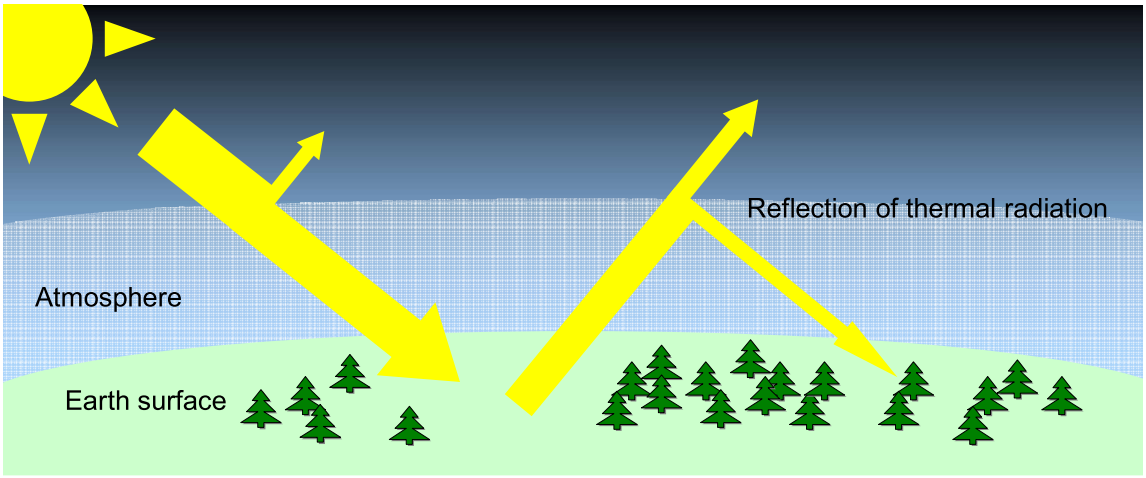

Illustration 2 Greenhouse effect

Apart from the natural greenhouse effect, there are also other factors that contribute to the man-made, anthropogenic greenhouse effect. These include the burning of different types of energy resources; livestock breeding; the production of various products without purifying the resulting exhaust gases, etc.

EN 15804 groups the global warming potential into three subcategories.

1. Subcategory global warming potential – fossil
   This category covers global warming potential emissions and capture in all media resulting from oxidation and/or the reduction of fossil fuels or fossil carbon-containing substances through their transformation or decay (e.g. incineration, landfill, etc.). Furthermore, it includes emissions from peat and the calcination of limestone as well as bonding through carbonation of cement materials and lime.

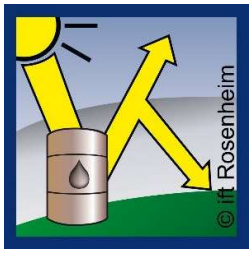

Illustration 3 Global warming potential – fossil

2. Subcategory global warming potential – biogenic
   This category includes carbon emissions to air (as CO_2, CO and CH_4) resulting from oxidation and/or the reduction of aboveground biomass through its transformation or decay (e.g. incineration, digestion, composting, etc.), as well as the sequestration of carbon from the air as CO_2 sequestration from the atmosphere through photosynthesis during biomass growth.

Illustration 4 Global warming potential – biogenic

3. Subcategory global warming potential – Land use and land use change (GWPLuluc)
   This category includes sequestration and emissions of carbon (CO_2, CO and CH_4) resulting from changes in carbon stock due to land use and land use change (e.g. deforestation, road construction, unsustainable forestry, etc.)

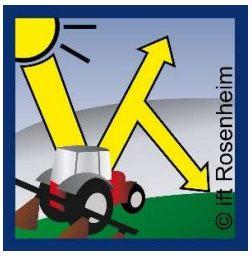

Illustration 5 Global warming potential – Land use

The total global warming potential (GWP total) is the sum of the three subcategories.

The impact indicator for that is an increase in infrared radiation (W/m²), i.e. radiation ranging between 10 and 15 µm, which increases the temperature on Earth, an effect known as global warming. Category end points can include extensive periods of drought, the death of coral reefs, and the melting of glaciers. Global warming potential provides a way of measuring and adding up the weighted relevant emissions/trace gases. Weighting is based on 1 kg carbon dioxide. Methane, for instance, corresponds to 25 kg carbon dioxide. Due to the fact that the gases relevant to global warming have different lifetimes, a time horizon of 100 years is assumed. Methane has an average lifetime of 12 years. This means that methane can remain in the atmosphere for up to 12 years and cause damage.
The LCA does not include carbon dioxide from probiotic/biological sources because this contribution was released from the atmosphere only a relatively short time ago and is returned to the atmosphere by combustion or aerobic decomposition again after a relatively short time.

Characterization:
The total amount per functional unit is obtained by summing up the individual CO_2 equivalents that are calculated by multiplying the greenhouse gas load (m_i per functional unit) from the inventory by the respective global warming factor (GWP):

$$Global\ warming\ potential_i = \sum_i (m_i\ x\ GWP_i)\ in\ kg\ CO_2\ equivalent$$

Where GWP_i is the global warming potential of the individual climate-relevant gases and m_i is the load of the gases that contribute to global warming per functional unit.

4 Scope of the study

The ecological comparison of the transport scenarios in A4 refers exclusively to the following life cycle stage for cast glass from company Glasfabrik Lamberts GmbH & Co. KG:

- **A4, Transport to construction site.**

Accordingly, the following life cycle stages were **not** included in this study:

- A1, raw material extraction and processing, processing of secondary material input (e.g. recycling processes),
- A2, transport to the manufacturer,
- A3, manufacturing,

including provision of all materials, products and energy, as well as waste processing up to the end-of-waste state (DIN EN 15804 +A2: Clause 6.3.5.5) or disposal of final residues during the product stage.

The deployment phase includes:

- A5, installation in building,

including both the provision of all materials, products and energy, as well as the complete waste processing up to the end-of-waste state or disposal of final residues during the construction phase. These information modules also include impacts and aspects linked to losses during the construction phase (i.e. production, transport, waste processing and disposal, and material losses).

The use phase, which refers to the building fabric, includes:

- B1, use or application of the installed product,
- B2, inspection, maintenance, cleaning,
- B3, repair,
- B4, exchange, replacement,
- B5, improvement, modernization,

including both the provision and transport of all materials, products, energy and water consumption, as well as the complete waste processing up to the end-of-waste state or disposal of final residues in this part of the utilization phase. These information modules also include impacts and aspects linked to losses in this part of the utilization phase (i.e. production, transport, waste processing and disposal, and material losses).

The use phase, which refers to the operation of the building, includes

- B6, the energy use for the operation of the building (e.g. operation of a heating system and other technical building equipment),
- B7, the water use for operating the building.

These information modules include the provision and transportation of both all materials and products, as well as energy and water, complete waste handling.

The end-of-life stage covers:

- C1, deconstruction, demolition,
- C2, transport to waste handling,
- C3, waste handling for re-use, recovery and/or recycling,
- C4, disposal,

including provision and all transports, provision of all materials, products and the associated energy and water consumption.

Module D includes:

- D, re-use, recovery and/or recycling potentials, stated as net flows and benefits.

4.1 Product description and declared unit

Cast glass: Patterned glass, solar glass, wired glass and LINIT U-profiled glass of company Glasfabrik Lamberts GmbH & Co. KG can generally be described as follows:

All Lamberts glasses are manufactured by machine rolling process according to EN 572.

All glasses usually have at least one, sometimes two, ornamented glass surface(s).
Patterned glass and LINIT channel shaped glass are available in standard green and low-iron oxide glass melt, solar glass exclusively in low-iron oxide glass melt, wired glass exclusively standard green glass melt.

Lamberts LINIT U-profiled glass
The "U-shaped" cast glass channels are installed as single, double or multiple glazing units to the façade. Glass thicknesses range between 6 mm and 7 mm, web widths between 100 mm and 600 mm, flange heights between 20 mm and 80 mm. One channel may have a length of up to 7.50 m.
The glass can be provided with wire inlays and can be thermally toughened, color-enameled or even sandblasted as part of the refinement process. Coated glass was not considered.

Patterned glass
The great variety of surface patterns produces changing and surprising plays of light. Excellent light diffusion and daylighting of the interior, ac-companied by privacy protection, has been one of its most significant characteristics known for more than 150 years.
Larger glazing dimensions are produced in glass thicknesses between

3 mm and 12 mm and, depending on pattern and thickness, can be additionally finished (thermal toughening, enameling, lamination).

Solar glass
Solar glass is patterned glass for optimizing the energy coming into the building, and produced from low iron melt. They are produced in thick-nesses between 2 mm and 6 mm. Most of the glass is further processed into thermally toughened safety glass.

The **declared unit** refers to 1 m² surface area and 1 mm thickness cast glass.

In detail, the product groups/reference products defined in the underlying EPD "Cast Glass" (EPD-LPG-GB-28.1) are used for the modeling.

4.2 Transport scenarios A4

The cast classes are subdivided into the following product groups:

Product group (PG)	Balanced reference product	Area	Glass thickness	Weight per unit area
PG 1	LINIT U-profiled glass refined	1 m²	7 mm	25.81 kg/m²
PG 2	LINIT U-profiled glass	1 m²	7 mm	25.40 kg/m²
PG 3	Flat glass (patterned, solar, wired glasses)	1 m²	6 mm	15.00 kg/m²

Table 1 Reference product per product group

The product-specific information for module A4 is the product weight including packaging material in relation to the declared unit. The following transport weights result for each product group.

Product group (PG)	PG 1	PG 2	PG 3
Transport weight [kg]	3.70	3.64	2.50

Table 2 Transport weight per declared unit per product group

The starting point of all transport scenarios is defined by the location of the factory Glasfabrik Lamberts GmbH & Co. KG (Egerstraße 197, 95632 Wunsiedel). From there, the first leg to the port of Hamburg is identical and is mapped in two scenarios:

Means of transport, utilization, transport km
Truck, 12 t - 14 t total weight/**13.8 t payload**, Euro 0-6, freight, 100 % capacity used, 571.00 km
Truck, 14 t - 20 t total weight/**15.8 t payload**, Euro 0-6, freight, 100 % capacity used, 571.00 km

Table 3 Truck transport Wunsiedel to port of Hamburg

Based on this, further 10 transport routes by sea to America are accounted for. Destination ports and transport routes were determined by the manufacturer. Shown means of transport can be found in the table below.

Destination port	Transport scenario	Transport kilometers
East Coast/Gulf Coast		
New York	Overseas vessel, container freighter, 27,000 dwt payload, sea vessel	6,577.35 km
Savannah		7,746.25 km
Virginia		7,003.40 km
Charleston		7,580.60 km
Everglades		8,467.88 km
Houston		9,835.07 km
Montreal, Canada		6,217.67 km
West Coast		
Los Angeles	Overseas vessel, container freighter, 27,000 dwt payload, sea vessel	15,090.33 km
Oakland		15,602.27 km
Seattle		17,020.38 km

Table 4 Sea transport Hamburg to destination port (America)

4.2.1 Data / Assumptions

The specific data determined come from company Glasfabrik Lamberts GmbH & Co. KG. Generic data are from the professional database software "LCA for Experts". No other generic data were used for the calculation. Data gaps were filled with comparable data.

The software system for holistic balancing "LCA for Expert" version 10.7.0.183 was used for modeling.

4.2.1.1 Data derived from the data base

The data used as a basis originate from the latest version 2023.1, of the professional data base. The software and database were updated in 2023.

All scenarios defined for the transport routes could be mapped representatively via the database.

5 Results

Transport weight: 3.70 kg

Results per 1 m² surface area and 1 mm thickness of LINIT U-profiled glass refined

	Section*	WUN-HH 13.8 t	WUN-HH 15.8 t	HH to New York	HH to Savannah	HH to Virginia	HH to Charleston	HH to Everglades	HH to Houston	HH to Montreal	HH to Los Angeles	HH to Oakland	HH to Seattle
	Transport km	571.00	571.00	6577.35	7746.25	7003.40	7580.60	8467.88	9835.07	6217.67	15090.33	15602.27	17020.38
	Unit	**Core indicators**											
GWP-t	kg CO_2 equivalent	0.110	0.112	0.248	0.292	0.264	0.285	0.319	0.370	0.234	0.568	0.587	0.641
GWP-f	kg CO_2 equivalent	0.109	0.111	0.247	0.291	0.264	0.285	0.319	0.370	0.234	0.568	0.587	0.640
GWP-b	kg CO_2 equivalent	-4.01E-04	-4.09E-04	1.50E-04	1.76E-04	1.59E-04	1.72E-04	1.93E-04	2.24E-04	1.41E-04	3.43E-04	3.55E-04	3.87E-04
GWP-l	kg CO_2 equivalent	6.52E-04	6.65E-04	6.75E-06	7.95E-06	7.19E-06	7.78E-06	8.69E-06	1.01E-05	6.38E-06	1.55E-05	1.60E-05	1.75E-05

Key: **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 * WUN-HH – Wunsiedel to port of Hamburg

Transport weight: 3.64 kg

Results per 1 m² surface area and 1 mm thickness of LINIT U-profiled glass

	Section*	WUN-HH 13.8 t	WUN-HH 15.8 t	HH to New York	HH to Savannah	HH to Virginia	HH to Charleston	HH to Everglades	HH to Houston	HH to Montreal	HH to Los Angeles	HH to Oakland	HH to Seattle
	Transport km	571.00	571.00	6577.35	7746.25	7003.40	7580.60	8467.88	9835.07	6217.67	15090.33	15602.27	17020.38
	Unit	**Core indicators**											
GWP-t	kg CO_2 equivalent	0.108	0.110	0.244	0.287	0.259	0.281	0.314	0.364	0.230	0.559	0.578	0.630
GWP-f	kg CO_2 equivalent	0.108	0.109	0.243	0.287	0.259	0.281	0.313	0.364	0.230	0.559	0.578	0.630
GWP-b	kg CO_2 equivalent	-3.95E-04	-4.03E-04	1.47E-04	1.73E-04	1.57E-04	1.70E-04	1.89E-04	2.20E-04	1.39E-04	3.37E-04	3.49E-04	3.81E-04
GWP-l	kg CO_2 equivalent	6.41E-04	6.54E-04	6.64E-06	7.82E-06	7.07E-06	7.66E-06	8.55E-06	9.93E-06	6.28E-06	1.52E-05	1.58E-05	1.72E-05

Key: **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 * WUN-HH – Wunsiedel to port of Hamburg

Transport weight: 2.50 kg

Results per 1 m² surface area and 1 mm thickness of flat glass (patterned, solar, wired glasses)

	Section*	WUN-HH 13.8 t	WUN-HH 15.8 t	HH to New York	HH to Savannah	HH to Virginia	HH to Charleston	HH to Everglades	HH to Houston	HH to Montreal	HH to Los Angeles	HH to Oakland	HH to Seattle
	Transport km	571.00	571.00	6577.35	7746.25	7003.40	7580.60	8467.88	9835.07	6217.67	15090.33	15602.27	17020.38
	Unit	**Core indicators**											
GWP-t	kg CO_2 equivalent	7.40E-02	7.54E-02	0.167	0.197	0.178	0.193	0.215	0.250	0.158	0.384	0.397	0.433
GWP-f	kg CO_2 equivalent	7.38E-02	7.52E-02	0.167	0.197	0.178	0.193	0.215	0.250	0.158	0.384	0.397	0.433
GWP-b	kg CO_2 equivalent	-3.57E-04	-3.64E-04	1.01E-04	1.19E-04	1.08E-04	1.16E-04	1.30E-04	1.51E-04	9.55E-05	2.32E-04	2.40E-04	2.61E-04
GWP-l	kg CO_2 equivalent	5.79E-04	5.91E-04	4.56E-06	5.37E-06	4.86E-06	5.26E-06	5.87E-06	6.82E-06	4.31E-06	1.05E-05	1.08E-05	1.18E-05

Key: **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 * WUN-HH – Wunsiedel to port of Hamburg

The environmental impact of a total transport route from Wunsiedel to America is obtained by adding the corresponding values of the individual scenarios. For the first stage from Wunsiedel to the port of Hamburg, a choice can be made between the two scenarios shown of a 13.8 t truck and a 15.8 t truck.

6 Interpretation

The environmental impacts of the product groups for A4

- LINIT channel shaped glass refined (PG 1)
- LINIT channel shaped glass (PG 2)
- Wired glass (PG 3)

differ slightly in the individual scenarios. The differences lie in the different transport weights as well as deviating transport routes. Environmental impacts of transportation especially in the environmental impact "climate change (GWP)" are caused by the emission of greenhouse gases. The amount of greenhouse gases emitted increases with weight for the same transport distance. Similarly, the amount of greenhouse gases emitted increases with increasing transport distance for the same weight.

The environmental impacts obtained are significantly higher than the environmental impacts issued in the EPD "Cast Glass" (EPD-LPG-GB-28.1) for life cycle module A4. This is due to the much shorter transport distance of 150 km mapped as well as over the data set used for a 40 t truck.

7 Forecast

For a general approach, it is recommended not to focus exclusively on the environmental impact indicator "climate change (GWP)", but to also include the other indicators according to DIN EN 15804:2012+A2:2019 in the consideration. At the client’s request, these are not included in this report.

8 Bibliography

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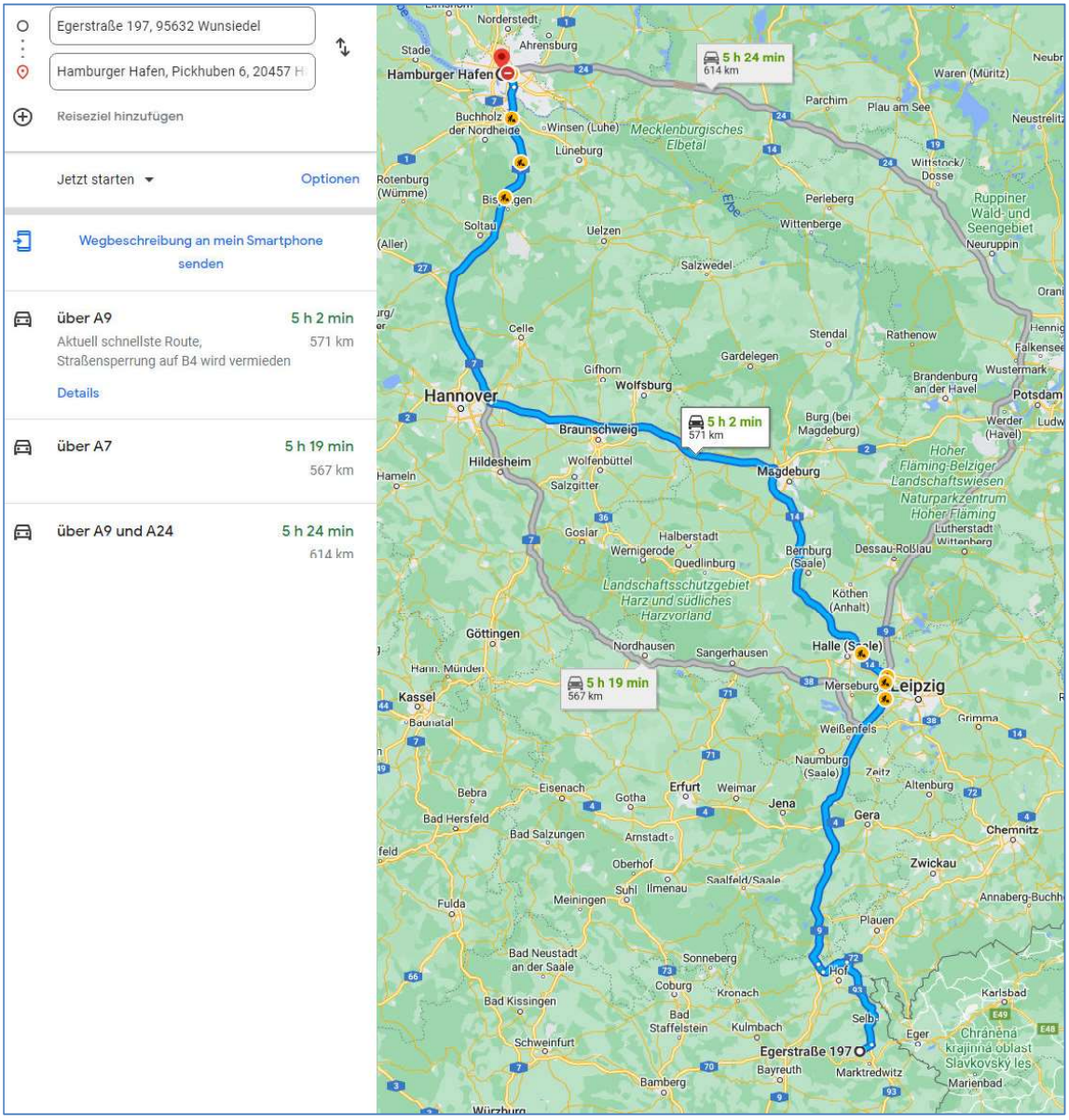
Annex

Determination of transport route Wunsiedel to port of Hamburg (WUN-HH)

Overland transport calculated via Google Maps (input from 28.05.2023)
[Egerstraße 197, 95632 Wunsiedel to Hamburg Port - Google Maps]



"LCA for Experts" models

Ecological comparison_ Glasfabrik Lamberts_transport scenarios in life cycle module A4_2023
process_ reference size
basic processes are indicated

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