LIFE CYCLE ASSESSMENT REPORT

Flat glass: clear float glass and coated glass

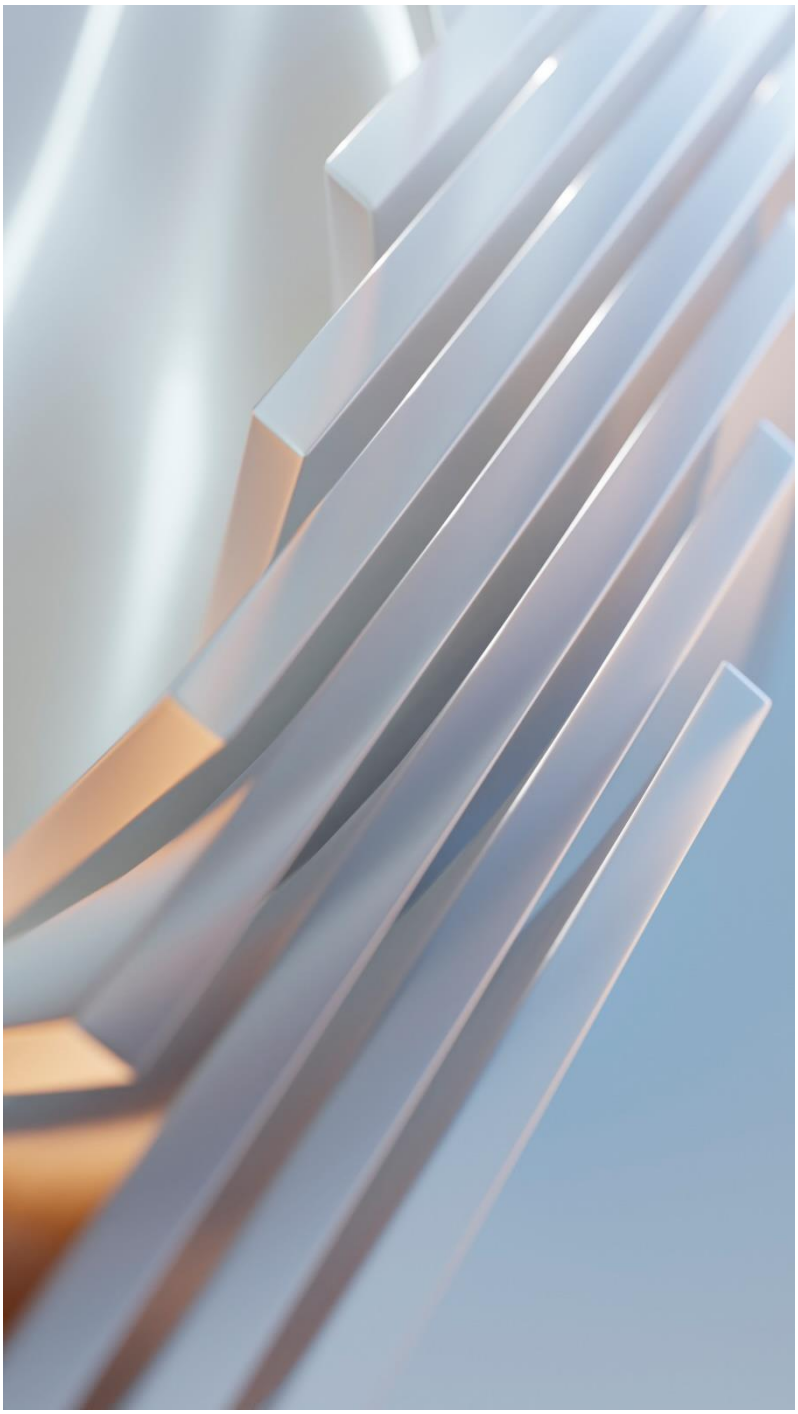

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TABLE OF CONTENTS

1. GENERAL INFORMATION 4
2. SCOPE OF PRODUCTS 4
3. AIM OF THE STUDY 5
4. SCOPE OF THE STUDY 6
4.1 Functional/Declared unit 6
4.2 Class of EPD 6
4.3 Product description and application 6
4.4 System boundaries 7
4.4.1 Product stage 9
4.4.2 Construction process stage 9
4.4.3 End-of-life stage and module D 9
5. LIFE CYCLE INVENTORY 10
5.1 Production Description 10
5.2 Data collection and calculation methods 11
5.3 Input/output balance 12
5.4 Transports 14
5.4.1 Transportation of raw materials 14
5.4.2 Transportation of finished product 14
6. LIFE CYCLE MODELLING 14
7. DATA QUALITY, ASSUMPTIONS AND ALLOCATION 20
7.1 Primary data 20
7.2 Background data 20
7.3 Allocation, Estimations, and assumptions 20
8. LIFE CYCLE INVENTORY AND IMPACT ASSESSMENT RESULTS 21
8.1 Clear float glass LCIA and LCI 21
8.2 Coated glass LCIA and LCI 25
9. REFERENCES 29

1. GENERAL INFORMATION

Manufacturer information

SALAVATSTEKLO Group is one of the largest and dynamically developing in Russia and neighboring countries. The group includes 3 plants for manufacturing glass and glass products with the widest range of products: JSC Salavatsteklo (Republic of Bashkortostan), JSC Saratovstroysteklo (Saratov region) and Salavatsteklo Kaspiy LLC (Republic of Dagestan).

Figure 1. JSC Salavatsteklo

Salavatsteklo, JSC is one of the largest manufacturers of glass and glass products in Russia with flat glass manufacturing capacity of 1150 tons per day. The company produces float and float tinted glass, architectural and coated glass, mirrors, bottles, soluble sodium silicate, tempered construction and automative glass, as well as double-glaized windows. JSC Salavatsteklo is capable to produce clear float and coated glass, conforming to International Quality standards, in a range of thickness from 1.8 to 12 mm for clear glass and from 4 to 12 mm for coated glass.

Standards

LCA study has been carried out in accordance with ISO 14040 and the product category rules of The International EPD® System PCR Construction products 2019:14, version 1.3.4 and c-PCR: Flat glass products.

2. SCOPE OF PRODUCTS

The LCA report describes the life cycle impacts of flat glass produced at JSC Salavatsteklo: 1m^2 of clear (uncoated) float glass and 1 m^2 of coated glass.

The trademarks of JSC Salavatsteklo glass included in the study are as follows (next page):

CLEAR FLOAT GLASS	Extraview M0 M1 Ultraview Ultraview R
COATED GLASS	Standart Comfort° MultiComfort° MF

The 1m^2 of clear and the coated glass with the thickness of 4mm and the weight 9.58 kg is taken as a representative unit. This is justified by the fact that 68.42% of gross volume of clear float glass and 73.84% of coated glass produced by JSC Salavatsteklo in 2023 constitute from glass with a thickness of 4 mm.

Since the allocation by mass could be applied, the following conversion factors could be used to calculate the environmental impacts of different thicknesses of clear float glass and coated glass.

Table 1. Conversion factor for the flat glass of different thickness

Thickness, mm	2.0	2.1	2,2	2.3	2.5	3.0	3.2	3.4
Conversion factor	0.52	0.54	0.55	0.57	0.64	0.76	0.84	0.89
Thickness, mm	3.5	**4.0**	5.0	6.0	8.0	10.0	12.0	
Conversion factor	0.91	**1**	1.27	1.53	2.05	2.54	3.08	

3. AIM OF THE STUDY

The aim of this study is to assess the environmental impacts of the clear and coated glass produced at JSC Salavatsteklo throughout its' life cycle, with the additional aim to create an Environmental Product Declaration (EPD) based on the LCA results.

Preparing an Environmental Product Declaration is intended to enable JSC Salavatsteklo to participate in international procurements, "green," and sustainable procurement, thereby enhancing the competitiveness of the products.

Additionally, the LCIA results for could be used to identify "hot spots" at different stages of the life cycle of JSC Salavatsteklo glass, with the goal of reducing its environmental impacts and to be able to compare it with the similar products from other manufacturers.

EPD can be used for B2B, B2C, B2G relationships and in various international (LEED, BREAM, WELL, and others) and national (GOST 70346-2022, certification system "Klever") green building certification systems to earn additional points within the certification system.

4. SCOPE OF THE STUDY

4.1 Functional/Declared unit

In the LCA, 1m^2 of clear float glass and 1m^2 of coated glass is used as a reference unit.

4.2 Type of EPD

The EPD created based on the LCA results will be a document of the following category:

Manufacturer's Declaration

☑ 1a Declaration of specific goods from the manufacturer's factory
☐ 1b Declaration of a specific product, averaged over several manufacturing plants
☐ 1c Declaration of average goods from the manufacturer's plant
☐ 1d Declaration of the average product produced by several factories of the manufacturer

Product modeled as:

☐ Average: Calculates the average based on the tested product range.
☑ Representative: Typical or representative properties of the product are identified.
☐ Worst case: the highest environmental impact is determined by the selected product category.

4.3 Product description and application

The report describes life cycle assessment of 2 types of the flat glass produced by JSC Salavatsteklo: clear flat glass produced by the float process (here and after – "clear float glass"), and coated glass produced by applying coating on a clear float glass (here and after – "coated glass").

Clear float glass

JSC Salavatsteklo's Clear Float Glass is manufactured according to national and international standards, such as GOST 111-2014 and EN 572-9.

Depending on specifics of client's project several types of clear float glass could be produced:

- Extraview
- M0, M1
- Ultraview, Ultraview R

Range of sizes: 2550x1605, 2250x3210, 2600x1800, 2550x3210, 6000x3210, <12000x3210. Range of thickness: 1.8-12 mm.

Clear float glass can be used to produce coated glass, insulating glass for construction purposes, insulating glass for road transport, interior elements, furniture items and for the manufacture of consumer electronics.

The LCA report describes life cycle impacts of weighted averaged clear float glass (Extraview, M0, M1, Ultraview, Ultraview R) produced at JSC Salavatsteklo in 2023

Coated glass

JSC Salavatsteklo's Coated Glass is manufactured according to national and international standards, such as GOST 31364-2014, GOST 33017-2014, GOST 33086-

2014 and EN 1096-4, as well as according internal technical specifications (TS 23.12.11-028-04616815-2020; TS 5913-026-04616815-2012).

Coated glass (architectural glass) is used in buildings transforming the look of modern cities. Such glass transmits daylight well, protects from the sun and keeps heat inside the room. It can be of varying degrees of mirroring, neutral shades and colored, without distorting the incoming daylight.

Depending on specifics of client's project several types of coated glass could be produced:

- Standart
- Comfort°
- MultiComfort°
- MF

Range of sizes: 2550x1605, 2250x3210, 2550x3210, 6000x3210. Range of thickness: 4-12 mm.

The LCA report describes lifecycle impacts of weighted averaged coated glass (Standart, Comfort°, MultiComfort°, MF) produced at JSC Salavatsteklo, JSC in 2023.

4.4 System boundaries

System boundary taken for the LCA is "Cradle-to-grave with modules A1-A3, A4-A5, module C and module D" according to the reference PCR (table 2, figure 2).

Table 2. Declared modules in the LCA

	Product stage			Construction process stage	Use stage							**End of life stage**				*
	Raw material supply	**Transport**	**Manufacturing**	Transport	Construction installation	Use	**Maintenance**	**Repair**	**Replacement**	**Refurbishment**	**Operational energy use**	**Operational water use**	**De-construction demolition**	**Transport**	**Waste processing**	**Disposal**	**Reuse-Recovery-Recycling-potential**
Module	**A1**	**A2**	**A3**	A4	A5	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X
Geography	RU	RU	RU	GLO	GLO	–	–	–	–	–	–	–	GLO	GLO	GLO	GLO	GLO
Specific data used	>90%				–	–	–	–	–	–	–	–	–	–	–	–	–
Variation – products	<10%					–	–	–	–	–	–	–	–	–	–	–	–
Variation – sites	Not relevant					–	–	–	–	–	–	–	–	–	–	–	–

(MND = module not declared; NR = not relevant)

Figure 2 describes the system boundaries of the JSC Salavatsteklo's clear and coated glass.

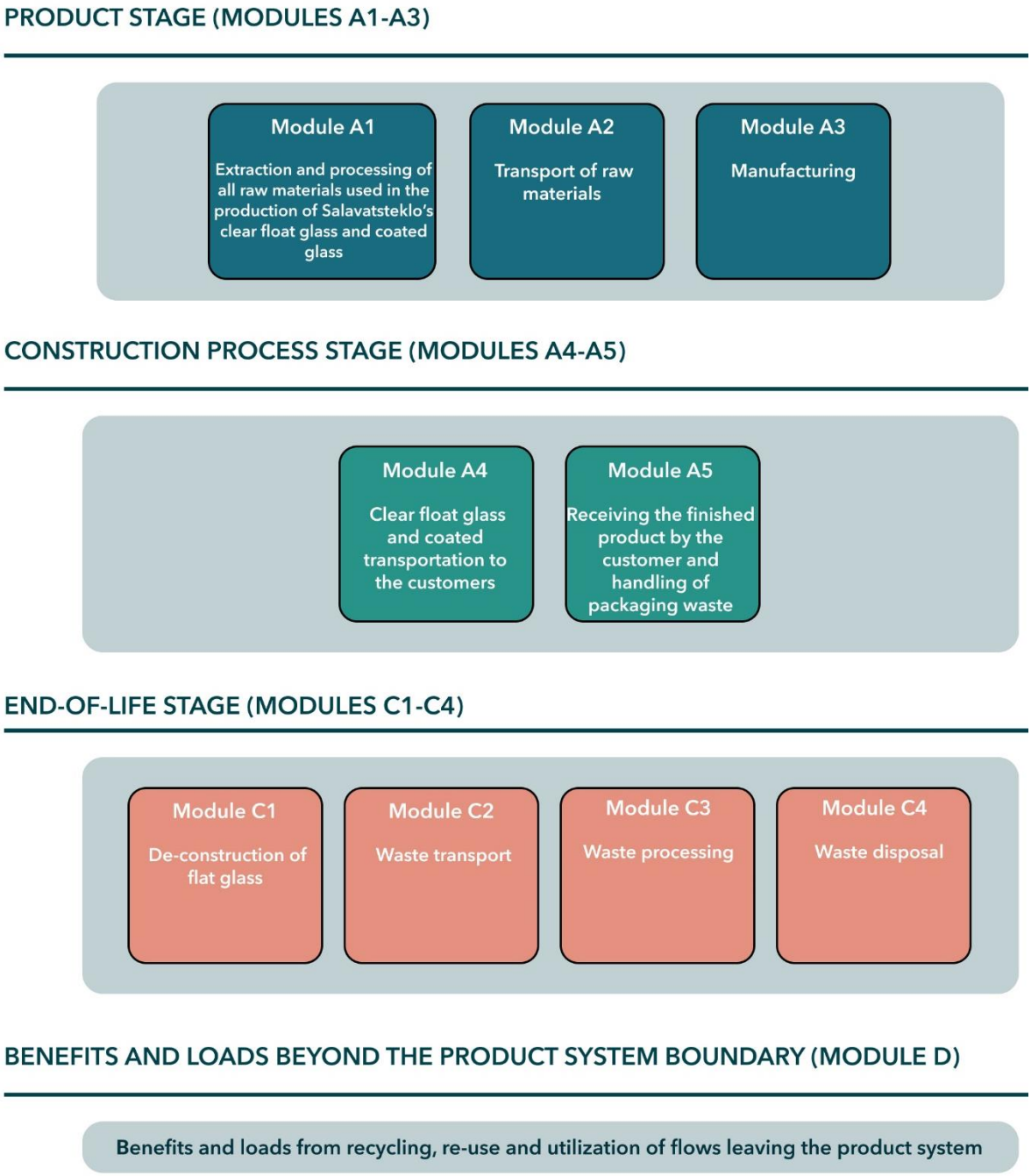

Figure 2. System boundaries of the LCA

System boundary with nature and between product systems

In the LCA all the input and output flows connected with nature (emissions, discharges, waste) and all connections between product systems such as: raw materials mining and processing, intermediate products production, transportation etc., are issued. The system boundaries include all the main and indirect processes within modules A1-A5, C1-C4 and module D. All the most significant flows which constitute at least 99% of the LCA inputs have been considered.

4.4.1 Product stage

Product stage include the following product life cycle modules.

Module A1: extraction and processing of all raw materials used in the production of JSC Salavatsteklo's clear float glass and coated glass (quartz sand, dolomite, soda ash, limestone, feldspar, sodium sulphate), as well as production of packaging (soft wood frames, steel tapes and brackets, PE film, "transfer powder") and auxiliary materials (tin, oxygen, argon, nitrogen, silica, selenium). Production of substances and metals used as "magnetron targets" for applying on a surface of a float glass as a "coat" (aluminum, chromium, nickel, niobium oxide, silicon, silver, titanium oxide, zinc, zirconium oxide).

Module A2: transport of raw materials including auxiliary materials and packaging to the manufacturing site considering actual distances from raw materials suppliers, as well as differences in used type of transport (lorry, railway transport, sea freight) used for each raw material supply in 2023.

Module A3: manufacturing of flat glass by float method and manufacturing of coated glass by magnetron sputtering technology, production and supply of energy used in the main manufacturing process (electricity, natural gas, process steam, water) and production waste processing - waste transportation by lorry and landfill scenario is considered.

The electricity used in the manufacturing processes in A3 is sourced from the Russian power grid, with climate impact of 0.713 kg CO2 eq./kWh based on GWP-GHG indicator from the Ecoinvent 3.9.1 database.

4.4.2 Construction process stage

Construction process stage include the following product life cycle modules.

Module A4: clear float glass and coated glass transportation to the customers. The module is based on weighted average of 70% largest deliveries in 2023 considering distribution by lorry trucks and railway freights.

Module A5: receiving the finished product by the customer and handling of packaging waste. The packaging waste landfill scenario has been considered.

4.4.3 End-of-life stage and module D

Module C1: de-construction of clear float glass and coated glass from the building (any other goods) it is integrated in.

Module C2: clear float glass and coated glass after losing its utilization properties transportation to the waste processing.

Module C3: product waste processing.

Module C4: product waste disposal/utilization. Landfilling considered as the basic scenario for the clear float glass and for the coated glass at a waste status.

Module D describes benefits and loads beyond the product system boundary – future reuse, recycling, or energy recovery potentials. Since the recycling rate is considered as 0%, no benefit is generated.

5. LIFE CYCLE INVENTORY

5.1 Production Description

Clear float glass production.

The process of manufacturing float glass by thermal molding on a molten metal includes the following processes:

1. Batch preparation and melting.

Batch is a mixture of raw materials and cullet. It consists of quartz sand, soda ash, limestone, dolomite, feldspar, sodium sulfate and auxiliary materials like pigments, erbium oxide, cobalt oxide, selenium and a cullet. All raw materials are mixed in a batch process, then fed together with a controlled proportion of cullet into a furnace, where it is heated to approximately 1500-1600 °C.

2. Forming glass ribbon on molten metal (tin).

The glass ribbon is formed in a melt bath using molten tin. To protect the molten tin from oxidation in the melt bath, a protective gas atmosphere consisting of nitrogen and hydrogen is used. The glass flows onto the tin surface forming a ribbon of even thickness with smooth surfaces on both sides. As the glass flows along the tin bath, the temperature is gradually reduced from 1100 °C until at approximately 600 °C the ribbon can be lifted from the tin onto rollers. The glass ribbon is pulled off the bath by rollers at a controlled speed. Variation in the flow speed and roller speed enables glass ribbon of varying thickness to be formed.

3. Annealing of the glass ribbon in an annealing furnace.

The annealing process is the process of uniform cooling of a moving glass ribbon along its width after production to temperatures 70 – 65°C, at which residual stresses are reduced and the occurrence of temporary destructive stresses is prevented.

4. Quality control.

Glass undergoes quality control and compliance with standards. Glass that does not pass quality control becomes cullet and is returned to the cycle at the glass melting stage.

5. Cutting and further processing if needed.

Glass is cut to required sizes and may undergo additional processing like coating.

6. Packaging and transportation.

Glass sheets are packed in an endcaps and transported by road or railway.

Coated glass production.

The process of manufacturing coated glass is a sputter depositing coatings in a form of optically transparent layers of particles with required properties. Coating process based on magnetron sputtering and includes following processes:

1. Incoming inspection and delivery of uncoated glass sheets to the load end of the coating line.

Coating must be deposited only on the "air side" of the glass sheet (the side which was not in contact with the tin during the float glass manufacturing process), so glass sheets undergoes quality control and is positioned correctly.

2. Washing and drying glass.

Glass sheets are washed with deionized water and dried with a high-pressed air dryer.

3. Coating

Glass sheets go through sequence of vacuum chambers, which gradually reduce pressure. After that the coating process begins. The coating system is a universal, high-performance installation for applying multilayer coatings to glass. The coating application method is based on the physical process of sputtering the coating material in an inert gaseous environment (like argon) under vacuum, using a magnetron. The coating system is designed as a modular multi-chamber system. The shape of the cameras is determined by the functions they perform. They are interconnected by special welded and threaded structures to create and maintain high vacuum. Coating material is in the form of a relatively small magnetron target. JSC Salavatsteklo the following types of targets for coating:

- SiAl – silicon and aluminum
- ZnAl – zinc and aluminum
- ZrOx – zirconium oxide
- Ag - silver
- NiCr – nickel and chromium
- Cr - chromium
- Si - silicon
- TiOx – titanium oxide
- NbOx – niobium oxide

4. Quality control

Glass undergoes quality control and compliance with standards.

5. Packaging and transportation

Glass sheets are packed in endcaps and transported by road or railway.

5.2 Data collection and calculation methods

The life cycle assessment is modeled based on the results of an inventory analysis of all stages of the life cycle within the production system boundaries. Manufacturer-specific primary data from 2023 has been collected to model the production of clear float glass and production of coated glass by applying specific additives on its surface to produce coated glass. These are raw materials and energy are required for production of 249,651.38 t of clear float glass, 61 371.46 t of which were applied to produce 60 369.46 t of coated glass, as well as emissions and wastes occurred during the manufacturing processes. After compiling gross mass balance, the recalculation was done to convert the results to the declared unit (1m^2 of float glass, 4mm thickness, 9.58 weight).

The supplier transportations are modelled specifically based on primary data from the JSC Salavatsteklo, as well as finished product transportations, while the generic datasets were used to model the transport processes themselves.

Realistic assumptions were made for waste disposal scenarios in modules A5, C2 and C4. The next types of flows were considered.

Inputs

- **Material flows** (raw materials, auxiliary materials, additives, packaging)
- **Energy flows** (electricity, natural gas, steam)

Outputs

- **Material flows** (finished products, waste)
- **Elementary flows** (emissions to air, water, and soil)

5.3 Input/output balance

The following is a summary tables with the mass balance and the energy consumption per total volume of flat glass included in the LCA (and EPDs) produced in 2023.

Table 3. Inputs/Outputs for the clear float glass production

Input stream	Unit	Quantity
Quartz sand	t	175 380.94
Soda Ash	t	52 313.30
Dolomite	t	42 920.36
Limestone	t	13 688.27
Feldspar	t	9 395.21
Sodium sulfate	t	2 281.41
Coal	t	89.84
Return cullet	t	67 184.60
External cullet	t	737.3
Other additives	t	23.18
TOTAL	t	**364 014.41**
Packaging		
Soft wood for endcap	t	1 340.17
PE film for endcap	t	23.98
Steel tape and brackets for endcap	t	161.84
Other additives	t	8.58
TOTAL	t	1 534.57
Output stream	**Unit**	**Quantity**
Clear float glass	t	249 651.38
Cullet (by-product)	t	67 921.90
Technological losses (losses due to calcination of carbonate compounds, moisture from raw materials, spills)	t	44 712.64
Waste		
Non-hazardous waste	t	181.2
Emissions		
Emissions to air	t	1525.88
- Emissions associated only with the clear float glass sold	t	1186.79
- Emissions associated only with the clear float glass that went into the coatings	t	339.08

Emissions to water	t	21.42
TOTAL		**364 014.41**

Table 6. Inputs/Outputs for the coated glass production in 2023.

Input stream	Unit	Quantity
Clear flat glass	t	61 371.46
SiAl magnetron target	t	1.42
ZnAl magnetron target	t	0.87
ZrOx magnetron target	t	2.10E-03
Ag magnetron target	t	0.65
NiCr magnetron target	t	0.53
Cr magnetron target	t	0.63
Si magnetron target	t	2.61E-03
TiOx magnetron target	t	0.37
NbOx magnetron target	t	0.10
Nitrogen	t	2528.79
Oxygen	t	847.5
TOTAL	**t**	**64 752.32**
Packaging		
Soft wood for endcap	t	444.23
PE film for endcap	t	7.95
Steel tape and brackets for endcap	t	53.64
Other additives	t	1.13
TOTAL	t	506.95
Output stream	**Unit**	**Quantity**
Coated glass	t	60 369.46
Cullet (by-product)	t	1 002
Technological losses	t	3 322.97
Wastes		
Non-hazardous waste	t	51.77
Emissions		
Emissions to water	t	6.12
TOTAL	**t**	**64 752.32**

Table 5. Energy consumption during the clear float glass production in 2023.

Input stream	Unit	Quantity
Natural gas	m3	63 434 090.61
Electricity, high voltage	kWh	54 826 525.57
Steam	MJ	331 470.14
Deionized water	m3	164 602.97

Table 6. Energy consumption during the coated glass production in 2023.

Input stream	Unit	Quantity
Electricity, high voltage	**kWh**	**9 297 982**
Deionized water	**m3**	**36 956.2**

5.4 Transports

5.4.1 Transportation of raw materials

To model the transportation of the raw materials and packaging primary data were taken (like manufacturer's address, distance and type of transportation) provided by JSC Salavatsteklo. Raw materials and auxiliary materials delivered by rail, road and sea transport.

5.4.2 Transportation of finished product

Transportation of finished products from the plant is carried out by railway and road (lorry transport, freight transport) in the following proportion (table 7). These data were used to assess the type of transportation.

To estimate the delivery distance for each type of transportation, a weighted average distance was used, where weight is the volume of delivery at a given distance. The weighted average distance was calculated for 50% of the total delivery of the final product by each type of transport mode.

Table 7. Distribution of transport activity for finished product

	Railway	Road
Clear float glass		
Share, %*	64.37%	35.63%
Distance, km**	2 896.82	320.65
Coated glass		
Share, %*	66.38%	33.62%
Distance, km**	2 152.75	673.45

*of total volume supplied

**weighted average distance

6. LIFE CYCLE MODELLING

JSC Salavatsteklo's flat glass life cycle modeling is performed using "OpenLCA" software version 1.9.0 including Ecoinvent 3.9.1 cut-off, EF 2.0 and ELCD 3.2 databases. In the following, unit processes and background datasets in the models are explained.

Figure 3 shows the life cycle model compiled in OpenLCA. Each of the material and energy flows that make up the flat glass production system and are modeled in OpenLCA are indexed according to the given flow number in Table 8 outlining the datasets taken for modeling.

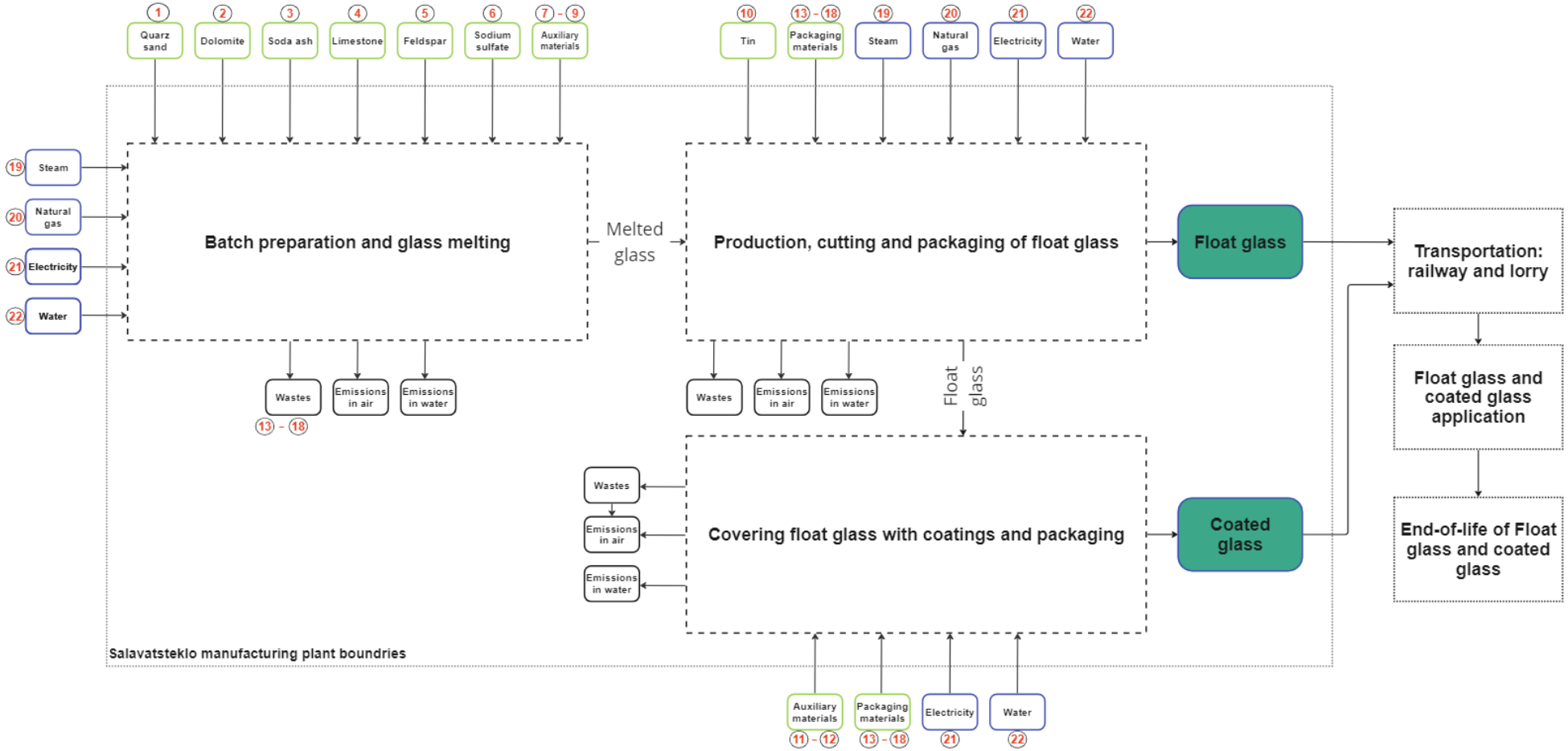

Figure 3. Clear float and coated glass life cycle model in OpenLCA

Table 8. Datasets used for the LCA modelling.

№	Unit process	Dataset	Database	Process data collected by region	Representative year
1	Production of quartz sand	Quartz/Silica sand, single route, at plant, mining, cleaning, grinding, screening, sand 0/2	Environmental Footprint	Europe [EU-28+EFTA]	2020
2	Production of dolomite	1) Dolomite mining, production mix, at plant, dolomite mining, washing, drying, 2.90 g/cm3 2) Dolomite grinding, production mix, at plant, dolomite grinding, 2.90 g/cm3	Environmental Footprint	1, 2) Global [GLO]	2020
3	Production of soda ash	Soda production, production mix, at plant, technology mix, 100% active substance - RER	Environmental Footprint	Europe [RER]	2020
4	Production of limestone	Ground calcium carbonate production, production mix, at plant, technology mix, 100% active substance	Environmental Footprint	Europe [RER]	2020
5	Production of feldspar	Feldspar (mining, open pit), production mix, at plant, feldspar mining, washing, drying, 2.56 g/cm3	Environmental Footprint	Global [GLO]	2020
6	Production of sodium sulfate	Sodium sulphate production, production mix, at plant, technology mix, 100% active substance	Environmental Footprint	Europe [RER]	2020
7	Production of coal (carbon containing material)	Hard coal mix consumption mix to consumer technology mix	Environmental Footprint	Europe [EU-27]	2020

8	Production of red pigment "Atrin"	Iron oxide, red pigment, Production mix, at plant, Technology mix,	Environmental Footprint	Global [GLO]	2020
9	Production of selenium	Selenium production, production mix, at plant, technology mix, 100% active substance	Environmental Footprint	Europe [RER]	2020
10	Production of tin	Tin, production mix, at plant, sand extraction and processing, reduction, 118.71 g/mol	Environmental Footprint	Global [GLO]	2020
11	Production of argon	Argon, liquid production, production mix, at plant, technology mix, 100% active substance	Environmental Footprint	Europe [RER]	2020
12	Production of oxygen	Oxygen production, production mix, at plant, technology mix, 100% active substance	Environmental Footprint	Europe [RER]	2020
13	Production of PE film	Plastic Film, PE, production mix, at plant, raw material production, plastic extrusion, grammage: 0.0943 kg/m2	Environmental Footprint	Europe [EU-28+EFTA]	2020
14	Production of soft wood	Sawn wood, softwood, at plant, planed, dried, per kg sawn wood	Environmental Footprint	World w/o EEU-28+3, US, CA	2020
15	Production of steel tape	Steel cold rolled coil, single route, at plant, blast furnace route, carbon steel	Environmental Footprint	Rest of world [RoW]	2020
16	Production of silica	Silica (silicone dioxide), Production mix, at plant, Technology mix, calcinated and precipitated,	Environmental Footprint	Global [GLO]	2020

17	Production of transfer powder	1) Adipic acid production, production mix, at plant, technology mix, 100% active substance 2) Polymethyl methacrylate (PMMA) granulate, production mix, at plant, bulk polymerisation, from methyl methacrylate, 1.18 g/cm3	Environmental Footprint	1) Europe [RER] 2) World w/o EU-28+EFTA	2020
18	Production of galvanized steel bracket	Steel hot dip galvanised, single route, at plant, steel sheet hot dip galvanization, 1.5 mm sheet thickness, 0.02 mm zinc thickness	Environmental Footprint	Rest of world [RoW]	2020
19	Production of steam from natural gas	Process steam from natural gas, production mix, at heat plant, technology mix regarding firing and flue gas cleaning, MJ, 90% efficiency	Environmental Footprint	Rest of world [RoW]	2020
20	Production and supply of natural gas	market for natural gas, high pressure	Ecoinvent 3.9.1	Russia [RU]	2022
21	Electricity generation and transmission	market for electricity, high voltage	Ecoinvent 3.9.1	Russia [RU]	2022
22	Water	Deionized water, production mix, at plant, reverse osmosis, from surface water	ELCD	Europe [RER]	2010
23	Road transportation	Articulated lorry transport, Total weight 28-32 t, mix Euro 0-5, consumption mix, to consumer, diesel driven, Euro 0 - 5 mix, cargo, 28 - 32t gross weight / 22t payload capacity	Ecoinvent 3.9.1	Europe [EU-28+3]	2020

24	Railway transportation	Freight train, electricity traction, consumption mix, to consumer, electricity driven, cargo, average train, gross tonne weight 1000t / 726t payload capacity	Ecoinvent 3.9.1	Europe [EU-28+EFTA]	2020
25	Marine transportation	Transoceanic ship, containers, consumption mix, to consumer, heavy fuel oil driven, cargo, 27.500 dwt payload capacity, ocean going	ELCD	Global [GLO]	2020
26	Landfilling of inert construction waste	Landfill of inert (construction materials), production mix (region specific sites), at landfill site, landfill including leachate treatment and with transport without collection and pre-treatment	Environmental Footprint	Europe [EU-28+EFTA]	2020
27	Landfilling of plastic waste	Landfill of plastic waste, production mix (region specific sites), at landfill site, landfill including leachate treatment and with transport without collection and pre-treatment, The carbon and water content are respectively of 62%C and and 0% Water (in weight %)	Environmental Footprint	Europe [EU-28+EFTA]	2020
28	Landfilling of processed wood	Landfill of processed wood, production mix (region specific sites), at landfill site, landfill including leachate treatment and with transport without collection and pre-treatment, The carbon and water content are respectively of 45%C and and 8% Water (in weight %)	Environmental Footprint	Europe [EU-28+EFTA]	2020
29	Landfilling of metals	Landfill of inert (steel), production mix (region specific sites), at landfill site, landfill including leachate treatment and with transport without collection and pre-treatment	Environmental Footprint	Europe [EU-28+EFTA]	2020

7. DATA QUALITY, ASSUMPTIONS AND ALLOCATION

7.1 Primary data

The material and energy data collected directly from the manufacturer. The data collected have been checked for reliability and consistency. The implemented management and quality systems at the JSC Salavatsteklo imply excellent quality of the primary data.

7.2 Background data

The manufacturing process was modelled based on manufacturer-specific data. However, generic background datasets were used for the upstream and downstream processes. For most of the upstream and downstream processes datasets based on European manufacturers were selected, since similar datasets for modeling by Russian manufacturers are not available at the time of conducting LCA. Nevertheless, the quality, representativeness, methodological comparability, and reliability of the datasets used can be assessed as "good".

7.3 Allocation, Estimations, and assumptions

Data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts have been included. 1% cut-off rule according to the reference PCR is applied. Scenarios of A1-A4 modules are based on a specific data, where the scenarios for modules A5, C1-C4 are based on assumptions considering the most realistic scenarios for the product system analysed.

Allocation in Module A3 is excluded by gathering primary data for all the main processes directly. Allocation in other Modules of the clear float glass and the coated glass according to the datasets taken.

8. LIFE CYCLE INVENTORY AND IMPACT ASSESSMENT RESULTS

In this section, the LCA results for 1m^2 of clear float glass and 1m^2 of coated glass with thickness of 4mm and with weight of 9.58 kg are provided. Since the allocation by mass could be applied, the conversion factors from Para 2 could be used to calculate the environmental impacts of different thicknesses of clear and coated glass produced by JSC Salavatsteklo.

8.1 Clear float glass LCIA and LCI

Mandatory impact category indicators according to EN 15804

Results per 1m^2 of clear float glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq.	9.35E+00	2.30E-01	6.45E-03	ND	0.00E+00	5.60E-02	0.00E+00	2.61E-01	0.00E+00
GWP-biogenic	kg CO_2 eq.	2.91E-03	7.24E-04	8.79E-02	ND	0.00E+00	9.96E-05	0.00E+00	0.00E+00	0.00E+00
GWP-luluc	kg CO_2 eq.	5.85E-03	5.11E-04	9.21E-06	ND	0.00E+00	4.07E-04	0.00E+00	1.12E-03	0.00E+00
GWP-total	kg CO_2 eq.	9.36E+00	2.32E-01	9.46E-02	ND	0.00E+00	5.65E-02	0.00E+00	2.62E-01	0.00E+00
ODP	kg CFC 11 eq.	9.01E-08	6.90E-11	-1.40E-12	ND	0.00E+00	1.36E-13	0.00E+00	4.35E-13	0.00E+00
AP	mol H^+ eq.	5.31E-02	8.47E-04	1.36E-05	ND	0.00E+00	3.46E-04	0.00E+00	1.53E-03	0.00E+00
EP-freshwater	kg P eq.	3.76E-04	6.88E-07	1.99E-07	ND	0.00E+00	3.56E-07	0.00E+00	3.85E-06	0.00E+00
EP-marine	kg N eq.	1.99E-02	2.42E-04	3.53E-05	ND	0.00E+00	1.61E-04	0.00E+00	4.57E-04	0.00E+00
EP-terrestrial	mol N eq.	2.37E-01	2.63E-03	8.66E-05	ND	0.00E+00	1.79E-03	0.00E+00	5.09E-03	0.00E+00

POCP	kg NMVOC eq.	6.40E-02	5.56E-04	5.37E-05	ND	0.00E+00	3.06E-04	0.00E+00	1.25E-03	0.00E+00
ADP-minerals&metals*	kg Sb eq.	1.58E-05	5.93E-08	-4.34E-10	ND	0.00E+00	3.28E-09	0.00E+00	2.42E-08	0.00E+00
ADP-fossil*	MJ	1.43E+02	3.81E+00	-2.36E-02	ND	0.00E+00	7.68E-01	0.00E+00	3.43E+00	0.00E+00
WDP*	m^3	5.64E+01	2.73E-02	-4.70E-05	ND	0.00E+00	2.16E-03	0.00E+00	2.01E-02	0.00E+00
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption									

Additional mandatory and voluntary impact category indicators

Results per 1m^2 of clear float glass										
Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-GHG[1]	kg CO_2 eq.	9.35E+00	2.30E-01	6.45E-03	ND	0.00E+00	5.60E-02	0.00E+00	2.61E-01	0.00E+00

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

[1] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

Resource use indicators

Results per 1 m^2 of clear float glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	5.29E+00	1.03E+00	-7.31E-03	ND	0.00E+00	4.35E-02	0.00E+00	3.15E-01	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	5.29E+00	1.03E+00	-7.31E-03	ND	0.00E+00	4.35E-02	0.00E+00	3.15E-01	0.00E+00
PENRE	MJ	4.04E+01	3.81E+00	-2.35E-02	ND	0.00E+00	7.69E-01	0.00E+00	3.45E+00	0.00E+00
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	4.04E+01	3.81E+00	-2.35E-02	ND	0.00E+00	7.69E-01	0.00E+00	3.45E+00	0.00E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	3.57E+00	1.38E-02	-2.25E-04	ND	0.00E+00	3.45E-04	0.00E+00	6.21E-03	0.00E+00
Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water									

Waste indicators

Results per 1m² of clear float glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	4.60E-07	5.17E-08	4.77E-09	ND	0.00E+00	5.79E-08	0.00E+00	7.67E-07	0.00E+00
Non-hazardous waste disposed	kg	6.53E-02	6.07E-03	3.51E-02	ND	0.00E+00	1.09E-04	0.00E+00	9.68E+00	0.00E+00
Radioactive waste disposed	kg	2.13E-02	4.82E-04	-1.17E-05	ND	0.00E+00	1.10E-06	0.00E+00	3.01E-08	0.00E+00

Output flow indicators

Results per 1m² of clear float glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	1.39E-02	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

8.2 Coated glass LCIA and LCI

Mandatory impact category indicators according to EN 15804

Results per 1m² of coated glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq.	1.14E+01	3.13E-01	8.85E-03	ND	0.00E+00	9.27E-07	0.00E+00	4.32E-06	0.00E+00
GWP-biogenic	kg CO_2 eq.	3.66E-03	8.77E-04	1.21E-01	ND	0.00E+00	1.65E-09	0.00E+00	5.03E-09	0.00E+00
GWP-luluc	kg CO_2 eq.	9.13E-03	1.09E-03	1.26E-05	ND	0.00E+00	6.74E-09	0.00E+00	1.86E-08	0.00E+00
GWP-total	kg CO_2 eq.	1.14E+01	3.15E-01	1.30E-01	ND	0.00E+00	9.35E-07	0.00E+00	4.35E-06	0.00E+00
ODP	kg CFC 11 eq.	1.03E-07	.06E-11	-1.92E-12	ND	0.00E+00	2.25E-18	0.00E+00	7.20E-18	0.00E+00
AP	mol H^+ eq.	6.42E-02	1.34E-03	1.86E-05	ND	0.00E+00	5.73E-09	0.00E+00	2.54E-08	0.00E+00
EP-freshwater	kg P eq.	4.47E-04	1.20E-06	2.73E-07	ND	0.00E+00	5.90E-12	0.00E+00	6.38E-11	0.00E+00
EP-marine	kg N eq.	2.37E-02	4.70E-04	4.84E-05	ND	0.00E+00	2.67E-09	0.00E+00	7.57E-09	0.00E+00
EP-terrestrial	mol N eq.	2.79E-01	5.17E-03	1.19E-04	ND	0.00E+00	2.96E-08	0.00E+00	8.43E-08	0.00E+00
POCP	kg NMVOC eq.	7.52E-02	9.92E-04	7.37E-05	ND	0.00E+00	5.06E-09	0.00E+00	2.06E-08	0.00E+00
ADP-minerals&metals*	kg Sb eq.	1.69E-05	6.51E-08	-5.94E-10	ND	0.00E+00	5.43E-14	0.00E+00	4.01E-13	0.00E+00

ADP-fossil*	MJ	1.64E+02	4.95E+00	-3.24E-02	ND	0.00E+00	1.27E-05	0.00E+00	5.68E-05	0.00E+00
WDP*	m^3	5.76E+01	3.08E-02	-6.45E-05	ND	0.00E+00	3.58E-08	0.00E+00	3.33E-07	0.00E+00
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption									

Additional mandatory and voluntary impact category indicators

Results per 1m^2 of coated glass										
Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-GHG[2]	kg CO_2 eq.	1.14E+01	3.14E-01	9.06E-03	ND	0.00E+00	9.34E-07	0.00E+00	4.34E-06	0.00E+00

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

[2] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

Resource use indicators

Results per 1m² of coated glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	7.02E+00	1.11E+00	-1.00E-02	ND	0.00E+00	7.21E-07	0.00E+00	5.21E-06	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	7.02E+00	1.11E+00	-1.00E-02	ND	0.00E+00	7.21E-07	0.00E+00	5.21E-06	0.00E+00
PENRE	MJ	5.56E+01	4.95E+00	-3.22E-02	ND	0.00E+00	1.27E-05	0.00E+00	5.72E-05	0.00E+00
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	5.56E+01	4.95E+00	-3.22E-02	ND	0.00E+00	1.27E-05	0.00E+00	5.72E-05	0.00E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	5.76E+01	1.46E-02	-3.09E-04	ND	0.00E+00	5.71E-09	0.00E+00	1.03E-07	0.00E+00
Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water									

Waste indicators

Results per 1m² of coated glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	7.21E-07	1.33E-07	6.54E-09	ND	0.00E+00	9.60E-13	0.00E+00	1.27E-11	0.00E+00
Non-hazardous waste disposed	kg	2.56E+00	6.35E-03	4.82E-02	ND	0.00E+00	1.80E-09	0.00E+00	1.60E-04	0.00E+00
Radioactive waste disposed	kg	2.16E-02	4.94E-04	-1.60E-05	ND	0.00E+00	1.82E-11	0.00E+00	4.99E-10	0.00E+00

Output flow indicators

Results per 1m² of coated glass										
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	4.62E-03	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

9. REFERENCES

General Programme Instructions of the International EPD® System. Version 4.0.

PCR: Construction products 2019:14, version 1.3.4 (the International EPD® System)

c-PCR: Flat glass products (the International EPD® System)