ENVIRONMENTAL PRODUCT DECLARATION
in accordance with ISO 14025 and EN 15804:2012 + A2:2019

SLIDING SYSTEMS E50, ES70

Owner of the declaration:	ETEM
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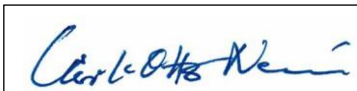
GENERAL INFORMATION [It starts and finishes at page 2]

Owner of the declaration	ETEM Ir. Politechniou 1-4, Magoula 19018, Greece www.etem.com
Manufacturer	ETEM Ir. Politechniou 1-4, Magoula 19018, Greece
Publisher and Programme holder	EUROPEAN ALUMINIUM AISBL Avenue de Terveuren 168 B-1150 Brussels Belgium  Dr Gerd Götz, Director General
The declaration is based on the Product Category Rules	[European Aluminium General Programme Instructions version 3, 23rd of September 2020]
Declared Unit	1 m^2 of sliding sistem
Scope of the Environmental Product Declaration	This EPD covers two sliding systems for doors and windows, namely E50 and ES70, characterised by a double-glazing unit. These EPD results have been calculated from an LCA tool for EPD, based on the GaBi database, initially realised by Thinkstep in 2013 and updated by Ecoinnovazione in 2019. The EPD results have been calculated based on specific bill of materials. UN CPC Code 42120 Doors, windows and their frames and thresholds for doors, of iron, steel or aluminium. The EPD may be used in a B2B context within the European Market.
Liability	The owner of the declaration is liable for the underlying manufacturing information and European Aluminium is not liable in this respect.
Disclaimers	This EPD cannot be used as a guarantee of the recycled content of the actual product sold on the market. A specific declaration may be asked to the supplier. The use of this EPD within BIM tools is in principle limited to the products explicitly included in the EPD. The scaling of results to model similar products can only be done if justified and transparently reported in the project report. Any responsibility regarding the misuse of this EPD by third parties is not accepted by the Programme Operator.

Verification

EN15804:2012+A2:2019 serves as core PCR completed by European Aluminium PCR 03/2020.			
Verification of the EPD by an independent third party in accordance with ISO 14025			
☐	Internally	☒	Externally

Verifier



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1 PRODUCT

1.1 Product description and applications

This EPD refers to two products E50 and ES70, which are fabricated by manufacturers being in close collaboration with ETEM, based on its own designs and instructions. E50 is a high-end sliding system with thermal break, designed for medium and large openings. ES70 is a high-end thermo-insulating system, suitable for door height windows with exceptional requirements for functionality and aesthetics.

All the products can have the double and triple glazing option, but EPD results have been calculated for the double-glazing option, whose characteristics are reported in Table 1.

Table 1 Analysed products

Product	Size (W x H)	Glazing	Surface area (m^2)	**Glass thickness** (m^2)
E50 and ES70	3 m x 2.18 m	double	6.54	8

The products consist of the following main components and materials listed below. For detailed information about the exact share of each material see Table 3.

- Aluminium frame production
- Flat glass production and glazing units production
- Thermal breaks, e.g. polyamide reinforced with glass fibers
- Gaskets, e.g. EPDM - Ethylene Propylene Diene Monomer or TPE – ThermoPlastic Elastomer
- Hardware mainly composed of stainless steel, Zinc cast and composite elements
- Foams (polyethylene, polyurethane and polyester foam) and polymers (PVC and Polyoxymethylene)

The aluminium profiles used in the products are produced in two production sites, Greece and Bulgaria. From either site, the aluminium profiles are sent to the manufacturers where the final product is assembled. The final products are then delivered from the manufacturer to the client by trucks. Typically, no packaging is used for the transport, but reusable steel stands.

No hazardous substances from the candidate list in accordance with Article 59(10) of the REACH Regulation are included either in raw materials intended for in house industrial production, or in purchased final components aimed for reselling as systems accessories.

1.2 Technical Data

The most relevant technical data are reported in Table 2.

Table 2 Most relevant technical data

Category	**Standards**	**E50**	**ES70**
		Classification/value	
Air permeability	EN 1026/EN 12207	up to Class 4	Class 4
Watertightness	EN 1027/EN 12208	up to Class E1200	E750
Resistance to wind load	EN 12211/EN 12210	up to Class C3	C5
Thermal transmittance (U_f)	EN ISO 10077-2	from 2.0 W/(m^2K)	from 2.73 W/(m^2K)
Acoustic performance	EN ISO 10140-2	up to 41 dB	

For the most up-to-date values of the technical data, please refer to the product specifications available on the ETEM website in the relevant curtain walling product section.

Most relevant standards for applications of aluminium window or door products in buildings are EN 14351-1 (performances) & EN 12519 (terminology).

Note: This EPD cannot be used as an evidence of the recycled content of the actual product sold on the market. For this purpose, a specific declaration may be asked to the manufacturer in addition to the EPD.

1.3 Process description

The window and door fabrication consists mainly in the following operations:

- Aluminium profile preparation mainly via sawing, milling and gluing. Those aluminium profiles are powder coated and thermally broken profiles.
- Frame production by assembling the various profiles via corner connections and fixing via gluing and/or crimping. Connectors are composed of aluminium die cast.
- Positioning and fixing the various gaskets.
- The fittings integration (if relevant).
- The fixing of the glazing unit via the glazing bead.

The main background production processes are reported in Figure 1.

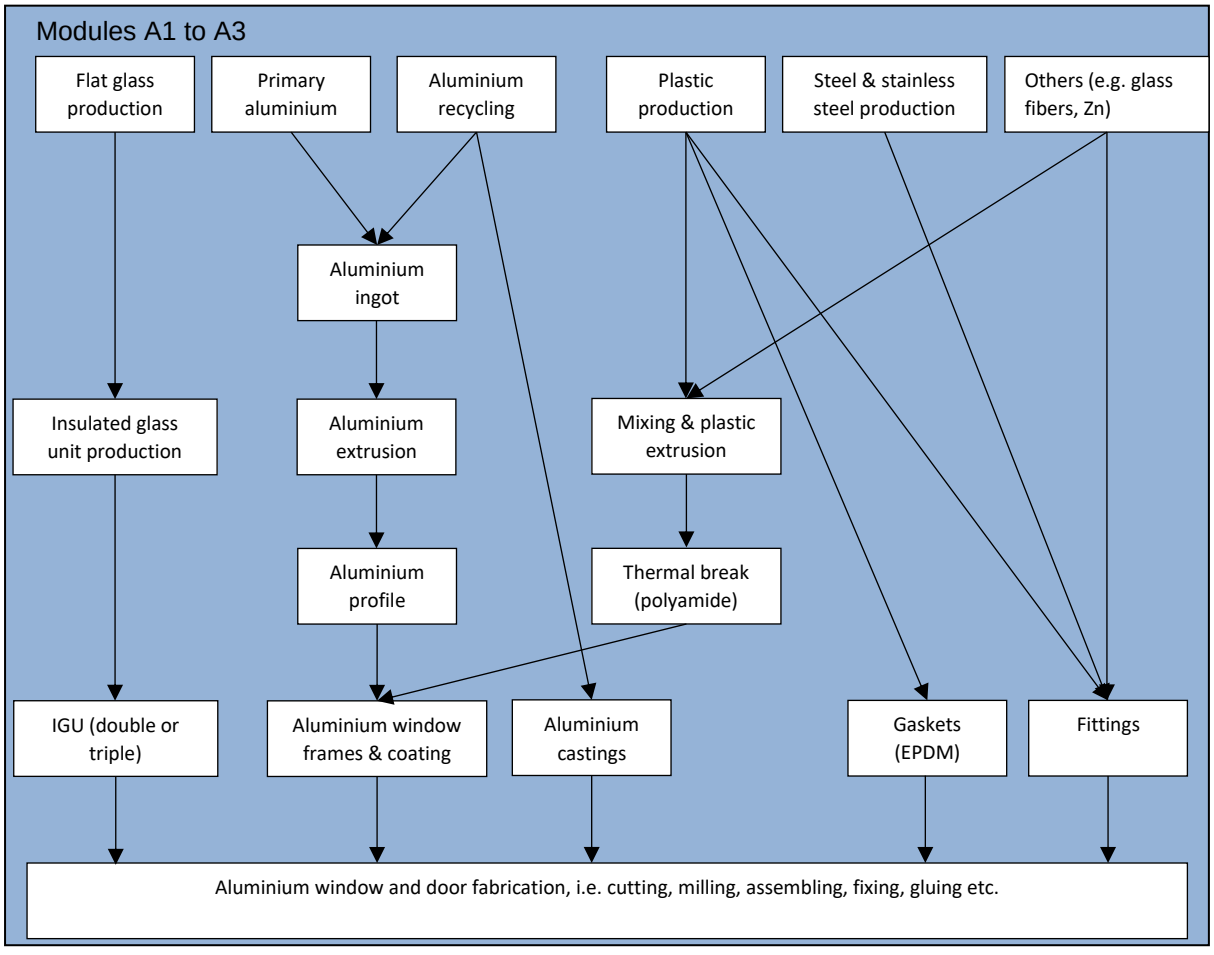

Figure 1 Main production processes and components of aluminium windows and doors

The upstream aluminium processes have been modelled using European Aluminium LCI datasets for the primary aluminium production, recycling and remelting as described in the European Aluminium Environmental profile report 2018.

For the other processes and materials, e.g. thermal break, gaskets, glass unit or hardware, datasets from the GaBi database have been used. The powder coating of aluminium profiles has been modelled using GaBi datasets as well.

At the end-of-life stage, aluminium windows and doors should be specifically dismantled and collected in order to be treated since they include several materials which can be efficiently recycled or can be used for energy recovery. In particular, the aluminium profiles are systematically dismantled and sent for recycling. Gaskets, thermal breaks and hardware are collected together with the aluminium profiles and are then treated through shredding and sorting with the aluminium profile. Regarding the glazing unit, according to the information collected by Glass For Europe, many different steps need to be implemented before waste glass can be recycled by the glass industry, including a proper dismantling of the sliding system or the glazing from buildings before demolition, the collection of these systems or glazing after building demolition or renovation, and the segregation of glass from other sliding system components before recycling in a glass furnace. However, the glazing unit might not be systematically collected at the building renovation or demolition site. Hence, two extreme end of life scenarios have been used for flat glass: 100% recycling or 100% landfilling.

1.4 Health and safety aspects during production and installation

There are no critical health and safety aspects during the production of aluminium windows and doors. Cr-free pre-treatments are used for the pre-treatment of aluminium profile prior the VOC-free powder coating process There are no relevant aspects of occupational health and safety during the further processing and installation of ETEM sliding systems. Under normal installation, no measurable environmental impacts can be associated with the use of ETEM sliding systems. The appropriate safety measures need to be taken at the building site, especially if installation takes place on a high-rise building.

1.5 Reference service life

The analysed products E50 and ES70 are customised building products which are assembled on the building site. This EPD does not cover the downstream process to install the products at the building site.

2 LCA – CALCULATION RULES

2.1 Declared unit & bill of materials

The Bill of Materials of the two analysed products are reported in Table 3. The declared unit corresponds to 1 m^2 of sliding system.

Table 3 Bill of materials (kg) of the declared unit for the 2 products

Reference	E50	ES70
Type	Double-glazed	Double-glazed
Glass	16,3 (60,1%)	16,1 (53,9%)
Aluminium frame	7,07 (26,1%)	9,98 (33.4%)
Thermal brake (PA)	0,66 (2,4%)	0,65 (2,2%)
Gasket	0,58 (2,1%)	0,53 (1,8%)
Fitting and others	2,53 (9,3%)	2,62 (8,8%)
TOTAL	**27,1 (100%)**	**29,9 (100%)**

2.2 System boundary

This EPD is from cradle to gate with modules C1-C4 and module D, as reported in Table 4.

The production stage (modules A1-A3) includes processes that provide materials and energy input for the system, manufacturing and transport processes up to the factory gate, as well as waste processing. For the end of life, the default scenario defined in the General Product Instructions and detailed in 3.2 is applied, considering two scenarios for the glazing units: one with 100% recycling of the glass and one with 100% landfill of the glass.

Table 4 Modules declared

Production			Installation		Use stage							End-of-Life				Next product system
Raw material	Transport	Manufacturing	Transport to	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy	Operational water	Deconstruction	Transport	Waste processing	Disposal	Reuse recovery
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X

Note: ND: Not Declared; **X**: Module included in the LCA.

Module A4 is declared for a distance of 1 km to give the possibility to adjust the resulting environmental impact depending on the specific distance at hand.

2.3 Energy mix

In the models developed the background electricity mix used is the European electricity mix (EU-28 Electricity grid mix (2016). Details about the electricity modelling in the datasets: production of primary aluminium, extrusion, rolling and recycling please refer to the Environmental Profile Report 2018.

In the foreground, the production process has very limited impact, which is below the cut-off rule of 5%, and was not modelled, as described under point 2.5.

2.4 Allocation

The scrap which are produced along the production chain are recycled into the same production chain and are modelled as "closed loop" within Module A. This recycling loop has been modelled in the GaBi model so that the aluminium sliding system is the only product exiting the gate. Hence, the production process does not deliver any co-products.

At the end-of-life stage, the sliding systems are sent to an end of life treatment which is modelled according to the scenario reported in 3.2. The environmental burdens and benefits of recycling and energy recovery are calculated in module D accordingly.

2.5 Assumptions and Cut off criteria

The aluminium profiles were composed of a mix of 60% primary aluminium and 40% recycled aluminium. Such mix represents the typical sourcing of aluminium in Europe, all markets included. For the primary aluminium, a primary aluminium ingot consumption mix was considered (European production + net fraction of imports into Europe). Alloying elements were not considered, and a pure aluminium profile has been assumed as a proxy.

No specific data were collected and used to model the fabrication stage, which has a limited impact on the full life cycle profile of the sliding system. The process of integrating the thermal break into the aluminium profiles has very limited impact which is below the cut-off rule of 5%. Hence, no specific LCA modelling has been done on that process step, except a scrap rate of 5% for the aluminium profile which has been considered. All other known operating data was taken into consideration in the analysis.

2.6 Data quality

Representativeness

Technological: All primary and secondary data were modelled to be specific to the technologies or technology mixes under study. Where technology-specific data were unavailable, proxy data were used. For the aluminium production, extrusion profiles and recycling, the datasets described in the Environmental Profile Report 2018 of European Aluminium have been used. The modelling reflects the specific BoM of the analysed products. Technological representativeness is considered to be very good.

Geographical: All primary data were collected specific to the countries under study. Regarding secondary data, where EU region specific data were unavailable, DE datasets were used. For the aluminium production, extrusion profiles and recycling, the datasets described in the Environmental Profile Report 2018 of European Aluminium have been used. Geographical representativeness is considered to be good.

Temporal: Primary data refer to the year 2020, and all secondary data come from the GaBi database SP40, including those on aluminium production, which are the most recent ones as described in the Environmental Profile Report 2018 of European Aluminium.

Completeness

All relevant process steps are considered and modelled to represent the specific situation for this supply chain. No specific process data have been collected considering that their impact on the whole product life cycle is limited. The products object of this EPD are fabricated by manufacturers being in close collaboration with ETEM, based on its own designs and instructions. Hence, collecting data on this process step is also very challenging. In any case, energy and consumables used at the fabrication

stage are below the cut-off rule of 5% and were not considered. A scrap rate of 5% at fabrication stage was anyway considered in the model.

The process chain is considered sufficiently complete regarding the goal and scope of this study.

Overall, the data quality can be described as good.

2.7 Software and databases

These EPD results have been calculated from an LCA tool for EPD, based on the GaBi database. Currently the EPD software is using the software GaBi V10.0.0.71 and the Service Pack 40 (SP40).

2.8 Comparability

As a general rule, a comparison or evaluation of EPD data may be possible when all of the data to be compared has been drawn up in accordance with EN 15804 and the building context or product-specific characteristics are taken into consideration.

3 LCA – SCENARIOS AND ADDITIONAL INFORMATION

3.1 Scenario for additional modules

Module A4 is taken into consideration in this Declaration, and it has been modelled according to the information reported in Table 5.

Table 5 Module A4 – Transport to the building site

Scenario information	Unit (expressed per DU)
Fuel type and consumption of vehicle or vehicle type used for transport e.g. long-distance truck, boat, etc.	Truck-trailer, Euro 4, 34 - 40t gross weight / 27t payload capacity, diesel driven
Distance	1 km
Capacity utilisation (including empty returns)	61 %
Bulk density of transported products	-
Volume capacity utilisation factor (factor = 1 or <1 or ≥1 for compressed or nested packaged products)	Not applicable

3.2 Scenario for Mod. C1-C4

The default scenario for the end of life of the sliding system, as reported in the General Programme Instructions, is the following:

- collection rate: 99%;
- shredding efficiency: 95%;
- scrap recycled through refining process: 96.5%
- overall aluminium recycling rate: 91%.

For the glass used in the sliding systems, two extreme end of life scenarios were modelled: one with 100% recycling of the glass and one with 100% landfill of the glass.

Table 6 reports the main parameters of the end of life scenarios for the main materials and components.

Table 6 Parameters of the end of life scenarios for the main materials and components, related to the DU – Scenario 100% glass recycling and 100% glass landfill

Processes	Unit (expressed per FU or DU of components, products or materials and by type of material)	E50	ES70
Collection process specified by type	Kg collected separately	Glass: 16,3 kg	Glass: 16,1 kg
		Aluminium frame: 6,99 kg	Aluminium frame: 9,88 kg
		Thermal brake: 0,65 kg	Thermal brake: 0,64 kg
		Gasket: 0,57 kg	Gasket: 0,52 kg
		Metal fittings and others: 2,5 kg	Metal fittings and others: 2,59 kg
	Kg collected with mixed construction waste	0	0
	Kg for re-use	0	0

Recovery system specified by type	Kg for recycling	Glass: 16,3 kg (scenario 100% glass recycling)	Glass: 16,1 kg (scenario 100% glass recycling)
		Aluminium frame: 6,64 kg	Aluminium frame: 9,39 kg
		Metal fittings: 0,23 kg	Metal fittings: 1,22 kg
	Kg for energy recovery	Thermal brake: 0,62 kg	Thermal brake: 0,61 kg
		Gasket: 0,54 kg	Gasket: 0,49 kg
		Others: 1,28kg	Others: 1,25 kg
3isposal specified by type	Kg product or material for final deposition	Aluminium frame: 0,35 kg	Aluminium frame: 0,49 kg
		Thermal brake: 0,03 kg	Thermal brake: 0,03 kg
		Gasket: 0,03 kg	Gasket: 0,03 kg
		Fittings and others: 0,08 kg	Fittings and others: 0,13 kg
		Glass: 16,3 kg (scenario 100% glass landfill)	Glass: 16,1 kg (scenario 100% glass landfill)
Assumptions for scenario development, e.g. transportation	Units as appropriate		

3.3 Scenario Mod. D

Module D includes:

- a transport from the scrap dealers to the recycling plants, considering an average distance of 200 km;
- recycling of Aluminium through refining.
- For the scenario 100% recycling for glass: transport to recycling (200 km) + glass recycling

The calculation of module D has been implemented in line with the General Programme Instructions of European Aluminium, thus based on the difference between the scrap used at the input and output side. In some cases, this may result in environmental burdens instead of environmental benefits if the product system is a net consumer of valuable secondary material.

3.4 Additional environmental information

During use, the indoor air quality, i.e. VOC emission, is not affected by aluminium windows and doors. Since the use phase is not modelled, no specific information can be given about the Reference Service Life. In normal use, aluminium building products are not altered or corroded over time. A regular cleaning (e.g. once a year) of the product suffices to secure a long service life. However, the use of highly alkaline (pH >10) or highly acidic (pH < 4) cleaning solutions should be avoided. In practice, a service life of 50 years can be assumed in normal use for such application, with the exception of the IGU (Insulated Glass Unit) which needs to be replaced usually after 30 years due to a slow degradation of its performance. In case of fire, aluminium is a non-combustible construction material (European Fire Class A1) in accordance with Directive 96/603/EC and does therefore not make any contribution to fire.

4 LCA – RESULTS Sliding system E50

4.1 Result of the LCA – Environmental impact Sliding system E50, 1 m^2

The tables below report the results of the LCA study for the two glass scenarios: 100% recycling and 100% landfill.

4.1.1 Core environmental impact indicators

Scenario 100% glass recycling

Table 7 Core environmental impact indicators for 1 m^2 sliding system E50, ***scenario 100% glass recycling***

Impact category	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP - total	kg CO_2 eq.	9,55E+001	1,31E-003	9,75E-002	2,79E-001	9,44E-001	6,39E+000	-3,04E+001
GWP – fossil	kg CO_2 eq.	9,50E+001	1,31E-003	9,78E-002	2,78E-001	7,71E-001	6,39E+000	-3,03E+001
GWP – biogenic	kg CO_2 eq.	3,67E-001	5,30E-007	-4,65E-004	1,13E-004	1,69E-001	-2,42E-003	-7,48E-002
GWP - luluc	kg CO_2 eq.	5,46E-002	5,51E-006	1,86E-004	1,17E-003	4,13E-003	8,03E-004	-1,09E-002
ODP	kg CFC 11 eq.	5,46E-010	3,23E-019	1,78E-015	6,87E-017	8,27E-015	5,88E-015	-1,27E-010
AP	mol H^+ eq.	4,25E-001	7,46E-006	2,59E-004	1,59E-003	1,13E-003	3,82E-003	-1,61E-001
EP - freshwater	kg PO_4^{3-} eq.	3,22E-004	2,87E-009	2,51E-007	6,10E-007	2,40E-006	3,39E-006	-2,34E-005
EP - marine	kg N eq.	1,04E-001	3,66E-006	7,79E-005	7,78E-004	6,93E-004	1,70E-003	-2,61E-002
EP - terrestrial	mol N eq.	1,16E+000	4,05E-005	8,41E-004	8,62E-003	7,86E-003	1,95E-002	-3,29E-001
POCP	kg NMVOC eq.	2,88E-001	6,98E-006	2,16E-004	1,48E-003	1,21E-003	4,46E-003	-7,27E-002
ADP-MM (**)	kg Sb eq.	1,59E-003	1,09E-010	2,47E-008	2,33E-008	1,05E-007	8,73E-008	-1,43E-003
ADPF (**)	MJ	1,33E+003	1,75E-002	1,64E+000	3,72E+000	2,81E+000	7,86E+000	-3,74E+002
WDP (**)	m^3	1,96E+001	5,67E-006	1,76E-002	1,21E-003	6,64E-002	5,70E-001	-4,34E+000

Scenario 100% glass landfill

Table 8 Core environmental impact indicators for 1 m^2 sliding system E50, ***scenario 100% glass landfill***

Impact category	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP - total	kg CO_2 eq.	9,55E+001	1,31E-003	9,75E-002	1,61E-001	3,31E-001	6,62E+000	-2,04E+001
GWP – fossil	kg CO_2 eq.	9,50E+001	1,31E-003	9,78E-002	1,60E-001	3,28E-001	6,64E+000	-2,03E+001
GWP – biogenic	kg CO_2 eq.	3,67E-001	5,30E-007	-4,65E-004	6,49E-005	2,04E-003	-2,20E-002	-6,17E-002
GWP - luluc	kg CO_2 eq.	5,46E-002	5,51E-006	1,86E-004	6,76E-004	7,99E-004	1,51E-003	-5,77E-003
ODP	kg CFC 11 eq.	5,46E-010	3,23E-019	1,78E-015	3,96E-017	1,03E-014	6,80E-015	-1,27E-010

AP	mol H^+ eq.	4,25E-001	7,46E-006	2,59E-004	9,15E-004	5,62E-004	5,59E-003	-1,05E-001
EP - freshwater	kg PO_4^{3-} eq.	3,22E-004	2,87E-009	2,51E-007	3,52E-007	1,39E-006	3,82E-006	-1,56E-005
EP - marine	kg N eq.	1,04E-001	3,66E-006	7,79E-005	4,48E-004	1,58E-004	2,16E-003	-1,47E-002
EP - terrestrial	mol N eq.	1,16E+000	4,05E-005	8,41E-004	4,97E-003	1,65E-003	2,45E-002	-1,60E-001
POCP	kg NMVOC eq.	2,88E-001	6,98E-006	2,16E-004	8,56E-004	3,98E-004	5,84E-003	-4,46E-002
ADP-MM (**)	kg Sb eq.	1,59E-003	1,09E-010	2,47E-008	1,34E-008	1,25E-007	1,09E-007	-1,43E-003
ADPF (**)	MJ	1,33E+003	1,75E-002	1,64E+000	2,14E+000	4,15E+000	1,11E+001	-2,64E+002
WDP (**)	m^3	1,96E+001	5,67E-006	1,76E-002	6,95E-004	7,36E-003	5,96E-001	-3,34E+000

Note: GWP – Global Warming Potential; ODP – Ozone Depletion; AP – acidification potential for soil and water; EP – Eutrophication potential; POCP – formation potential of tropospheric ozone; ADP - MM – abiotic depletion potential for non fossil resources; ADPF – Abiotic depletion potential for fossil resources; WDP – Water deprivation potential.

(**) **Disclaimer**: 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.

4.1.2 Additional environmental impact indicators

Scenario 100% glass recycling

Table 9 Additional environmental impact indicators for 1 m² sliding system E50, ***scenario 100% glass recycling***

Impact category	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particular Matter emissions	Disease incidence	4,51E-006	3,09E-011	2,49E-009	6,58E-009	1,06E-009	3,53E-008	-2,08E-006
Ionising radiation - human health (*)	[kBq U235 eq.]	8,47E+000	1,78E-006	3,53E-002	3,78E-004	-3,63E-002	2,68E-002	-3,47E+000
Eco-toxicity (freshwater) (**)	[CTUe]	1,80E+003	1,46E-002	7,88E-001	3,10E+000	4,47E+000	6,05E+000	-9,70E+002
Human toxicity - cancer effects (**)	[CTUh]	2,77E-007	3,47E-013	2,11E-011	7,37E-011	5,59E-011	2,54E-010	-3,25E-009
Human toxicity - non-cancer effects (**)	[CTUh]	1,97E-006	1,62E-011	8,31E-010	3,45E-009	4,38E-009	2,51E-008	1,73E-007
Land Use related impacts/ Soil quality (**)	dimensionless	2,00E+002	5,48E-003	5,20E-001	1,16E+000	3,51E+000	1,71E+000	-2,52E+001

Scenario 100% glass landfill

Table 10 Additional environmental impact indicators for 1 m² sliding system E50, ***scenario 100% glass landfill***

Impact category	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particular Matter emissions	Disease incidence	4,51E-006	3,09E-011	2,49E-009	3,79E-009	4,15E-009	5,72E-008	-1,45E-006
Ionising radiation - human health (*)	[kBq U235 eq.]	8,47E+000	1,78E-006	3,53E-002	2,18E-004	3,85E-002	3,06E-002	-3,19E+000
Eco-toxicity (freshwater) (**)	[CTUe]	1,80E+003	1,46E-002	7,88E-001	1,79E+000	1,66E+000	7,90E+000	-8,95E+001
Human toxicity - cancer effects (**)	[CTUh]	2,77E-007	3,47E-013	2,11E-011	4,25E-011	2,29E-010	5,28E-010	-1,64E-009
Human toxicity - non-cancer effects (**)	[CTUh]	1,97E-006	1,62E-011	8,31E-010	1,99E-009	1,89E-009	5,53E-008	3,60E-007
Land Use related impacts/ Soil quality (**)	dimensionless	2,00E+002	5,48E-003	5,20E-001	6,71E-001	2,05E+000	2,38E+000	-1,85E+001

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

(**) **Disclaimer**: 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.

4.2 Result of the LCA – Resource use Sliding system E50, 1 m²

The tables below report the results of the resource use for the two glass scenarios: 100% recycling and 100% landfill.

Scenario 100% glass recycling

Table 11 Resource use sliding system E50 (1 m²), ***scenario 100% glass recycling***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
PERE	MJ	3,20E+02	1,02E-03	6,40E-01	2,17E-01	1,24E+00	1,52E+00	-1,18E+02
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	3,20E+02	1,02E-03	6,40E-01	2,17E-01	1,24E+00	1,52E+00	-1,18E+02
PENRE	MJ	1,33E+03	1,75E-02	1,64E+00	3,72E+00	2,81E+00	7,87E+00	-3,74E+02
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	1,33E+03	1,75E-02	1,64E+00	3,72E+00	2,81E+00	7,87E+00	-3,74E+02
SM	kg	2,89E+00	0,00E+00	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	7,34E-01	9,12E-07	7,37E-04	1,94E-04	1,24E-03	1,42E-02	-2,91E-01

Scenario 100% glass landfill

*Table 12 Resource use sliding system E50 (1 m²), **scenario 100% glass landfill***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
PERE	MJ	3,20E+02	1,02E-03	6,40E-01	1,25E-01	2,24E+00	1,94E+00	-1,12E+02
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	3,20E+02	1,02E-03	6,40E-01	1,25E-01	2,24E+00	1,94E+00	-1,12E+02
PENRE	MJ	1,33E+03	1,75E-02	1,64E+00	2,14E+00	4,15E+00	1,11E+01	-2,64E+02
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	1,33E+03	1,75E-02	1,64E+00	2,14E+00	4,15E+00	1,11E+01	-2,64E+02
SM	kg	2,89E+00	0,00E+00	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	7,34E-01	9,12E-07	7,37E-04	1,12E-04	1,21E-03	1,50E-02	-2,64E-01

Note: 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 resources; SM – Use of secondary materials; RSF – Use of renewable secondary fuels; NRSF – use of non-renewable secondary fuels; FW – use of net fresh water.

4.3 Result of the LCA – Output flows, waste categories Sliding system E50, 1 m²

The tables below report the results of the resource use for the two glass scenarios: 100% recycling and 100% landfill

Scenario 100% glass recycling

*Table 13 Output flows, waste categories – sliding system E50 (1 m²), **scenario 100% glass recycling***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
HWD	kg	3,72E-06	6,54E-10	8,80E-09	1,39E-07	2,73E-07	3,38E-08	-3,80E-07
NHWD	kg	1,43E+01	3,07E-06	1,04E-03	6,53E-04	1,96E-02	2,95E+00	-5,24E+00
RWD	kg	5,25E-02	1,84E-08	2,15E-04	3,92E-06	-7,34E-06	2,46E-04	-1,97E-02
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,28E+01	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,49E+00	0,00E+00
EET	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,54E+01	0,00E+00

Scenario 100% glass landfill

*Table 14 Output flows, waste categories – sliding system E50 (1 m²), **scenario 100% glass landfill***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
HWD	kg	3,72E-06	6,54E-10	8,80E-09	8,01E-08	3,23E-09	8,32E-08	-1,45E-07
NHWD	kg	1,43E+01	3,07E-06	1,04E-03	3,76E-04	4,29E-03	1,92E+01	-4,86E+00
RWD	kg	5,25E-02	1,84E-08	2,15E-04	2,26E-06	3,91E-04	2,83E-04	-1,79E-02
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,03E+00	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,49E+00	0,00E+00
EET	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,54E+01	0,00E+00

Note: 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

5 LCA – RESULTS Sliding system ES70

5.1 Result of the LCA – Environmental impact Sliding system ES70, 1 m^2

The tables below report the results of the LCA study for the two glass scenarios: 100% recycling and 100% landfill.

5.1.1 Core environmental impact indicators

Scenario 100% glass recycling

Table 15 Core environmental impact indicators for 1 m^2 sliding system ES70, ***scenario 100% glass recycling***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP - total	kg CO_2 eq.	1,16E+002	1,45E-003	9,92E-002	3,03E-001	1,02E+000	6,05E+000	-3,72E+001
GWP – fossil	kg CO_2 eq.	1,16E+002	1,44E-003	9,95E-002	3,02E-001	8,53E-001	6,06E+000	-3,71E+001
GWP – biogenic	kg CO_2 eq.	3,86E-001	5,84E-007	-5,39E-004	1,22E-004	1,67E-001	-2,42E-003	-9,27E-002
GWP - luluc	kg CO_2 eq.	6,38E-002	6,07E-006	1,93E-004	1,27E-003	4,31E-003	7,24E-004	-1,21E-002
ODP	kg CFC 11 eq.	6,60E-010	3,56E-019	1,78E-015	7,47E-017	1,10E-014	5,25E-015	-1,77E-010
AP	mol H^+ eq.	5,24E-001	8,22E-006	2,68E-004	1,72E-003	1,27E-003	3,83E-003	-1,99E-001
EP - freshwater	kg PO_4^{3-} eq.	4,24E-004	3,16E-009	2,55E-007	6,62E-007	2,75E-006	3,19E-006	-2,73E-005
EP - marine	kg N eq.	1,21E-001	4,03E-006	8,18E-005	8,45E-004	7,29E-004	1,72E-003	-3,14E-002
EP - terrestrial	mol N eq.	1,33E+000	4,46E-005	8,84E-004	9,36E-003	8,23E-003	1,97E-002	-3,85E-001
POCP	kg NMVOC eq.	3,36E-001	7,69E-006	2,27E-004	1,61E-003	1,31E-003	4,51E-003	-8,88E-002
ADP-MM (**)	kg Sb eq.	1,89E-003	1,21E-010	2,48E-008	2,53E-008	1,38E-007	7,83E-008	-1,71E-003
DPF (**)	MJ	1,61E+003	1,93E-002	1,66E+000	4,04E+000	3,93E+000	7,14E+000	-4,58E+002
WDP (**)	m^3	2,72E+001	6,25E-006	1,76E-002	1,31E-003	6,77E-002	5,48E-001	-5,43E+000

Scenario 100% glass landfill

Table 16 Core environmental impact indicators for 1 m^2 sliding system ES70, ***scenario 100% glass landfill***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP - total	kg CO_2 eq.	1,16E+002	1,45E-003	9,92E-002	1,86E-001	4,19E-001	6,28E+000	-2,73E+001
GWP – fossil	kg CO_2 eq.	1,16E+002	1,44E-003	9,95E-002	1,86E-001	4,15E-001	6,30E+000	-2,72E+001
GWP – biogenic	kg CO_2 eq.	3,86E-001	5,84E-007	-5,39E-004	7,52E-005	2,58E-003	-2,18E-002	-7,98E-002

GWP - luluc	kg CO_2 eq.	6,38E-002	6,07E-006	1,93E-004	7,83E-004	1,01E-003	1,43E-003	-7,02E-003
ODP	kg CFC 11 eq.	6,60E-010	3,56E-019	1,78E-015	4,59E-017	1,30E-014	6,16E-015	-1,77E-010
AP	mol H^+ eq.	5,24E-001	8,22E-006	2,68E-004	1,06E-003	7,12E-004	5,58E-003	-1,44E-001
EP - freshwater	kg PO_4^{3-} eq.	4,24E-004	3,16E-009	2,55E-007	4,07E-007	1,76E-006	3,61E-006	-1,95E-005
EP - marine	kg N eq.	1,21E-001	4,03E-006	8,18E-005	5,20E-004	2,00E-004	2,17E-003	-2,01E-002
EP - terrestrial	mol N eq.	1,33E+000	4,46E-005	8,84E-004	5,76E-003	2,08E-003	2,46E-002	-2,19E-001
POCP	kg NMVOC eq.	3,36E-001	7,69E-006	2,27E-004	9,92E-004	5,03E-004	5,87E-003	-6,10E-002
ADP-MM (**)	kg Sb eq.	1,89E-003	1,21E-010	2,48E-008	1,55E-008	1,58E-007	1,00E-007	-1,71E-003
ADPF (**)	MJ	1,61E+003	1,93E-002	1,66E+000	2,48E+000	5,25E+000	1,03E+001	-3,50E+002
WDP (**)	m^3	2,72E+001	6,25E-006	1,76E-002	8,06E-004	9,32E-003	5,74E-001	-4,45E+000

Note: GWP – Global Warming Potential; ODP – Ozone Depletion; AP – acidification potential for soil and water; EP – Eutrophication potential; POCP – formation potential of tropospheric ozone; ADP - MM – abiotic depletion potential for non fossil resources; ADPF – Abiotic depletion potential for fossil resources; WDP – Water deprivation potential.

(**) **Disclaimer**: 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.

5.1.2 Additional environmental impact indicators

Scenario 100% glass recycling

Table 17 Additional environmental impact indicators for 1 m^2 sliding system ES70, ***scenario 100% glass recycling***

Impact category	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particular Matter emissions	Disease incidence	5,81E-006	3,41E-011	2,59E-009	7,15E-009	2,20E-009	3,27E-008	-2,63E-006
Ionising radiation - human health (*)	[kBq U235 eq.]	1,13E+001	1,96E-006	3,53E-002	4,11E-004	-2,52E-002	2,45E-002	-4,48E+000
Eco-toxicity (freshwater) (**)	[CTUe]	2,07E+003	1,60E-002	8,07E-001	3,36E+000	4,88E+000	5,42E+000	-9,89E+002
Human toxicity - cancer effects (**)	[CTUh]	3,30E-007	3,82E-013	2,15E-011	8,01E-011	1,19E-010	2,31E-010	-4,36E-009
Human toxicity - non-cancer effects (**)	[CTUh]	2,29E-006	1,79E-011	8,53E-010	3,75E-009	4,85E-009	2,27E-008	2,21E-007
Land Use related impacts/ Soil quality (**)	dimensionless	2,53E+002	6,03E-003	5,27E-001	1,26E+000	4,04E+000	1,54E+000	-2,87E+001

Table 18 Additional environmental impact indicators for 1 m^2 sliding system ES70, ***scenario 100% glass landfill***

Impact category	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particular Matter emissions	Disease incidence	5,81E-006	3,41E-011	2,59E-009	4,39E-009	5,25E-009	5,44E-008	-2,00E-006
Ionising radiation - human health (*)	[kBq U235 eq.]	1,13E+001	1,96E-006	3,53E-002	2,52E-004	4,87E-002	2,82E-002	-4,21E+000
Eco-toxicity (freshwater) (**)	[CTUe]	2,07E+003	1,60E-002	8,07E-001	2,07E+000	2,10E+000	7,25E+000	-1,19E+002
Human toxicity - cancer effects (**)	[CTUh]	3,30E-007	3,82E-013	2,15E-011	4,92E-011	2,90E-010	5,02E-010	-2,76E-009
Human toxicity - non-cancer effects (**)	[CTUh]	2,29E-006	1,79E-011	8,53E-010	2,31E-009	2,39E-009	5,25E-008	4,05E-007
Land Use related impacts/ Soil quality (**)	dimensionless	2,53E+002	6,03E-003	5,27E-001	7,78E-001	2,60E+000	2,21E+000	-2,21E+001

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

(**) **Disclaimer**: 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.

5.2 Result of the LCA – Resource use Sliding system ES70, 1 m^2

The tables below report the results of the resource use for the two glass scenarios: 100% recycling and 100% landfill.

Scenario 100% glass recycling

*Table 19 Resource use sliding system ES70 (1 m^2), **scenario 100% glass recycling***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
PERE	MJ	4,24E+02	1,12E-03	6,41E-01	2,35E-01	1,85E+00	1,36E+00	-1,58E+02
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	4,24E+02	1,12E-03	6,41E-01	2,35E-01	1,85E+00	1,36E+00	-1,58E+02
PENRE	MJ	1,61E+03	1,93E-02	1,66E+00	4,04E+00	3,93E+00	7,14E+00	-4,59E+02
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	1,61E+03	1,93E-02	1,66E+00	4,04E+00	3,93E+00	7,14E+00	-4,59E+02
SM	kg	4,07E+00	0,00E+00	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	9,63E-01	1,00E-06	7,38E-04	2,11E-04	1,56E-03	1,36E-02	-3,89E-01

Scenario 100% glass landfill

*Table 20 Resource use sliding system ES70 (1 m²), **scenario 100% glass landfill***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
PERE	MJ	4,24E+02	1,12E-03	6,41E-01	1,45E-01	2,84E+00	1,78E+00	-1,51E+02
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	4,24E+02	1,12E-03	6,41E-01	1,45E-01	2,84E+00	1,78E+00	-1,51E+02
PENRE	MJ	1,61E+03	1,93E-02	1,66E+00	2,48E+00	5,25E+00	1,03E+01	-3,50E+02
PENRM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	1,61E+03	1,93E-02	1,66E+00	2,48E+00	5,25E+00	1,03E+01	-3,50E+02
SM	kg	4,07E+00	0,00E+00	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	9,63E-01	1,00E-06	7,38E-04	1,30E-04	1,53E-03	1,44E-02	-3,62E-01

Note: 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 resources; SM – Use of secondary materials; RSF – Use of renewable secondary fuels; NRSF – use of non-renewable secondary fuels; FW – use of net fresh water.

5.3 Result of the LCA – Output flows, waste categories Sliding system ES70, 1 m²

The tables below report the results of the resource use for the two glass scenarios: 100% recycling and 100% landfill.

Scenario 100% glass recycling

*Table 21 Output flows, waste categories – sliding system ES70 (1 m²), **scenario 100% glass recycling***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
HWD	kg	3,75E-06	7,20E-10	9,63E-09	1,51E-07	2,70E-07	3,08E-08	-4,19E-07
NHWD	kg	1,92E+01	3,38E-06	1,05E-03	7,09E-04	2,06E-02	2,86E+00	-7,14E+00
RWD	kg	6,89E-02	2,03E-08	2,15E-04	4,26E-06	1,01E-04	2,23E-04	-2,51E-02
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,53E+01	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,32E+00	0,00E+00
EET	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,50E+01	0,00E+00

Scenario 100% glass landfill

*Table 22 Output flows, waste categories – sliding system ES70 (1 m²), **scenario 100% glass landfill***

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
HWD	kg	3,75E-06	7,20E-10	9,63E-09	9,28E-08	4,08E-09	7,96E-08	-1,86E-07
NHWD	kg	1,92E+01	3,38E-06	1,05E-03	4,36E-04	5,43E-03	1,90E+01	-6,77E+00
RWD	kg	6,89E-02	2,03E-08	2,15E-04	2,62E-06	4,94E-04	2,59E-04	-2,34E-02
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,75E+00	0,00E+00	0,00E+00
MER	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,32E+00	0,00E+00
EET	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,50E+01	0,00E+00

Note: 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.

6 LCA – INTERPRETATION

The results are analysed and interpreted for modules A1-A3 and for modules C1-D. Results for module A4 are not further interpreted, as calculated only for 1 km.

Production stages: modules A1 to A3.

The majority of the environmental impacts come from the aluminium profile and to a lesser extent from the glazing unit. Hence, most indicators are influenced by the mass of aluminium in the declared unit: The higher the aluminium mass, the higher the indicator. Hence, the GWP indicator evolves from 95,46 [kg CO_2-eq] for the E50 to 116,35 [kg CO_2-eq] for ES70.

Within the aluminium production processes, the primary aluminium production is dominant, especially the alumina production and the electrolysis. The recycled ingot production, which presents a much lower impact than the primary ingot production, is used in Module A1-A3 for the fraction of aluminium coming from recycling. The extrusion process which converts ingot, i.e. billets, into profile is much less significant. The LCA modelling and the impact of the primary aluminium production is detailed in the Environmental Profile Report 2018. The impact of the other components, e.g. thermal break, gaskets and fittings, is less significant due to their low contribution to the BoM.

End of life stage: modules C1-C4 and module D

Modules C1-C3: they are negligible for all products compared to modules A1-A3 (<2%) and for both glass scenarios.

Module C4: In the case of the glass recycling scenario, the contribution of module C4 (disposal) is very limited compared to modules A1-A3 and module D. However, the mass of non-hazardous waste disposed becomes significant, i.e. corresponding at least to the mass of the glazing unit.

Module D: The environmental benefits come not only from the recycling of aluminium and metal fittings but also from glass recycling in case of glass recycling scenario, and also from the energy recovery from the incineration of the gaskets and the thermal break. About 20% to 30% of GWP savings are obtained in Module D compared to the value calculated for module A1-A3. These calculations show the relevance to consider Module D in the full assessment of sliding system in the building context.

7 OTHER INFORMATION

ETEM Group's operation and development is founded on the concept of corporate responsibility, and includes recognition of the need for positive actions, and continuous support and development of the local communities that neighbour our facilities.

Through its Environmental Management System, ETEM actively implements best practices regarding environmental protection through significant investments and measures, by optimizing the production cycle, implementing new procedures that reduce the energy footprint of our plants, and the vigilant prevention of any possibility of environmental pollution.

Additional information about ETEM, its corporate responsibility and sustainability policy and the products can be found at ETEM website www.etem.com.

These EPD results have been calculated from an LCA tool for EPD, based on the GaBi database, initially realised by thinkstep in 2013 and updated by Ecoinnovazione in 2019 (Ecoinnovazione S.r.l. – spin-off ENEA Via d'Azeglio 51, 40123 Bologna www.ecoinnovazione.it)

8 REFERENCES

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