ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	ARGE – The European Federation of Locks and Building Hardware Manufacturers
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-ARG-20230549-IBG1-EN
Issue date	02.04.2024
Valid to	01.04.2029

Sliding door hardware

ARGE – The European Federation of Locks and Building Hardware Manufacturers

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1. General Information

ARGE – The European Federation of Locks and Building Hardware Manufacturers

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-ARG-20230549-IBG1-EN

This declaration is based on the product category rules:

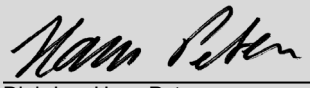
Building Hardware products, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

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Valid to

01.04.2029



Dipl.-Ing. Hans Peters
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Sliding door hardware

Owner of the declaration

ARGE – The European Federation of Locks and Building Hardware Manufacturers
Offerstraße 12
42551 Velbert
Germany

Declared product / declared unit

1 kg sliding door hardware

Scope:

This ARGE EPD covers hardware systems for sliding doors, sliding corner doors, sliding folding doors and sliding gates used for buildings as well as mechanisms used to support doors of varying materials and allow their opening and closing by a sliding action. It does not include sliding folding windows or door height windows. The reference product used to calculate the impact this product group has on the environment is an item of sliding door hardware composed primarily of aluminium and has been selected for the LCA (Life Cycle Assessment) because it is the product with the highest impact for 1 kg of product. A validity scope analysis has also been carried out to determine the limiting factors for sliding door gear covered by this EPD. In a preliminary study (simplified LCA), it has been confirmed that this EPD represents the worst-case condition and it can therefore be used to cover all sliding door hardware manufactured in Europe by ARGE member companies.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally



Dr. Matthew Fishwick,
(Independent verifier)

2. Product

2.1 Product description/Product definition

This EPD covers sliding door hardware intended to be used for buildings. The sample group used to calculate the LCA data for this EPD includes all functional hardware necessary to move a sliding door safely.
For the application and use the respective national provisions apply.

2.2 Application

These products are designed to be integrated into door and gate assemblies consisting of various materials and used for various applications. Their purpose is to ensure the fastening of the door or gate and to open and close it safely. They may be used for either interior or exterior doors or for gates.

2.3 Technical Data

Ideally, products should comply with a suitable technical specification. *EN 1527:2019+A1:2021, Building hardware – Hardware for sliding doors and folding doors – Requirements and test methods* and *EN 13126-15:2019, Building hardware - Hardware for windows and door height windows - Requirements and test methods - Part 15: Rollers for horizontal sliding and hardware for sliding folding windows* are examples of such specifications and some products will comply with them. The relevant grading structure is shown in the following table:

Grading structure according to EN 1527 and EN 13126-15

Name	Value	Unit
Category of use	-	Grade
Durability	1 - 6	Grade
Door mass	1 - 4	Grade
Fire resistance	-	Grade
Safety	1	Grade
Corrosion resistance	0 - 5	Grade
Security – burglar resistance	-	Grade
Category of door	1, 2, 3	Grade

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

2.4 Delivery status

The products are sold by unit. Deliveries of individual items are possible but are an exception. Standard deliveries comprise a larger quantity of sliding door hardware, as it is marketed as "B2B" product and not to end-users.

2.5 Base materials/Ancillary materials

Composition of product analysed for this EPD:

The values given are for the product analysed for this EPD. Ranges of the values for other products covered by the validity scope analysis are given in brackets.

Name	Value	Unit
Aluminium (0.00% – 97.20%)	97.2	%
Nylon 6 (0.00% – 8.28%)	2.5	%
Steel (0.31% – 100.00%)	0.31	%

Aluminium is a non-ferrous metal produced from bauxite by the Bayer process. Components made of aluminium are manufactured by extrusion or other types of mechanical processing.

Nylon 6 is a polymer, in particular polyamide. It is formed by the ring-opening polymerisation of caprolactam. Components made of Nylon 6 are formed by injection moulding or other thermal forming processes.

Steel is produced by combining iron with carbon as well as other elements depending on the desired characteristics. Components made of steel are formed by stamping or other types of mechanical processing.

1) This product/article/at least one partial article contains substances listed in the *ECHA candidate list* (date: 14.06.2023) exceeding 0.1 percentage by mass: Certain components may contain small amounts of lead (CAS no. 7439-92-1) as an alloying element.

2) This product/article/at least one partial article contains other cancerogenic, mutagenic, reprotoxic (CMR) substances in categories 1A or 1B which are not on the *ECHA candidate list*, exceeding 0.1 percentage by mass: no.

3) Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) *Ordinance on Biocide Products No. 528/2012*): no.

2.6 Manufacture

The manufacture of sliding door hardware usually follows a 3-step process:

1. Manufacture of the components: this step may include surface treatment in the factory or by external contractors.
2. Pre-assembly of modules (in the factory).
3. Final assembly (in the factory).

2.7 Environment and health during manufacturing

Regular measurements of air quality and noise levels are carried out by the manufacturers, the ARGE member companies. The results shall be within the mandatory safety levels. In areas where employees are exposed to chemical products, the required protective clothing and technical protective devices shall be provided. Regular health checks are mandatory for employees in production facilities.

2.8 Product processing/Installation

The installation of the products may vary depending on the type of door or gate and the specific situation, but the products shall not require energy consumption for installation.

2.9 Packaging

Normally, each individual product is packed in paper or cardboard. These individual products are then packed in a cardboard box and stacked on wooden pallets for transport to the customer.

Waste from product packaging is collected separately for waste disposal (including recycling).

2.10 Condition of use

Once installed, the products shall require no servicing during their expected service lives. There shall be no consumption of water or energy linked to their use, and they shall not cause any emissions.

2.11 Environment and health during use

No environmental damage or health risks are to be expected during normal conditions of use.

2.12 Reference service life

The reference service life is 30 years under normal working conditions. This corresponds to passing a mechanical endurance test of 100.000 cycles as specified in the *EN 1527* and *EN 15706*. The reference service life is dependent on the actual frequency of use and environmental conditions. It is required that installation, as well as maintenance of the product, must be done in line with instructions provided by the manufacturer.

2.13 Extraordinary effects

Fire

There are no specific fire resistance requirements.

Water

The declared product is intended to be used for a building under normal conditions (indoor or outdoor use) It shall not emit hazardous substances in the event of flooding.

Mechanical destruction

Mechanical destruction of the declared product shall not materially alter its composition or have any adverse effect on the environment.

2.14 Re-use phase

Removal of sliding door hardware (for re-use or recycling) shall have no adverse effect on the environment.

2.15 Disposal

Sliding door gear should be re-cycled wherever possible, providing that there is no adverse effect on the environment . The waste code in accordance with the *European Waste Code* is 17 04 07.

2.16 Further information

Details of all types and variants can be found on the manufacturers' websites. The respective website addresses are available at https://arge.org.

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit for all products covered by ARGE EPD is 1 kg (of product). Since individual products will rarely weigh exactly 1 kg it is necessary to establish the exact weight of the product and then use this as a correction factor to determine the true values for 1 kg of product in the tables (Section 5).

Declared unit

Name	Value	Unit
Declared unit	1	kg
Mass of declared product	3.92	kg
Raw density	1	kg/m^3

3.2 System boundary

Type of the EPD: "cradle to gate with options, with modules C1 – C4, and module D (A1-A3, C1-C3, D and additional modules)"

The analysis of the product life cycle includes the production and transport of the raw materials, the manufacture of the product and the packaging materials which are declared in modules A1-A3.
Losses during production are considered as waste and are sent for recycling. No recycling processes are taken into account except for transport and electricity consumption for grinding the metals. When recycled metals are used as raw material only their transformation process is taken into account and not the extraction of the raw material.
A4 module represents the transport of the finished sliding door gear to the installation site.
There is no waste associated with the installation of the product. The A5 module therefore represents only the disposal of the product packaging.
The End-of-Life (EoL) stages are also considered. The transportation to the EoL disposal site is taken into account in module C2. Module C4 covers the disposal of the locks. Module C3 covers the recycling of the individual elements according to European averages, with the remaining waste divided between incineration and landfill. Such a mixed scenario is declared due to the complex material mix of the product and the dependency of the EoL-route on the EoL-route of the product the sliding door hardware has been integrated into.
In practice, the end of life has been modelled as follows:

- when a material is sent for, recycling, generic transport and electric consumption of a shredder is taken into account (corresponding to the process 'Grinding, metals'). Only then, is the material considered to have attained the 'end-of-waste' state.
- each type of waste is modelled as a transport to the treatment site with a distance of 30 km. Parts sent for recycling include electricity consumption (grinding) and a flow ('Materials for recycling, unspecified').

3.3 Estimates and assumptions

The LCA data of the declared product had been calculated using the production data of an ARGE member company that manufactures 6 different products. The company had been chosen by ARGE as being representative by virtue of their production processes and market share. The sliding door hardware chosen as representative for this calculation follows the "worst-case" principle as explained under 6 LCA interpretation.

3.4 Cut-off criteria

The cut-off criteria considered are 1% of renewable and non-renewable primary energy usage and 1% of the total mass of that unit process. The total neglected input flows per module shall be a maximum of 5% of energy usage and mass.

For this study, all input and output flows have been considered at 100%, including raw materials as per the product composition provided by the manufacturer and packaging of raw materials as well as the final product. Energy and water consumptions have also been considered at 100% according to the data provided.

With the approach chosen, no significant environmental impacts are known to have been cut off.

3.5 Background data

For the life cycle modelling of the considered product, all relevant background datasets are taken from *ecoinvent v3.8* (system model: cut-off by classification).

3.6 Data quality

The objective of this evaluation is to evaluate the environmental impacts generated by the products throughout their entire life cycles. To this end, *ISO 14040*, *ISO 14044* and *EN 15804* have been met regarding the quality of data on the following different criteria:

Time: The life cycle inventory data used come from:

- Data collected specifically for this study on the ARGE member companies' manufacturing sites. Datasets are based on 1-year averaged data (time period: January 2013 to December 2013 considered representative for 2022).
- In the absence of collected data, generic data from the *ecoinvent v3.8* database have been used. This is updated regularly and is representative of current processes (the entire database having been updated in 2021).

Geography: Data come from production sites of the ARGE member companies. Generic data come from the *ecoinvent* database, representative for European production processes.

Technology: Material shaping technologies are based on European technology in the case of the use of generic data.

A total of 6 typical products (based on sales figures) have been evaluated, and the worst-case results are used in the tables.

3.7 Period under review

The data of the LCA is based on the annual production data of an ARGE member from 2013, considered representative for the year 2022.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Europe

3.9 Allocation

The products are produced in one production site. All data were provided by the manufacturer of the products per unit and then divided by the mass of the product to give a value per kg of product produced.

The assumptions relating to the EoL of the product are described in the section System Boundaries.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account.
ecoinvent v3.8 (system model: cut-off by classification) has been used as the background database.

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the biogenic carbon content at factory gate

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

Name	Value	Unit
Biogenic carbon content in product	0	kg C
Biogenic carbon content in accompanying packaging	0.0354	kg C

The following information is the basis of the declared modules within the LCA in this EPD.

Transport to the building site (A4)

Name	Value	Unit
Litres of fuel	25.8	l/100km
Transport distance	3500	km

Installation into the building (A5)

Name	Value	Unit
Material loss	0.144	kg

Reference service life

Name	Value	Unit
Reference service life	30	a
Test cycles over RSL (EN 1527, EN 15706)	100'000	cycles

End of life (C1-C4)

Name	Value	Unit
Collected separately waste type	1	kg
Recycling	0.472	kg
Energy recovery	0.243	kg
Landfilling	0.285	kg

It is assumed that a 16–32-ton truck is used to transport the product:
- Transport to shredding facility for metal recovery: 150 km
- Transport to municipal waste incineration plant: 50 km
- Transport to landfill: 30 km

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Module D contains the benefits and loads beyond the system boundary related to the recycling of metals, which result from the treatment of recycled materials from the point of end-of-waste status to the point of substitution (as costs) and the substitution of primary resources (as benefits).

According to *EN 16710*, clause 6.4.3.3: 'In module D substitution effects are calculated only for the resulting net output flow.

For building hardware, the following rules apply for the quantification of net output flows:
- all production scrap and cuttings leave modules A1-B3 as sorted scrap without allocated burdens from primary production; the corresponding amounts are declared as material for recycling (MFR);
- net amounts of a metal leaving the product system are quantified as the material for recycling leaving modules A1-C4 minus the input of secondary scrap (secondary material, SM) to the product system;
- in the case of brass and zinc alloys, which are composed of two different constituting metals, no difference shall be made between the input of secondary constituting metals (Cu and Zn; Cu and Sn) and its alloys (CuZn; CuSn).

Negative net output flows have been considered in the quantification of module D.
It also includes the benefits and loads related to 'exported energy electricity' and 'exported energy heat' resulting from the energy recovery from plastic wastes in a municipal waste incineration plant as modelled in Modules A3, A5 and C4.

5. LCA: Results

In Table 1 "Description of the system boundary", the declared modules are indicated with an "X"; all modules that are not declared within the EPD but where additional data are available are indicated with "MND". Those data can also be used for building assessment scenarios. The values are declared with three valid digits in exponential form.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MNR	MNR	MNR	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 kg of sliding door gear

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
GWP-total	kg CO_2 eq	1.7E+01	6.21E-01	1.43E-01	0	1.65E-02	3.67E-03	2.56E-02	-6.52E+00
GWP-fossil	kg CO_2 eq	1.71E+01	6.21E-01	1.33E-02	0	1.65E-02	3.66E-03	2.56E-02	-6.49E+00
GWP-biogenic	kg CO_2 eq	-1.3E-01	0	1.3E-01	0	0	0	0	0
GWP-luluc	kg CO_2 eq	4.66E-02	2.48E-04	8.53E-07	0	6.59E-06	9.13E-06	3.39E-06	-2.42E-02
ODP	kg CFC11 eq	6.55E-07	1.44E-07	4.89E-10	0	3.82E-09	1.86E-10	1.63E-09	-2.15E-07
AP	mol H^+ eq	1.16E-01	1.76E-03	7.88E-06	0	4.68E-05	1.89E-05	4.74E-05	-4.25E-02
EP-freshwater	kg P eq	5.65E-04	4.43E-06	1.63E-08	0	1.17E-07	4.11E-07	8.81E-08	-2.37E-04
EP-marine	kg N eq	1.79E-02	3.5E-04	2.15E-06	0	9.3E-06	2.42E-06	1.83E-05	-6.3E-03
EP-terrestrial	mol N eq	1.97E-01	3.9E-03	2.36E-05	0	1.04E-04	2.79E-05	1.91E-04	-6.94E-02
POCP	kg NMVOC eq	5.73E-02	1.5E-03	7.53E-06	0	3.98E-05	7.64E-06	5.56E-05	-2.06E-02
ADPE	kg Sb eq	1.1E-04	2.2E-06	7.63E-09	0	5.84E-08	8.87E-09	2.87E-08	3.27E-05
ADPF	MJ	1.67E+02	9.41E+00	3.26E-02	0	2.5E-01	7.76E-02	1.26E-01	-5.83E+01
WDP	m^3 world eq deprived	2.62E+00	2.86E-02	1.43E-04	0	7.6E-04	8.67E-04	-1.14E-03	-8.94E-01

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential)

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 kg of sliding door gear

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	1.79E+01	1.32E-01	-6.57E-02	0	3.51E-03	1.47E-02	1.39E-02	-7.83E+00
PERM	MJ	8.04E-01	0	-6.57E-01	0	0	0	0	0
PERT	MJ	1.87E+01	1.32E-01	-7.23E-01	0	3.51E-03	1.47E-02	1.39E-02	-7.83E+00
PENRE	MJ	1.66E+02	9.41E+00	1.95E-01	0	2.5E-01	7.83E-02	3.91E-01	-5.85E+01
PENRM	MJ	7.38E-01	0	-1.63E-01	0	0	0	-2.65E-01	0
PENRT	MJ	1.67E+02	9.41E+00	3.26E-02	0	2.5E-01	7.83E-02	1.26E-01	-5.85E+01
SM	kg	3.93E-01	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0
FW	m^3	1.08E-01	9.98E-04	1.4E-05	0	2.65E-05	5E-05	2.22E-04	-4.36E-02

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 material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 kg of sliding door gear

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
HWD	kg	2.67E-03	2.46E-05	1E-07	0	6.52E-07	2.75E-08	2.09E-07	8.55E-04
NHWD	kg	4.44E+00	4.95E-01	1.89E-03	0	1.31E-02	2.92E-04	3.66E-01	-1.59E+00
RWD	kg	6.2E-04	1.36E-04	4.54E-07	0	3.61E-06	1.04E-06	1.65E-06	-1.8E-04
CRU	kg	0	0	0	0	0	0	0	0
MFR	kg	1.94E-01	0	8.09E-02	0	0	5.48E-01	0	0
MER	kg	0	0	0	0	0	0	0	0
EEE	MJ	0	0	9.2E-03	0	0	0	1.12E-02	0

EET	MJ	0	0	6.09E-02	0	0	0	7.43E-02	0

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 OF THE LCA – additional impact categories according to EN 15804+A2-optional:
1 kg of sliding door gear

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
PM	Disease incidence	1.37E-06	4.99E-08	1.76E-10	0	1.32E-09	5.04E-11	1.15E-09	-5.51E-07
IR	kBq U235 eq	2.84E-01	4.09E-02	1.37E-04	0	1.08E-03	7.07E-04	6.78E-04	-6.74E-02
ETP-fw	CTUe	4.46E+02	7.39E+00	2.74E-02	0	1.96E-01	3.9E-02	1.39E+02	-1.38E+02
HTP-c	CTUh	2.24E-08	2.38E-10	1.33E-12	0	6.3E-12	1.04E-12	1.6E-11	-7.37E-09
HTP-nc	CTUh	4.34E-07	7.46E-09	4.68E-11	0	1.98E-10	3.39E-11	2.47E-10	-1.24E-07
SQP	SQP	4.12E+01	6.56E+00	2.2E-02	0	1.74E-01	1.19E-02	2.24E-01	-8.95E+00

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Disclaimer 1 – for the indicator 'Potential Human exposure efficiency relative to U235'. 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 or radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators 'abiotic depletion potential for non-fossil resources', 'abiotic depletion potential for fossil resources', 'water (user) deprivation potential, deprivation-weighted water consumption', 'potential comparative toxic unit for ecosystems', 'potential comparative toxic unit for humans – cancerogenic', 'Potential comparative toxic unit for humans - not cancerogenic', 'potential soil quality index'. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

6. LCA: Interpretation

Figure 1 illustrates the relative contributions of the different modules along the life cycle of the declared products.

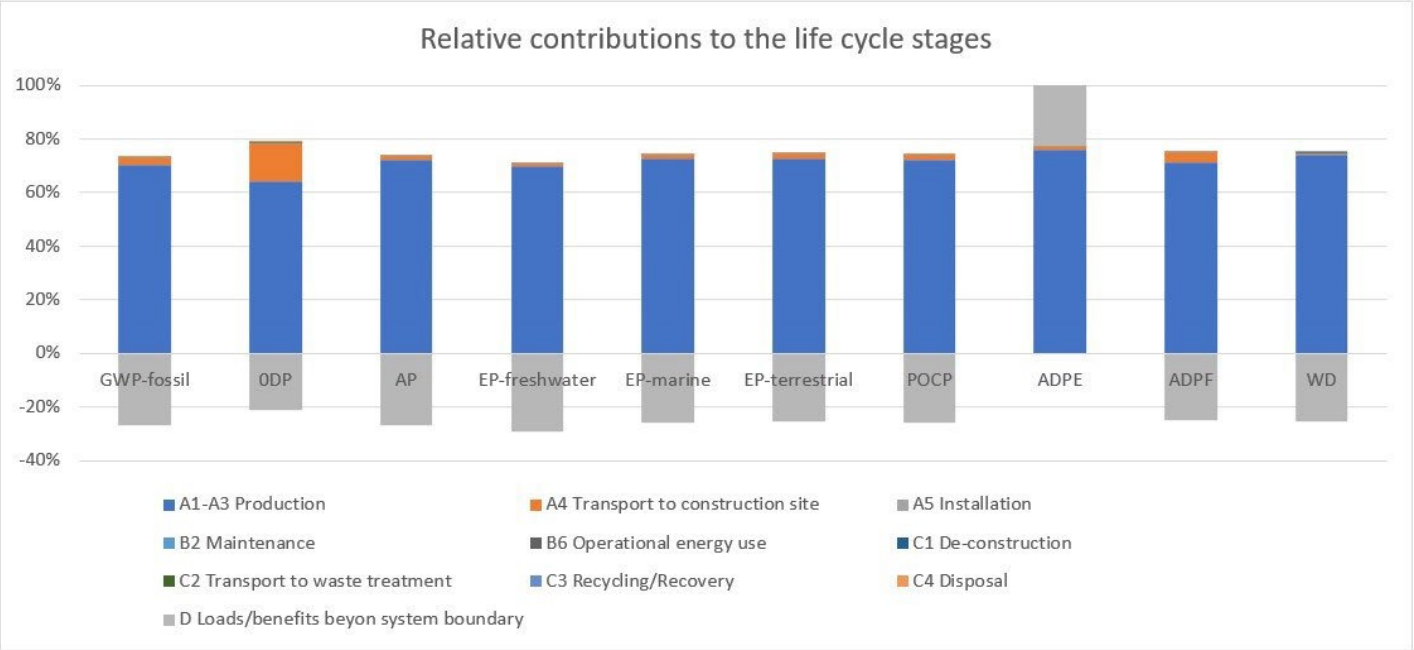


Figure 1: Environmental impacts of sliding door hardware along its life cycle

The largest part of environmental impacts is caused during production (modules A1-A3); comparably small impacts are caused during the transport of the product to the construction site (via the manufacturer of the product, which the sliding door gear has been integrated into).

All the other modules related to the product life cycle are not significant.

Benefits and burdens beyond the system boundary (module D) are in the order of 20 % to 30 % of the impacts over the product life cycle (modules A1-A3) and relate basically to the recycling of metals; module. Only for ADP elements, the negative net amount of zinc leaving the product system leads to additional burdens in module D from the compensation of material losses with primary production of zinc.

A total of 6 typical products (based on sales figures) have been evaluated and the worst-case results are used in section 5 of this EPD. In chapter 2.5, the tabulated range of relative weight per material ensures that the variability of results stays within +/- 40% of the declared values (assessed for the indicators GWP, PENRT, and non-hazardous waste).

7. Requisite evidence

No testing results are required by the PCR part B.

8. References

Product category rules of IBU

IBU (2021)
IBU (2021): General Instructions for the EPD Programme of the Institut Bauen und Umwelt e.V. (General Instructions for the IBU EPD Programme). Version 2.0, Institut Bauen und Umwelt, Berlin.

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