Umweltproduktdeklaration

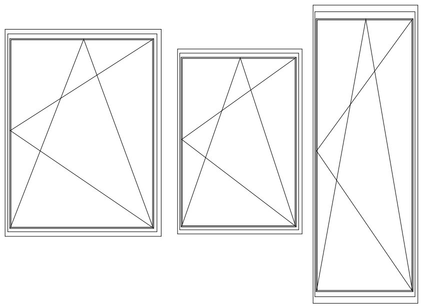
Environmental Product Declaration (EPD)

according to DIN ISO 14025

PUBLISHED BY QUALITÄTSVERBAND KUNSTSTOFFERZEUGNISSE E.V. AND
EUROPEAN PVC WINDOW PROFILES AND RELATED BUILDUNG PRODUCTS ASSOCIATION

Plastic windows made of PVC-U

insulated double-glazing
depth 70 mm



Deklariert von

Declared by

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EPPA

European PVC Window Profiles
and Related Buildung Products
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Erstellt durch

Issued by

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Ökobilanz
geprüft von

Life cycle
assessment
reviewed by

Denkstatt GmbH, Wien

Foreword

The background behind, and purpose to, this Environmental Product Declaration is the desire to set out the specific environmental impacts and relevant health aspects along the life cycle of the product. This is what is known as an average EPD, in which the data from comparable plastic windows, produced from systems of the known systems manufacturers, are averaged and applied. Three designs of double-glazed plastic window, each with a depth of approx. 70 cm, were chosen.

This EPD, created with reference to ISO 14025, is based on the PCR[1] of the Swedish Environmental Management Council[2].

The purpose of this document is therefore to explain the effects, not assess them. Differences to environmental product declarations of other manufacturers generally arise from the requirements of the referenced PCR, the design of the declared window types and differing system boundaries and sensitivities. The required information can be taken from the background report.

Qualitätsverband Kunststofferzeugnisse e.V.

European PVC Window and Related Building Products Association

Bonn / Brussels

June 2011

www.qke-bonn.de

www.eppa-profiles.org

www.skz.de

1 Product Category Rules

2 Swedish Environmental Management Council | Vasagatan 15-17, SE-111 20 Stockholm, Sweden | Telephone +46(0) 8-700 66 90 | info@msr.se

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List of abbreviations

AP	Acidification potential
BF	Bundesverband Flachglas (Federal Flat Glass Association)
CSTB	Centre Scientifique et Technique du Bâtiment (Scientific and Technical Centre for Buildings)
EP	Eutrophication potential
EPPA	European PVC Window Profile and related building products Association
EPD	Environmental Product Declaration
EPDM	Ethylen propylene diene monomer
FVSB	Fachverband Schloss- und Beschlagsindustrie e.V. (Lock and Hardware Industry Association)
g-Wert	Solar energy transmittance
GWP	Global warming potential
CED	Cumulated energy demand
ODP	Ozone depletion potential
PCR	Product category rules
PMMA	Polymethyl methacrylate
POCP	Photochemical ozone creation potential
PVC	Polyvinyl chloride
QKE	Qualitätsverband Kunststofferzeugnisse e.V. (Quality Association for Plastic Products)
Q_{irr}	Solar heat gains
Q_{tr}	Transmission heat losses
R_w	Rated sound reduction index
TPE	Thermoplastic elastomers
UCTE	Union for the Coordination of the Transmission of Electricity
U_w-Wert	Heat transfer coefficient for windows
VOC	Volatile organic compounds

1. General information

This Environmental Product Declaration (EPD) was produced by SKZ - Das Kunststoffzentrum on behalf of the Qualitätsverband Kunststofferzeugnisse e.V. (QKE) with reference to ISO 14025 in accordance with the specifications of the product category rules for windows of the *Swedish Environmental Management Council* [PCR 2008]. The life cycle assessment in this EPD was prepared in accordance with the principles of ISO 14040/14044, documented in a comprehensive background report and subjected to critical review by Denkstatt GmbH, an independent institution.

The Environmental Product Declaration describes three standard window types that are manufactured in different European production facilities. It does not therefore relate to the specific product of any particular manufacturer and applies for all PVC windows of member companies of the European PVC Window Profile and related building products Association (EPPA) and of the QKE that conform to the stated requirements.

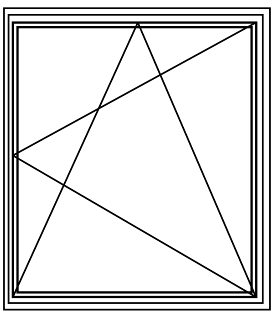
This Environmental Product Declaration is valid for three years from the date of issue.

2. Product description

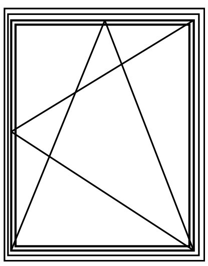
Windows serve to allow light into a building while at the same time protecting the interior of the building from the influences of the weather, providing ventilation and allowing people to look both inside and outside. Windows consist of two parts: a fixed frame that is installed in an opening in a wall or brickwork, and fixed or movable casements with transparent or translocated surfaces (generally made of glass).

This EPD considers the following product systems:

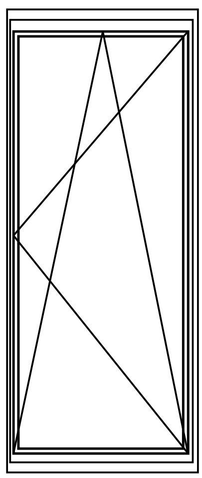
Window type A
Single-sash tilt and turn window
1,23 m x 1,48 m



Window type B
Tilt and turn bathroom window
1 m x 1,3 m



Window type C
Balcony door
0,9 m x 2,15 m



The technical specifications of these window types are set out in Table 1.

Table 1: Technical specifications of the window types [EPPA 2010]

	Window type A	Window type B	Window type C
Overall dimensions	1,23 m x 1,48 m	1 m x 1,3 m	0,9 m x 2,15 m
Profile depth	70 mm	70 mm	70 mm
Surface area	1,82 m²	1,3 m²	1,935 m²
Useful life	30 a (10 a, 50 a)	30 a (10 a, 50 a)	30 a (10 a, 50 a)
Glazing	insulated double-glazing	insulated double-glazing	insulated double-glazing
U_W-value	1,3 W/m²K	1,3 W/m²K	1,3 W/m²K
g-value	0,6	0,6	0,6

2.1 Manufacture and materials used

The manufacturing phase comprises all processes from extraction of the raw materials to production of the window. Capital goods (machinery, buildings etc.) and the heating and illumination of buildings are not considered.

Plastic windows are made from a variety of individual components. Each window consists of a PVC frame with seals, the glazing and the fittings. Larger window frames (window types A and C) are strengthened with steel reinforcement.

Table 2 sets out the quantities and proportions of the window components used for the three window types as well as the materials of which they essentially consist.

Table 2: Used materials and components [EPPA 2010]

	Window type A 1,23 x 1,48 m		Window type B 1 x 1,3m		Window type C 0,9 x 2,15 m	
Frame (PVC-U)	14,593 kg	25,7 %	12,66 kg	38,9 %	16,92 kg	26,2 %
Steel reinforcement (steel)	13,25 kg	23,3 %	-	0 %	17,68 kg	27,4 %
Seals (various plastics)	0,607 kg	1,1 %	0,49 kg	1,5 %	0,64 kg	1,0 %
Fittings (steel)	2,6 kg	4,6 %	2,21 kg	6,8 %	2,6 kg	4,0 %
Glazing (flat glass)	25,8 kg	45,4 %	17,15 kg	52,8 %	26,6 kg	41,3 %
Total sum	56,85 kg		32,51 kg		64,44 kg	

PVC profiles for window frames are manufactured in an extrusion process from a mixture of PVC powder and additives. The additives used are impact-resistance modifiers, fillers, pigments and thermostabilizers. These protect the PVC from damage during processing and give the profile the necessary properties (impact resistance, colour, weathering stability etc.).

The materials used and their respective classification in terms of their risks to human health and the environment are summarised in Table 3.

Table 3: Composition for PVC window profiles [PRO2011]

Material	percen-tage (%)	CAS No.	Environmental hazards according to GHS	Health hazards according to GHS
PVC	82,0 %	9002-86-2	–	–
Stabilizers (CaZn)	3,3 %	–	–	H302: Harmful if swallowed H318: Causes serious eye damage H317: May cause an allergic skin reaction Pictogram: Corrosive and exclamation mark
Pigments (TiO_2)	3,3 %	13463-67-7	–	–
Fillers (chalk)	6,5 %	471-34-1	–	–
Impact-resistance Modifiers	4,9 %	–	–	–

The majority of window frames are made from white unplasticized PVC profiles. Some frames, however, are made from profiles that are also laminated with PVC film, coated with PMMA or painted. These window frames and the additional materials required are considered in this Environmental Product Declaration according to their share of the plastic window market.

Seals are generally attached to the window profiles in a coextrusion process and consist of PVC-P, EPDM or TPE. All materials are likewise considered according to their share of the plastic window market.

The window profiles are then delivered in standard lengths to the window manufacturers. There they are sawn to the length actually required for the particular window. Where necessary, steel reinforcement is inserted and screwed in. The profiles are then welded, the fittings attached and the glass pane and glazing beads fitted. The window can now be supplied and fitted.

2.2 Usage

Usage covers transport to the building, fitting, the replacement of window components and compensating for heat losses.

The technical life of a plastic window can be around 50 years [BBR 2001]. The actual useful life may be shorter, so this Environmental Product Declaration considers scenarios with useful lives of 10, 30 and 50 years. Because the individual window components have different life expectancies, they must be replaced as necessary during such many years of use.

During use, heat exchange processes take place between the interior of the building and the surroundings. These must be compensated for by heating or cooling according to the location and the time of year if a pleasant temperature for people inside the building is to be guaranteed. How much energy is expended for this purpose depends on many different factors. These include regional to local climatic conditions, the orientation of the windows, the desired inside temperature and user behaviour. Such factors are often difficult to determine exactly and can differ widely in the case of specific buildings. The assumptions made reflect average, mean factors rather than extreme values. However, a specific case can differ from them.

The following assumptions were made for the reference location.

- The reference is an average European location. German climatic conditions are applied as an example of such a location.
- The operation of an air-conditioning system is not customary in the chosen climatic conditions, particularly in residential buildings, and so is not considered.
- Modern windows are tight even under high wind loads. The resulting ventilating heat losses are therefore low and can be ignored.
- Ventilation by the user is not considered.
- An average heating mix is assumed, i.e. different energy sources are considered according to their share of the market.

The energy demand during the usage phase at the reference location is thus calculated from the transmission heat losses Q_{tr} and the solar heat gains Q_{irr} in winter:

$$Q_{ges} = Q_{tr} - Q_{irr}$$

2.3 End-of-life

PVC windows are dismantled at the end of their life and the individual components then recycled or disposed of.

After treatment by specialist firms, 50 % of the PVC from used frames can be recycled and used to make new window profiles, for instance. 17.5 % of used frames are thermally recovered and 32.5 % dumped in landfills. Seals and coatings are recovered or disposed of together with the frame [EPPA 2011].

No explicit recovery rates are available for the window components made of steel (fittings and reinforcement). Steel is an asset with a high added value, can be easily separated from other materials by means of magnetic separators and so has a high material recovery rate, particularly in the construction sector. Worldwide, the recovery rate for steel is around 80 % [Wor 2008].

The glass pane is usually knocked out on site immediately after dismantling, so that the window is largely freed of glass. About 65 % of the glass is dumped in landfills as an inert building material and 15 % taken for glass recycling. The remaining 20 % is sent for waste incineration along with the window frame or with residues from the recycling of old windows [EPPA 2011].

According to [PCR 2008], consideration of the end-of-life phase is optional. In keeping with the life cycle approach, however, it is considered in this Environmental Product Declaration.

3. Environmental impacts

3.1 Methods

The life cycle assessment in this Environmental Product Declaration has been prepared in accordance with the principles of ISO 14040/14044. The impact assessment is based on the following impact indicators and life cycle inventory variables:

Impact indicators:

- Global warming potential (GWP) [kg CO_2 equivalent]
- Acidification potential (AP) [kg SO_2 equivalent]
- Ozone depletion potential (ODP) [kg R11 equivalent]
- Photochemical ozone creation potential (POCP) [kg C_2H_4 equivalent]
- Eutrophication potential (EP) [kg PO_4 equivalent]

Life cycle inventory variables:

- Consumption of non-renewable resources, cumulated energy demand (CED fossil) [MJ equivalent]
- Consumption of renewable resources, cumulated energy demand (CED reg.) [MJ equivalent]
- Waste [kg]

3.2 Functional unit

The functional unit is defined as follows:

Window type A:

Manufacture, 30 years of use and end-of-life of a white or coated single-sash tilt and turn window of dimensions 1.23 x 1.48 m and a depth of 70 mm, insulated double-glazing (g-value 0.6) and a U_w-value of 1.3 W/m²K.

Window type B:

Manufacture, 30 years of use and end-of-life of a white or coated tilt and turn bathroom window of dimensions 1.00 x 1.30 m and a depth of 70 mm, insulated double-glazing (g-value 0.6) and a U_w-value of 1.3 W/m²K.

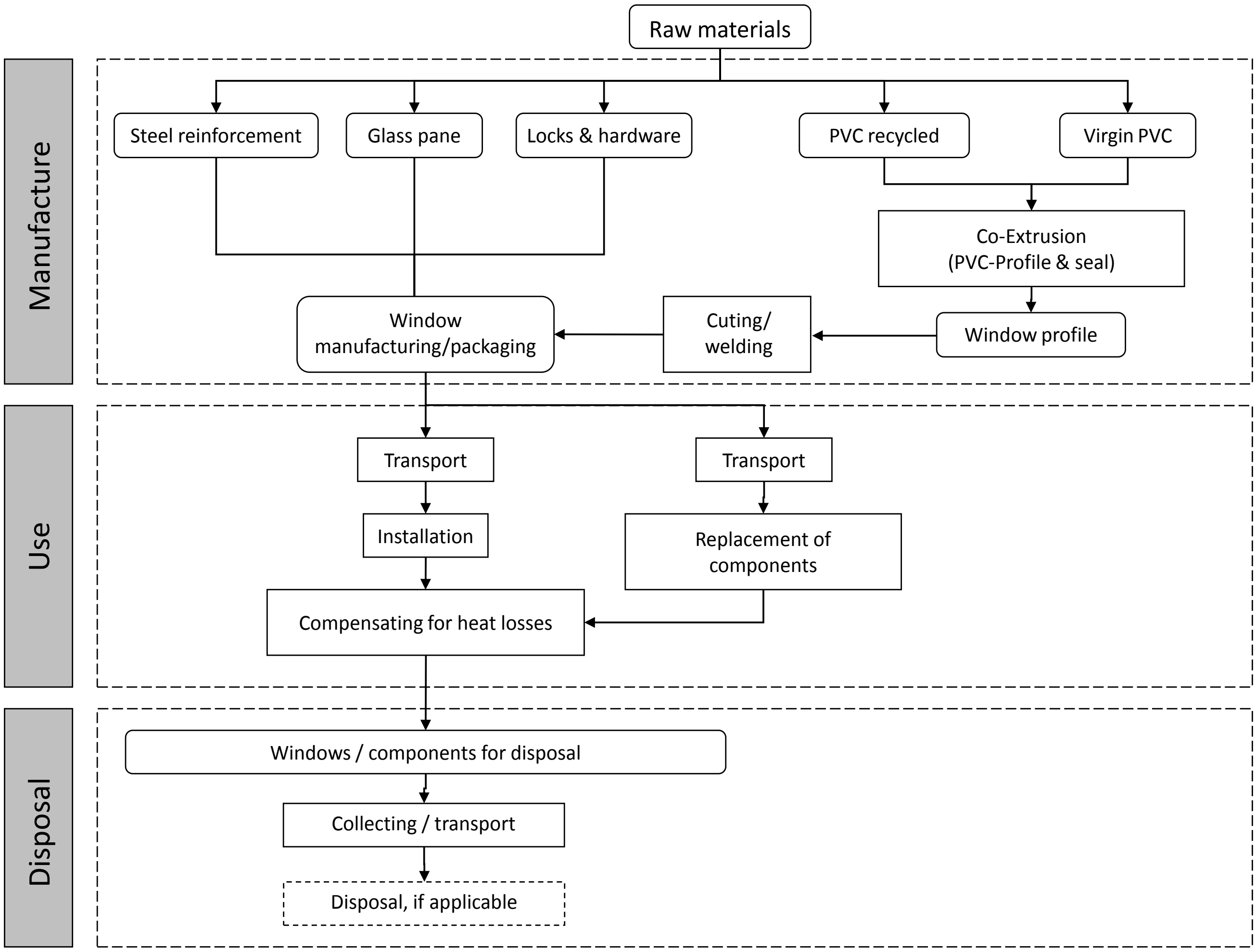
Window type C:

Manufacture, 30 years of use and end-of-life of a white or coated balcony door of dimensions 0.90 x 2.15 m and a depth of 70 mm, insulated double-glazing (g-value 0.6) and a U_w-value of 1.3 W/m²K.

In addition to the useful life of 30 years, additional scenarios with a useful life of 10 and 50 years were also considered for all window types.

3.3 Life cycle phases considered

A life cycle assessment pursuant to ISO 14040 / 14044 considers the potential environmental impacts of the window systems over their entire life, their manufacture, their use and their disposal. Figure 1 gives an overview of the system boundaries.



Note: Individual window components are replaced in the usage phase. Their manufacture and disposal are also considered.

Figure 1: Life cycle phases considered

The SimaPro V7.2.4 software was used to model the life cycle. All relevant background data records are taken from the databases of the SimaPro software or provided by the customer. To model the glazing and the fittings of the windows, the results of current Environmental Product Declarations for these window components are applied [BF 2011; FVSB 2011].

3.4 Geographical and time system boundaries

This EPD is intended to cover the geographical area in which the member companies of EPPA and QKE are active. The reference territory for the life cycle assessment is therefore Europe, and European conditions (state of the art, electricity mix UCTE) are applied for the production of the windows. The recovery rates achieved in Europe are applied when describing the end-of-life phase.

Heat transfer during the usage phage, and hence the heating and cooling demand, differs widely in the various climatic regions of Europe and is also influenced to a significant extent by the actual conditions prevailing where the building is located (orientation of the windows, shading, regional climate, etc.). The potential environmental loads from heat transfer are calculated for an average European climate scenario (central Europe).

The primary data used related largely to production processes of the 2008 financial year. The latest available data are generally used.

3.5 Cut-off criteria and allocation rules

Processes whose overall contribution to the final result by mass and in all impact categories to be considered is less than 1 % can be ignored. The total of the ignored processes must not exceed 5 % of the considered impact categories.

At the end of their life the great majority of windows are collected and the materials used in them recycled or thermally recovered. In accordance with the willingness-to-pay principle, the environmental loads and benefits of recovery are split between the surrendering system and the receiving system as specified in [PCR 2008]: as soon as a secondary user is willing to pay a price for a material or substance, the responsibility of the surrendering system ends and that of the receiving system begins; the responsibility of the receiving system is not considered in this life cycle assessment. This allocation rule is generally also applied for the recovery of production waste and the utilisation of recycled material over the entire life.

On the allocation procedure, it should be noted that the chosen procedure has an influence on the results of the impact assessment. If a different allocation procedure is applied, the results can differ markedly from those shown here, even if the other conditions are identical.

3.6 Results

3.6.1 Window type A

<u>Results of life cycle inventory variables</u>

Tables 4 and 5 show the results of the selected life cycle inventory variables for window type A – a single-sash tilt and turn window, overall dimensions 1.23 m x 1.48 m. Table 4 presents the cumulated energy demand.

Table 4: Window type A - Resource usage (CED) along the life cycle

	Manufacture	10 years of use	30 years of use	50 years of use	End-of-Life
Non-renewable resources, CED fossil [MJ-eq]	1,97E+03	2,93E+03	8,77E+03	1,53E+04	3,45E+01
Renewable resources, CED reg. [MJ-eq]	7,92E+01	1,17E+01	3,42E+01	8,39E+01	5,09E-02

Waste is produced at various points in the life of a window, whether when the raw materials are extracted, during the treatment and processing stages or through the provision of electricity. This waste is summarised in Table 5. Exceptionally, in this case the window itself is at the end of its life.

Table 5: Window type A - Waste from manufacture and use

	Manufacture	10 years of use	30 years of use	50 years of use
Dangerous waste [kg]	2,28E-01	3,03E-03	1,31E-02	9,70E-02
Other waste [kg]	1,13E+02	1,28E+00	3,72E+00	1,36E+02

Results of impact indicators

The results of the impact indicators are set out in Table 6.

Table 6: Window type A - Potential environmental impacts from emissions along the life cycle

	Manufacture	10 years of use	30 years of use	50 years of use	End-of-Life
Global warming potential, GWP [kg CO_2-eq]	1,20E+02	1,82E+02	5,45E+02	9,62E+02	2,40E+00
Acidification potential, AP [kg SO_2-eq]	5,45E-01	2,27E-01	6,74E-01	1,35E+00	7,17E-03
Ozone depletion potential, ODP [kg R11-eq]	5,54E-06	3,47E-05	1,04E-04	1,76E-04	3,18E-07
Photochemical ozone creation potential, POCP [kg C_2H_4-eq]	5,71E-02	8,79E-02	2,61E-01	4,54E-01	1,84E-03
Eutrophication potential, EP [kg PO_4-eq]	1,33E-01	4,39E-02	1,28E-01	2,47E-01	1,60E-03

Overview

Figure 2 shows the proportions of the individual life cycle phases for all impact indicators and the CED for 10, 30 and 50 years of use.

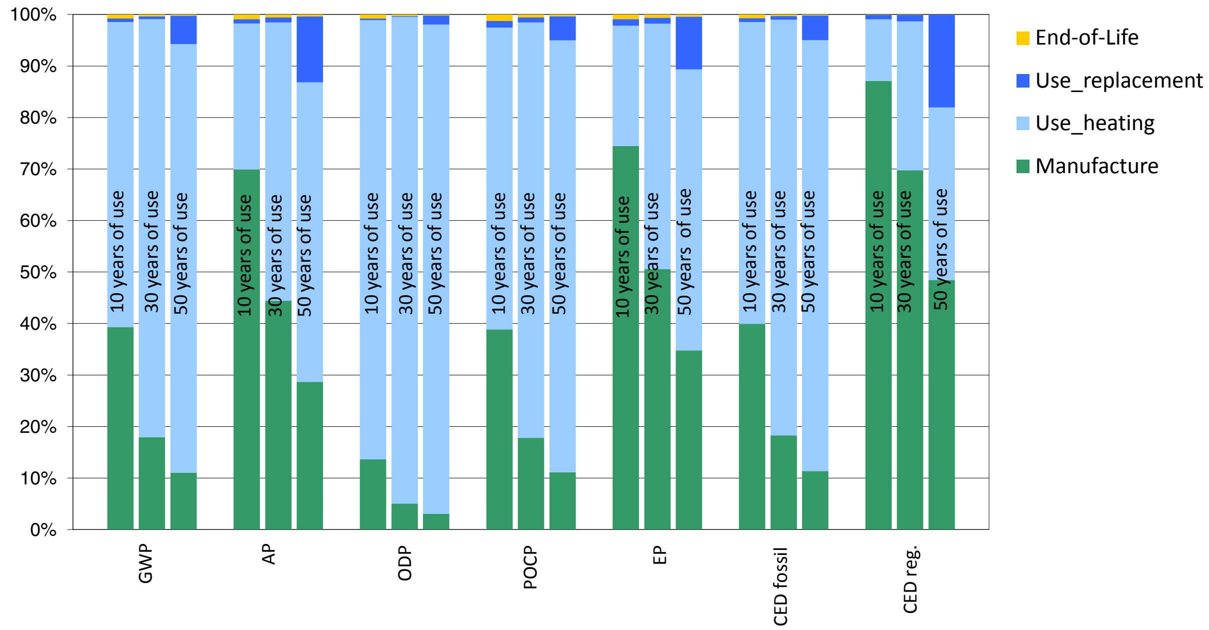


Figure 2: Environmental impacts of window A – as percentages according to life stages

3.6.2 Window type B

<u>Results of life cycle inventory variables</u>

Tables 8 and 9 show the results of the selected life cycle inventory variables for window type B – a tilt and turn bathroom window, overall dimensions 1 m x 1.3 m. Table 7 presents the cumulated energy demand.

Table 7: Window type B - Resource usage (CED) along the life cycle

	Manufacture	10 years of use	30 years of use	50 years of use	End-of-Life
Non-renewable resources, CED fossil [MJ-eq]	1,30E+03	2,37E+03	7,09E+03	1,23E+04	1,70E+01
Renewable resources, CED reg. [MJ-eq]	5,75E+01	9,58E+00	2,77E+01	6,49E+01	2,54E-02

Table 8 shows the waste that is produced in the manufacture and use of window type B. Exceptionally, in this case the window itself is at the end of its life.

Table 8: Window type B - Waste from manufacture and use

	Manufacture	10 years of use	30 years of use	50 years of use
Dangerous waste [kg]	2,06E-01	1,46E-03	1,06E-02	9,25E-02
Other waste [kg]	1,09E+02	1,05E+00	3,02E+00	1,27E+02

Results of impact indicators

The results of the impact indicators are set out in Table 9 .

Table 9: Window type B - Potential environmental impacts from emissions along the life cycle

	Manufacture	10 years of use	30 years of use	50 years of use	End-of-Life
Global warming potential, GWP [kg CO_2-eq]	7,46E+01	1,47E+02	4,40E+02	7,70E+02	1,18E+00
Acidification potential, AP [kg SO_2-eq]	2,83E-01	1,84E-01	5,45E-01	1,06E+00	3,73E-03
Ozone depletion potential, ODP [kg R11-eq]	2,84E-06	2,80E-05	8,40E-05	1,42E-04	1,56E-07
Photochemical ozone creation potential, POCP [kg C_2H_4-eq]	2,93E-02	7,12E-02	2,11E-01	3,65E-01	9,80E-04
Eutrophication potential, EP [kg PO_4-eq]	4,91E-02	3,57E-02	1,04E-01	1,95E-01	8,40E-04

Overview

Figure 3 shows the proportions of the individual life cycle phases for all impact indicators and the CED for 10, 30 and 50 years of use.

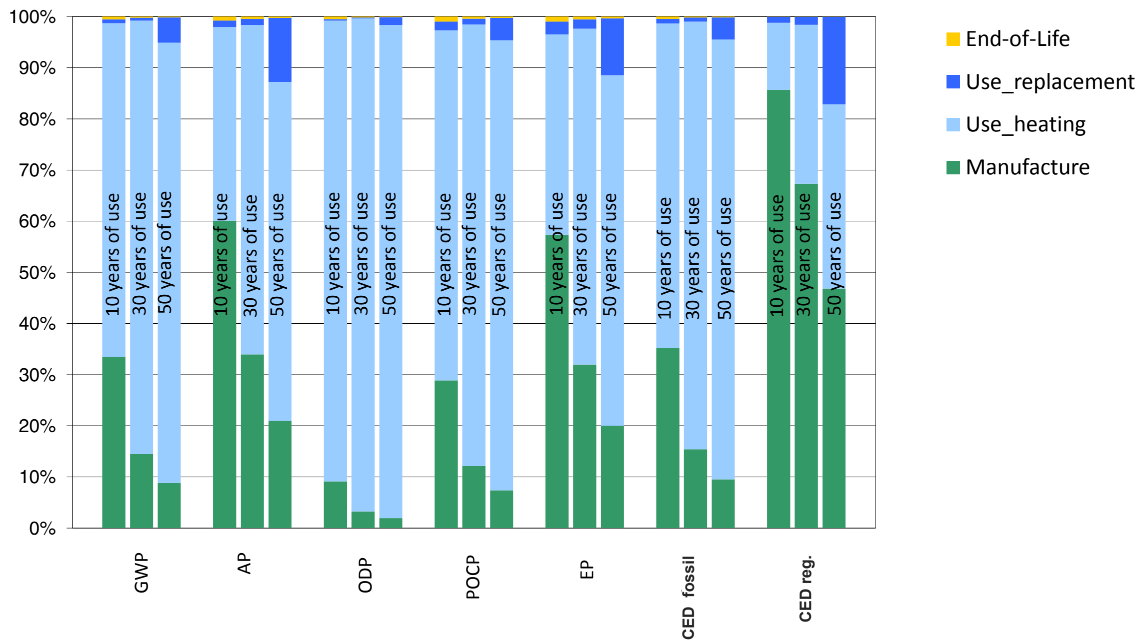


Figure 3: Environmental impacts of window B - as percentages according to life stages

3.6.3 Window type C

Results of life cycle inventory variables

Tables 10 and 11 show the results of the selected life cycle inventory variables for window type C – a balcony door, overall dimensions 0.9 m x 2.15 m. Table 10 presents the cumulated energy demand.

Table 10: Window type C - Resource usage (CED) along the life cycle

	Manufacture	10 years of use	30 years of use	50 years of use	End-of-Life
Non-renewable resources, CED fossil [MJ-eq]	2,25E+03	3,32E+03	9,92E+03	1,73E+04	4,07E+01
Renewable resources, CED reg. [MJ-eq]	8,92E+01	1,31E+01	3,85E+01	9,19E+01	5,97E-02

Table 11 shows the waste that is produced in the manufacture and use of window type C. Exceptionally, in this case the window itself is at the end of its life.

Table 11: Window type C - Waste from manufacture and use

	Manufacture	10 years of use	30 years of use	50 years of use
Dangerous waste [kg]	2,53E-01	3,43E-03	1,45E-02	9,94E-02
Other waste [kg]	1,14E+02	1,44E+00	4,21E+00	1,37E+02

Results of impact indicators

The results of the impact indicators are set out in table 12 .

Table 12: Window type C - Potential environmental impacts from emissions along the life cycle

	Manufacture	10 years of use	30 years of use	50 years of use	End-of-Life
Global warming potential, GWP [kg CO_2-eq]	1,35E+02	2,06E+02	6,16E+02	1,08E+03	2,83E+00
Acidification potential, AP [kg SO_2-eq]	6,32E-01	2,57E-01	7,63E-01	1,50E+00	8,28E-03
Ozone depletion potential, ODP [kg R11-eq]	6,35E-06	3,94E-05	1,18E-04	1,99E-04	3,74E-07
Photochemical ozone creation potential, POCP [kg C_2H_4-eq]	6,74E-02	9,94E-02	2,96E-01	5,12E-01	2,11E-03
Eutrophication potential, EP [kg PO_4-eq]	1,60E-01	4,95E-02	1,44E-01	2,76E-01	1,85E-03

Overview

Figure 4 shows the proportions of the individual life cycle phases for all impact indicators and the CED for 10, 30 and 50 years of use.

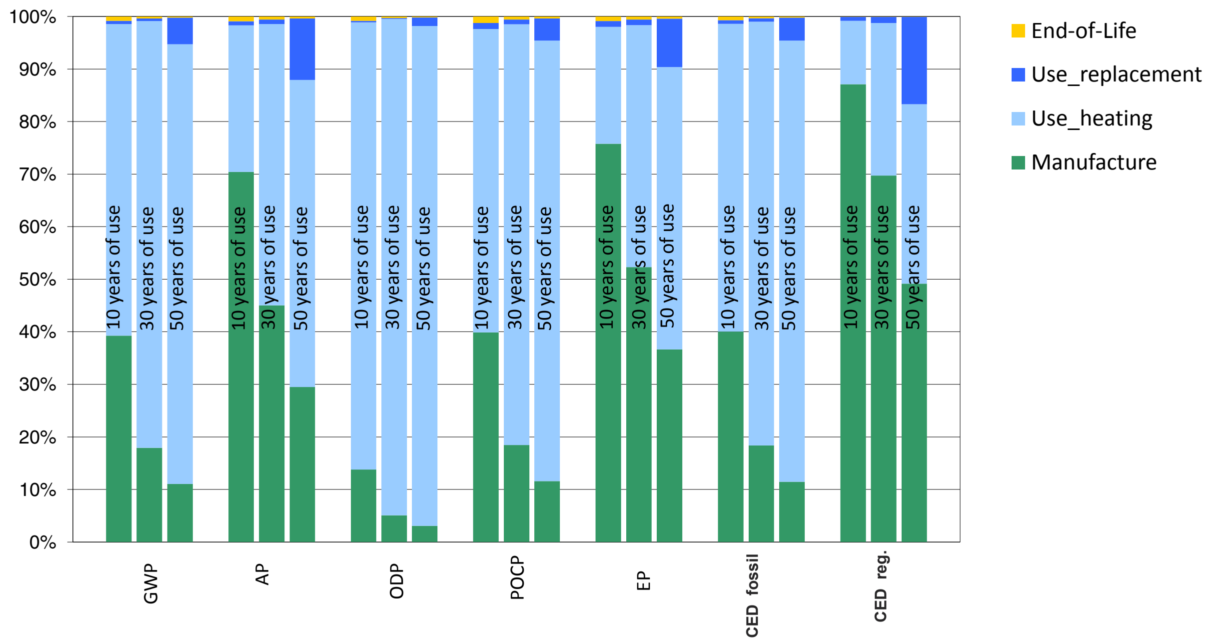


Figure 4: Environmental impacts of window C - as percentages according to life stages

3.7 Interpretation

3.7.1 Significant issues

The environmental burdens in the manufacturing phase are dominated by the provision of materials (plastics, steel, glass). The processing stages thereafter are less relevant. The manufacture of the windows from the individual components plays only a minor role.

The most important window components by mass – the window profile, steel reinforcement and glazing – also account for the largest proportion of the environmental burden associated with manufacture.

Looking at the life cycle as a whole, the environmental loads in the scenarios with a longer useful life (30 and 50 years) are dominated by the usage phase or, to be more precise, the provision of heating energy. This is particularly the case for the impact indicators of consumption of non-renewable resources, global warming potential, ozone depletion potential and photochemical ozone creation potential.

The environmental impacts in the usage phase depend to a very great extent on the actual climatic and technical circumstances of a specific building. The calculations for the heat losses and gains and the results of the impact assessment must therefore be understood as a theoretical calculation for average, non-extreme conditions.

The environmental impacts of the end-of-life phase are of less importance when considered over the entire life. Under the chosen allocation procedure, no credit is given for recycling or thermal recovery.

3.7.2 Sensitivity in terms of window size and overall dimensions

The size and overall dimensions of the window influences the results of the impact assessment. The environmental burdens per square metre of window area associated with the manufacture of window type B (bathroom window), for instance, differ sharply from those of the other two window types. Window B is an example of a smaller window whose frame does not need to be strengthened by steel reinforcement. The environmental burdens of its manufacture are therefore lower.

The window types considered in the study allow the following plastic windows to be presented:

- Single-sash window with steel reinforcement (window type A)
- Smaller single-sash window without steel reinforcement (window type B)
- Balcony doors (window type C)

In the case of special sizes and shapes (e.g. very small windows with a very large proportion of frame), the validity of the results may need to be reviewed on a case-by-case basis.

3.7.3 Interpretations of the scenarios for useful life

It should be noted that the scenarios for 10, 30 and 50 years of use cannot be compared directly with each other: if, for instance, a building is used over 50 years, in the "50 years of use" scenario only one window needs to be manufactured during this period, whereas in the "10 years of use" scenario a total of five windows will have to be manufactured. The effect on the results is presented in Figure 5: Comparison of the "10 years of use" and "50 years of use" scenarios over a period of 50 years based on the example of the global warning potential based on the example of the global warning potential.

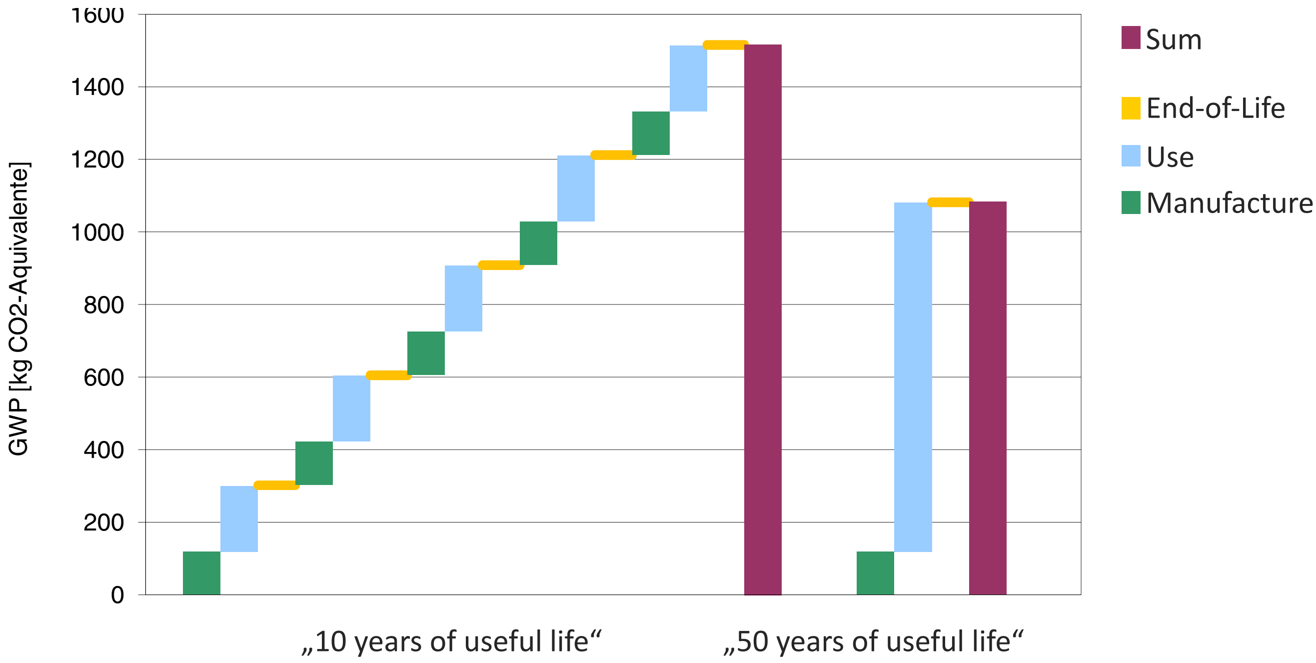


Figure 5: Comparison of the "10 years of use" and "50 years of use" scenarios over a period of 50 years based on the example of the global warning potential

Longer use could therefore be preferable to the more frequent replacement of the complete window. However, this does not take into account the fact that if the whole window is replaced, a window with improved thermal insulation could be fitted, thereby reducing the environmental loads in the following years of use.

4. Health aspects and comfort

4.1 Health aspects in respect of indoor pollution

PVC profiles and the glazing are easy to clean and maintain. Their smooth surfaces and the lack of condensation (see section 4.2) prevent the formation of mould fungus, which can cause allergies. A PVC window profile tested in 2004 by the Centre Scientifique et Technique du Bâtiment (CSTB) (test report no. SB-2004-19) was classified as a neutral product (F) in terms of its behaviour in respect of contamination with mould fungus [SNE 2005]. The tested PVC window profile is representative of the products evaluated in this EPD.

Emissions of volatile organic compounds (VOC): the Institut für Fenstertechnik e.V. and other research institutions and industrial partners in the internal door and window product areas carry out extensive measurements of VOC emissions in accordance with the requirements of the DIN EN ISO 16000-6 and 16000-9 standards. The emissions measured to date are very low or almost untraceable [BLI 2010]. A PVC window profile tested by the CSTB back in 2004 (test report no. SB-04-034) received the highest classification, C+ (very low emissions) [SNE 2005].

4.2 Hygrothermal comfort

In the case of a PVC window profile, the poor thermal conductivity of the PVC (lambda (λ) = 0.17 W/m²K) prevents the formation of surface condensation and cold bridges. The combination of air gaps and suitable PVC wall structures results overall in the following thermal insulation properties of the whole window: U_w = 1.3 W/m²K (at a U_f = 1.4 W/m²K, a U_g = 1.1 W/m²K and a surface area share of the frame of 30 % in accordance with DIN EN ISO 10077-1). This insulated window causes the condensation point to migrate outwards compared with a poorly insulated window (with a higher U_w-value), so that the window has a higher temperature on the inside of the glass. This considerably reduces the risk of condensation.

4.3 Acoustic comfort

The sound reduction index Rw of windows made of PVC profiles and double glazing is determined by a test carried out in accordance with EN ISO 140-3. A sound reduction index of up to R_w = 47 decibels is possible according to the CSTB [SNE 2005].

4.4 Visual comfort

There are no known requirements on visual comfort that cannot be met given the diversity of forms, structures and colours of the PVC profiles.

4.5 Olfactory comfort

Hard PVC emits almost no volatile organic compounds (VOC) and so causes no odours (see health aspects in respect of indoor pollution (NF P 01-010 § 7.2.1) and comfort (NF P 01-010 § 7.3)).

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PUBLISHED BY QUALITÄTSVERBAND KUNSTSTOFFERZEUGNISSE E.V. AND

EUROPEAN PVC WINDOW PROFILES AND RELATED BUILDUNG PRODUCTS ASSOCIATION

Deklariert von

Declared by

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Erstellt durch

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