

PVC Windows and related Building Products using rPVC and being Recyclable

Design-for Recycling Guidelines

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1. Introduction

An important step to achieve circularity in the plastics industry is to paving the way for more use of recycled materials in plastic products. To this aim, PVC window system suppliers commit to raise the uptake of recycled PVC in window profiles and related building products. Above all, this can be realized by improving the design of plastic products in two directions, first to make them recyclable and second to increase the content of recycled plastics.

EPPA signed the declaration of the Circular Plastics Alliance, which promotes voluntary actions for a well-functioning EU market in recycled plastics. The declaration lays out how the alliance will reach the target of 10 million tons of recycled plastics used to make new products every year in Europe, by 2025. This target was set by the European Commission in its 2018 Plastics Strategy, as part of its efforts to boost plastics recycling in Europe.

In this context, EPPA established the present Design for Recycling guidelines. They shall give guidance when designing PVC window profiles intended to contain recycled PVC. The guidelines define scope, terms and definitions, give references and specify general and product-specific design for recycling principles. They have been prepared with the spirit to be converted into a European Standard at a later stage.

2. Scope

The scope of the present document applies to PVC profiles that are used for windows and doors, shutters and related building products. To comply with design-for-recycling principles, products shall fulfil three major criteria:

- The product contains recycled PVC
- The product is recyclable
- The product meets quality requirements as expected from the market, which the use of rPVC does not counteract

To this end, the document describes general and specific design principles, in particular material properties, specific process conditions as well as functionality and quality aspects concerning the finished product. Flowcharts shall help to assess, whether (i) recycled content is intended and (ii) on how recyclability can be evaluated. Finally, measures to trace and verify are shown.

3. References

3.1 EN Standards

EN 12519, Windows and Doors, Terminology

EN 12608-1, Unplasticized poly(vinyl-chloride) (PVC-U) profiles for the fabrication of windows and doors - Classification, requirements and test methods – Part 1: Non-coated PVC-U profiles with light coloured surfaces.

prEN 12608-2, Unplasticized poly(vinyl-chloride) (PVC-U) profiles for the fabrication of windows and doors. Classification, requirements and test methods – Part 2: PVC-U profiles covered with foils bonded with adhesives.

EN 13245-1, Plastics – Unplasticized poly (vinyl chloride) (PVC-U) profiles for building applications – Part 1: Designation of PVC-U profiles

hEN 13245-2, Plastics – Unplasticized poly (vinyl chloride) (PVC-U) profiles for building applications – Part 2: PVC-U profiles and PVC-UE profiles for internal and external wall and ceiling finishes

EN 13245-3, Plastics - Unplasticized poly (vinyl chloride) (PVC-U) profiles for building applications - Part 3: Designation of PVC-UE profiles

hEN 13659, Shutters and external venetian blinds – Performance requirements including safety

ISO 14021, Environmental labels and declarations — Self-declared environmental claims

hEN 14351-1, Windows and doors - Product standard, performance characteristics - Part 1: Windows and external pedestrian doorsets

EN 15343, Plastics—Recycled Plastics—Recycling traceability and assessment of conformity

EN 15346, Plastics. Recycled plastics. Characterization of poly (vinyl chloride) (PVC) recyclates;

EN 15347, Plastics. Recycled Plastics. Characterization of plastics waste;

EN 15534-1, Composites made from cellulose-based materials and thermoplastics (usually called wood-polymer composites (WPC) or natural fiber composites (NFC)) — Part 1: Test methods for characterization of compounds and products

CEN/TS 15534-2, Wood-plastics composites (WPC) - Part 2: Characterization of WPC materials

EN 15534-4, Composites made from cellulose-based materials and thermoplastics (usually called wood-polymer composites (WPC) or natural fiber composites (NFC)) — Part 4: Specifications for decking profiles and tiles

EN 15534-5, Composites made from cellulose-based materials and thermoplastics (usually called wood-polymer composites (WPC) or natural fiber composites (NFC)) — Part 5: Specifications for cladding profiles and tiles

EN 15534-6, Composites made from cellulose-based materials and thermoplastics (usually called wood-polymer composites (WPC) or natural fiber composites (NFC)) — Part 6: Specifications for fencing profiles and systems

EN 17213, Windows and doors - Environmental Product Declarations - Product category rules for windows and pedestrian doorsets

EN 17410, Plastics - Controlled loop recycling of post-consumer PVC-U windows and doors.

EN 17508, Plastics - Unplasticized poly(vinyl-chloride) (PVC-U) profiles for the fabrication of windows and doors – Vocabulary of PVC based materials

EN 45555:2019, General Methods for assessing the recyclability and recoverability of energy related products

EN 45557:2020, General method for assessing the proportion of recycled material content in energy-related products

ISO 22095, Chain of custody

3.2 Technical Guidelines

Beside European standards, also Company internal procedures are referred to.

4. Terms & definitions

4.1 Design for Recycling, DfR

Design for Recycling Guidelines support product development by addressing product’s recyclability, recycled content and quality requirements.

4.2 Internally Reused Material, IRM

Reused material from internally extruded, virgin material; this includes mismeasured, unused products and offcuts (EN 17508). Note: Different defined formulations shall not be mixed. Material can be UV resistant, non-UV resistant, or reduced-UV resistant. ‘Internally’ refers to the same profile manufacturing company group even if located at different sites.

4.3 Recycled PVC, rPVC

Deriving from post-consumer or pre-consumer PVC waste streams (EN 17508)

4.4 Recycled Content of the profile, rContent

$$rContent = \frac{\text{Mass of recycled material}}{\text{Mass of product}}$$

4.5 Sight surface, non-sight visible surface, non-visible surface of window profiles

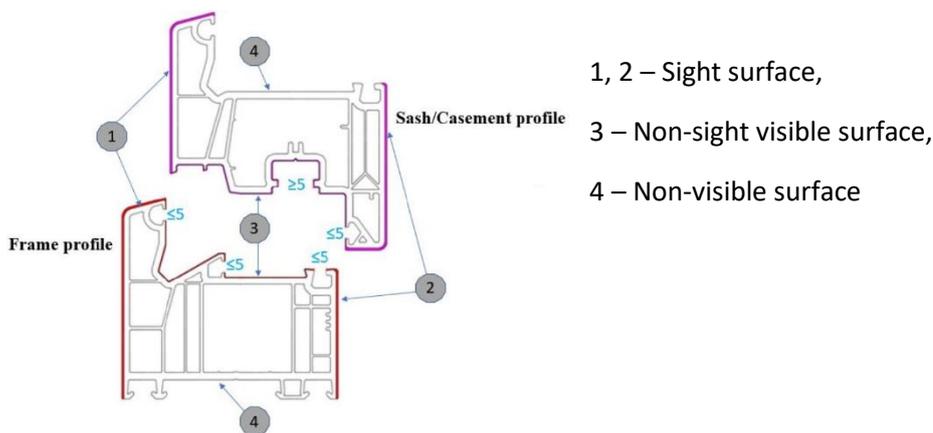


Fig. 1: Sectional drawing of a common sash and frame profile

4.6 Stages in the production/converting process, life cycle stages

Conceptually, the controlled loop in the PVC window profiles industry consists in the circular use of used PVC windows, thereof post-consumer PVC material, and offcuts, usually pre-consumer PVC material, for the manufacturing of new window profiles.

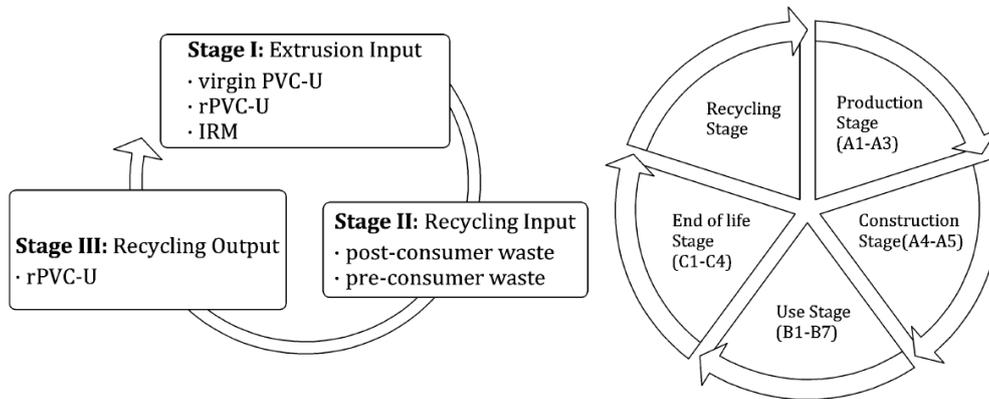


Fig. 2: Transformation stages in the Plastics converting process (EN 17410) and life cycle stages (EN 15804)

4.7 PVC materials stream in a controlled loop

The infographic below represents PVC material streams as they are commonly described in the production of window profiles. Extrusion input material (stage I) is either (i) PVC compound for mono-extrusion or (ii) PVC compound and recycled PVC for co-extrusion or a mix of virgin PVC-compound with recycled PVC for mono-extrusion. Internal reusable material (IRM) is also fed into the process, however, must fit to the applied formulation.

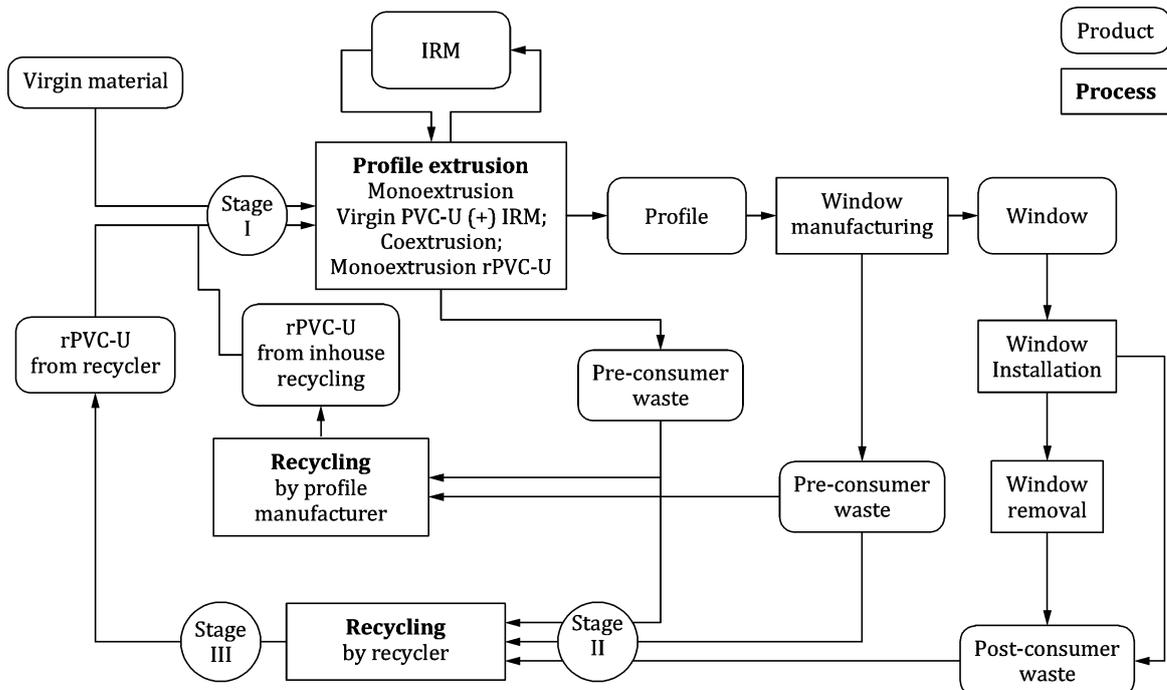


Fig. 3: Scheme of PVC material stream

5. General design principles for PVC window profile systems

The purpose of these general design rules is to ensure that PVC window profile systems and related products that accept recycled PVC and are themselves recyclable meet, at least, state-of-the-art quality of modern windows and doors. For this reason, criteria for raw materials, process conditions, the functionality of the product, quality and recyclability are named, which have to be considered during the design process.

In the following clauses, reference is made to both requirements derived from product-specific European standards and to those established in national/private quality certification schemes, as listed in Chapter 10.1.

5.1 Raw Material used for manufacturing of profiles

PVC window profiles and related building products are commonly made of PVC virgin compound, in combination with recycled PVC and internally reused PVC material.

5.1.1 Characteristics of PVC-Compound:

PVC compound may be procured as ready-to-use or prepared by the converter himself. In both cases, the formulation is company-specific. When the profile follows European Standards (EN 12608 series for PVC-U window profiles; EN 13245 series for PVC-U profiles for building applications) and/or is subject to quality certification, the formulation has to meet quality requirements to be confirmed by tests inter alia such as Vicat softening temperature, Charpy impact strength, the flexural modulus of elasticity and resistance to artificial weathering.

5.1.2 Characteristics of Recycled PVC

Recycled PVC originates from pre- and post-consumer PVC window frames or equivalent PVC waste and scrap according to EN 12608 series, EN 17410 and criteria defined by the value chain.

5.1.3 Characteristics of Internally PVC reusable material (IRM)¹

Internally reusable PVC material, hence rPVC not leaving the converter's perimeter, either on plant or group level, must be compatible with the intended/applied formulation.

5.1.4 Characteristics of PVC-UE (cellular PVC)

Cellular PVC refers to a type of polyvinyl chloride as designated in EN 13245-3. It is a un-plasticized poly(vinyl chloride) in which the density is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout the mass. This design makes cellular PVC softer and more flexible than many kinds of plastic, including standard PVC plumbing pipes, which is why cellular PVC is often used in construction and building. This soft but durable plastic can be shaped and moulded into just about any form without the need for specialized equipment².

5.1.5 Characteristics of Natural Fibre Composites (NFC), Wood Plastics Composites (WPC)

Wood and Natural-Fibre Plastic Composites, a subset of the natural fibre plastics composites (NFPC) group is a material made of PVC and mainly lignocellulosic fillers. The composition ranges

¹ According to prEN 17508 *Plastics - Unplasticized poly (vinyl chloride) (PVC-U) profiles for the fabrication of windows and doors - Terminology of PVC based materials*

² pvc-solutions.com

in a PVC/Wood material ratio between 20/80 up to 60/40. In the construction sector, WPC is used for flooring, cladding and fencing. WPC products are recyclable and therefore part of priority products³. Their quality and functionality aspects are referenced by EN 15534 series and national quality certification schemes (see also table 5.3.2).

5.1.6 **Characteristics of artificial (glass, carbon etc.) and non-artificial fibres for reinforcement purposes**

Glass fibre is an artificial material consisting of numerous fine fibres of glass, which are commonly used to reinforce the PVC structure and thus may make a steel reinforcement obsolete.

5.1.7 **Raw materials for components**

Material characteristics for PVC window system components such as joints, gaskets, films, adhesives etc. are mentioned in chapter 5.3.

5.2 **Process conditions of the extrusion line**

5.2.1 **Manufacturing Process**

The manufacturing process is designed to take up recycled PVC in a content that depends ultimately on the design of the profile. The raw material inflow from PVC compound and rPVC can be separate or mixed. A separate material flow is carried out by co-extrusion, a mixed material flow by mono-extrusion.

5.2.2 **Tool design**

The tool design to enable the use of recycled material relates first to the available recyclate quality and, second, whether mono- or co-extrusion is carried out.

5.2.3 **Design of Material Flow (Process stability aspects)**

In case, rPVC is available in constant quality and sufficient quantity, there are no specific material flow conditions to be regarded.

In case, there is a rupture in the rPVC flow, the extrusion line will usually be stopped and started up again from scratch, with the appropriate process settings.

5.2.4 **Other conditions**

With regard to design-for-recycling, no further process conditions are to be mentioned.

5.3 **Functionality and quality aspects**

Whatever recyclate content a profile shall have, its functional properties must comply at least with quality properties as they can be assigned to a profile with either 100% virgin or rPVC.

Note: When PVC window profiles shall comply with relevant product standards (EN 12608 series and EN 13245 series) as well as quality certification schemes (as listed in chapter 10.1), the requirements contained therein must be taken into account.

The most important properties are listed below.

³ See also Design Work Plan of the CPA working group 'construction'

5.3.1 Longevity, with regard to the finished product, i.e. PVC windows

Durability of PVC windows and doors in general is a fundamental requirement that is also part of the product standard EN 14351-1, chapter 4.24. From a holistic point of view, it depends on the long-term performance of each individual component, in particular from the PVC profile.

Other product features that are related to durability and the profile system are inter alia:

- Water tightness (Testing according to EN 1027, classification according to EN 12208)
- Air permeability (Testing according to EN 1026, classification according to EN 12207)
- Resistance to wind load (Testing according to EN 12211, classification according to EN 12210)
- Thermal transmittance (Determined according to EN ISO 12567 series or EN ISO 10077 series)
- Acoustic performance (ISO 10140-1, classification according to ISO 717-1)
- Reaction to fire and smoke (EN 13501-1)

In addition, by testing the behavior between different climates according to EN 13420 (Windows) and EN 1121 (Doors) and the resistance to repeated opening and closing according to EN 1191 the stability of the window system is proofed.

Maintaining the here mentioned properties also depends closely to the suitability of adjustable fittings, replaceable gaskets and a regular service (such as greasing).

Window profiles and gaskets are used to build windows, which are usually inserted into the outer shell of buildings to protect against weather for a life span of about 40 years. Functional aspects concerning the longevity of the product therefore are closely related to static properties of the window itself and resistance to weathering. These properties are mainly influenced by the physical and mechanical properties and the design of the profile cross-sections.

Beside the window profile itself, the welded corners have an important load-bearing function, hence by taking up the weight of the frame, glass and hardware. Weldability is determined by a tensile bending or compression bending test on welded corners or T-joints in accordance to EN 514, where the minimum breaking force considers the cross-section of the profile.

The profile surface can change its appearance in the course of time due to natural influences, this concerns both color changes and the formation of defects (delamination, erosion). The change in color, the weathering fastness, is determined as the fastness grade of the gray scale acc. EN 20105-A02, after a defined period of artificial weathering acc. to EN 513. This applies to common PVC window surfaces like untreated (virgin PVC), coated, foiled, or coextruded using other material.

The resistance to weathering of the profile material is expressed as the reduction in Charpy impact strength based on EN ISO 179-1 after artificial weathering.

5.3.2 Components: interaction, requirements and test methods

5.3.2.1 Gaskets

Gaskets do have an important role regarding the product characteristics of PVC windows and door sets. Gaskets can be either co-extruded or rolled in. EN 12365 describes the properties of gaskets.

Given the variety of profile surfaces (contact media), compatibility must be given regarding staining, bonding, softening of contact materials, stress cracking.

Regarding durability, base requirements are elastic properties (hardness, compression set, stress at 100% strain, strength at break and elongation) as well as visual properties, which both must maintain over the application period (approximately 15 years). This can be proven by artificial weathering (EN 513), artificial ageing (DIN 53508, ISO 188) and exposure to ozone (ISO 1341-1).

Since the service life of the gaskets is shorter than that of the window the gasket should be installed or fixed in such a way as to allow an easy replacement. This is also important as far as recyclability and durability are concerned.

Regarding recyclability, gaskets that can be rolled in are comparatively easy to remove. However, a certain residual part of coextruded TPE or PVC-P on the profile does not cause any problems to the mechanical recycling process.

An adverse effect of rPVC on gaskets is not known, so far.

5.3.2.2 Coating

The functionality of a coated surface has to be kept also in case of recycled PVC (regardless of its content) is used. If in this case the exact behaviour is not known, product designers must investigate it beforehand:

Adhesion of a coating at the base profile is determined by using the cross-cut test according to EN ISO 2409 before and after artificial weathering/ageing.

No adverse effect is allowed regarding the interaction of coating and rPVC.

With regards to recyclability, the mechanical recycling of coated profiles must not have any adverse effect on recyclate quality.

5.3.2.3 Adhesives and decorative foils for foil laminated profiles

Durable adhesion of the foil has to be provided and is commonly assessed by measuring the peel strength according to EN 17271.

Artificial ageing of the adhesive can be done by storing a foil laminated profile in a wet and hot climate according to prEN 12608-2.

No adverse effect is allowed regarding the interaction of adhesives and rPVC.

With regards to recyclability, the mechanical recycling of foil laminated profiles must not have any adverse effect on recyclate quality.

5.3.2.4 Adhesives for direct glazing

If direct glazing with adhesives or adhesive tapes is used the adhesive must be suitable to bear and transfer loads. Compatibility of the contact media (staining, bonding, softening of contact materials, stress cracking) must be given. Besides, ageing behaviour of the adhesive systems must be given as well and can be proofed by determining the influence of UV, moisture, temperature and cleaning agents to avoid any adverse effect in the recycling process. Further requirements can be found in the various national quality certification schemes, in particular RAL-GZ 716 Part 2 (PVC-U Window Profile Systems for direct glazing)

These requirements apply as well in case, direct glazing is carried out on PVC containing rPVC.

5.3.2.5 Components out of plastic materials other than PVC

These components have to be considered in the recyclability assessment.

5.3.3 Thermal transmittance, Energy efficiency

High energy efficiency properties are represented by the U-value of either the frame or the entire window. It depends on materials, design and installation.

A design rule is to establish an equilibrium between the use of resources for manufacturing and the energy-related properties of the building and/or the window along with the lifespan. This applies in particular when foam or glass fibre reinforcement is used.

5.3.4 Environmental impact

The environment impact of the PVC window profile design can be generally presented by Environmental Product Declarations (EPD) for building products acc. to EN 15804+A2, based on EN 17213 (Product category rules for windows). To comply with the existing Industrial EPDs for PVC windows, it has to be considered that the LCA relevant parameters of the new design shall not exceed the range of the dataset the EPD is based on (see also +/- 5% rule of EPDs).

5.3.5 Indoor climate

To avoid volatile organic compound (VOCs) indoors, building products shall not emit any VOC exceeding thresholds of European assessment schemes, as they are used for instance during the manufacturing process of components. The responsibility to inform the next processing stage is regulated by the European Chemical Law REACH. For the assessment of PVC window profiles, designers can refer to the VOC Emission Study of GKFP (2017).

5.3.6 Reaction to fire

PVC window profiles are classified regarding reaction to fire and smoke as up to B-s3⁴. This classification is based on an expert opinion deriving from an industrial SBI test (EN 13823) carried out for selected specimen.

The use of rPVC has no impact on the classification.

5.3.7 Identification (with regard to EoL scenario)

EN 17410: In particular for post-consumer waste, the material properties should be identifiable. This will avoid the needs for testing. Material properties, including the presence of certain chemical substances, ideally should be recognizable upon visible inspection or with the help of state-of-the art technology. The necessary information should be added to the window profile in the production phase.

5.3.8 Labelling, tracking codes and technologies

5.3.8.1 Barcode, integrated chips

So far, no adverse effect of these technologies is known on the use of rPVC.

5.3.8.2 Information to be provided for the technologies in use

The use of rPVC, as well as the nominal rPVC content, can be part of the label.

⁴ Efectis Expert Opinion July 27, 2012, www.efectis.com

5.4 Quality assurance and test methods used

5.4.1 Test method to measure mechanical and chemical properties

- Vicat softening temperature
- Charpy V-notch
- Modulus for elasticity
- Thermostability
- Tensile impact strength
- Transient welding factor
- Ash content
- Colour and appearance
- Dimensions and weight
- Density
- Behaviour after alternating climate load (heat and cold)
- Weldability

5.4.2 Test method to measure artificial weathering

The fastness to weathering and weather resistance is carried out by artificial weathering tests according to EN 513:2019 method 1 or 2.

After receiving a defined amount of radiant energy, the specimen are examined to determine whether artificial weathering has created colour changes. Furthermore, the Charpy V-notch impact strength shall identify material changes. Are profiles foil laminated, also the adhesion of the film or the coating or the protective layer or film are subject to specific tests.

5.4.3 Test method to define weldability

Weldability is determined by a compression and tensile bending test on welded corners or T-joints in accordance to DIN EN 514:2018-04.

5.4.4 Additional Quality Criteria and test methods (European Certification schemes)

Voluntary European quality certification scheme such as ATG (B), KOMO (NL), QB 36 (F) and RAL-GZ 716 (D) require additional physical properties, which are outlined in Table 9.1.

5.4.5 Factory production control

The type and scope of production control is regulated in company own guidelines.

6. Product specific design-for-recycling

These specific design guidelines are applicable to major Building Products such as

- PVC window profiles for windows, doors and sliding doors
- Shutters and shutter boxes
- Related building products like profile extensions, claddings, terrace flooring etc.



Fig. 4: Priority products, PVC windows and doors, cladding and shutters

6.1 General Design-for-Recycling pre-settings

In case,

- PVC window profiles and related building products are extruded from 100% recycled PVC and these products shall comply with EN 12608, a cover to protect the sight surface is mandatory.
- PVC window profiles and related building products are foil laminated or are out of different material packages, e.g. material mixtures, multilayer products, composites etc., the EoL scenario of the used materials has to be assessed whether there is a recycling solution available.
- Other plastics are used for the concerned window system, they must be recyclable, separately.

6.2 PVC profile systems for windows and doors (EN 12608, hEN 14351-1)

6.2.1 Raw material in use (prEN 17410)

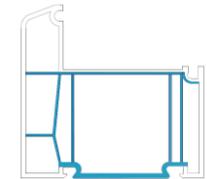
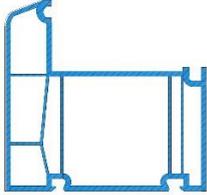
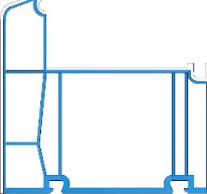
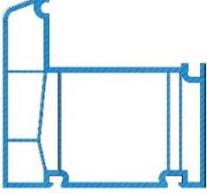
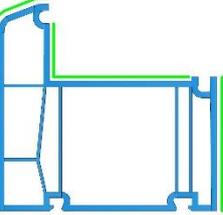
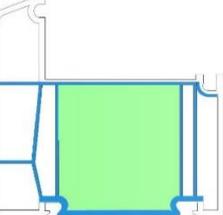
The material used is predominantly PVC compound, whose formulation is usually company specific. In addition to that, recycled PVC is technically added either by a mono- or a co-extrusion process. For that purpose, recycled PVC window material coming from pre- and postconsumer sources as well as internal by-products shall comply with European standards such as EN 12608, EN 17410 and EN 17508.

Raw Material in use	Quality references	Comments
PVC-U powder, compound*	EN 12608-1 EN 17410 prEN 12608-2	UV stabilized material (UVM) Reduced UV stabilized Material (RUVM) Not UV stabilized material (NUVM)
Recycled PVC, rPVC <ul style="list-style-type: none"> • Pre-consumer • Post-consumer 	EN 15346 EN 12608-1 EN 17410	

* Standards for profiles not covered by EN 12608-1 and prEN 12608-2 still have to be developed.

6.2.2 Constructive design elements (rPVC allocation and recycled content)

6.2.2.1 Allocation of recyclate (blue line or shape)

Product Type	Shape	Most common Technical Process	Recycled content (Reference values)
Window profile rPVC allocated in the core		Co-extrusion	0%<rPVC<45%
Window profile with rPVC/PVC mixture Needs cover, e.g. foil, aluminium cover, etc. to protect surface against UV radiation*, when applicable to EN 12608-1		Mono-extrusion	0%<rPVC<100%
Thin Layer PVC window profile rPVC allocated in the core and partly in the external wall		Co-extrusion	0%<rPVC<55%
Fibre re-enforced PVC window profile. Use of short or continuous fibres for reinforcement. Not covered by EN 12608-1.		Mono- and co-extrusion	0%<rPVC<100%
100% recycled material If EN 12608-1 shall apply, protection against UV radiation* is needed (green line), e.g. foil, aluminium cover, etc.		Mono- or Co-extrusion	100%
Foam inside (Applies to all product types) To ensure recyclability, foam material shall be non-sticking if it is different to the rest of the profile		Mono- or Co-extrusion	0%<rPVC<100%

*The value might vary depending on the size and design of the profile.

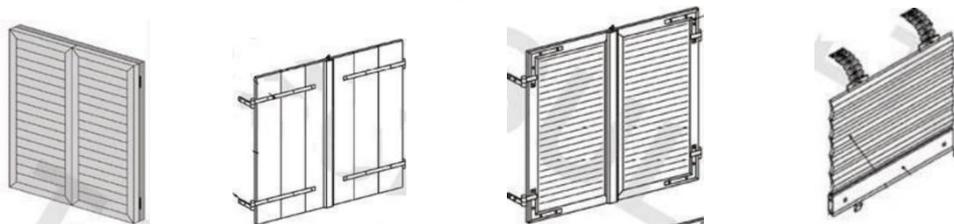
6.2.3 Design options

In addition to the pre-settings already mentioned, further design options that need to be considered in the context of DfR development are as follows:

- Wall thickness may vary; it is defined by EN 12608-1, chapter 4.4
- In case foam is used inside the profile, it must be easily removable and recyclable at EoL stage
- In case, glass fibres are used to reinforce the PVC matrix, a recycling technology must be available at EoL stage
- In case, glass fibres are used to reinforce the PVC matrix, a recycling technology must be available at EoL stage

6.3 Shutters (hEN 13659)

6.3.1 Different types of shutters (fixed, hinged, roller, sliding, Concertina and Venetian)



6.3.2 Raw material used (description)

According to 4.16.2 of hEN 13659 the minimum characteristics of suitability for use of PVC-U profiles shall be as specified in table 8, in reference to EN 13245-1.

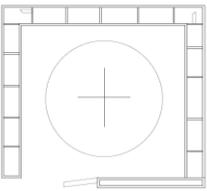
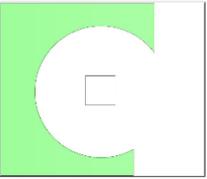
Material in use	Quality references	Product specifics*
“Virgin PVC” PVC-U powder, compound	EN 17410 EN 13245-1,3 hEN 13245-2 prEN 12608-2 – annex C	UVM RUVM NUVM
Recycled PVC, rPVC <ul style="list-style-type: none"> • Pre-consumer • Post-consumer 	EN 15346 EN 17410 EN 13245-1,3 hEN 13245-2	
Natural Fibre Composite (NFC), Wood Plastic Composite (WPC)	EN 15534, Part 1-2 Composites made from cellulose-based materials and thermoplastics (usually called wood-polymer composites (WPC) or natural fibre composites (NFC)) ⁵ NF 514 (AFNOR Certification)	
Artificial Fibers, glass fibres		

*Standards for profiles not covered by EN 12608-1 and prEN 12608-2 still have to be developed.

⁵ Qualitätsgemeinschaft Holzwerkstoffe

6.3.3 Constructive design elements

6.3.3.1 rPVC allocation and nominal recycled content

Product Type	Type	Process	Recycled content (Reference values)
Shutter PVC profile		Mono or co-extrusion	0%<rPVC<100%
Roller shutter boxes			0%<rPVC<100%
End-cap of a roller shutter box			0%<rPVC<100%

*The value might vary depending on the size and design of the profile.

6.3.4 Design options

So far, no further design options to be mentioned

6.4 Building applications, Profile extensions

(EN 13245-1, hEN 13245-2, EN 13245-3, EN 15534-1,2,4,5,6, EN 15534)

6.4.1 Product types using recyclate PVC

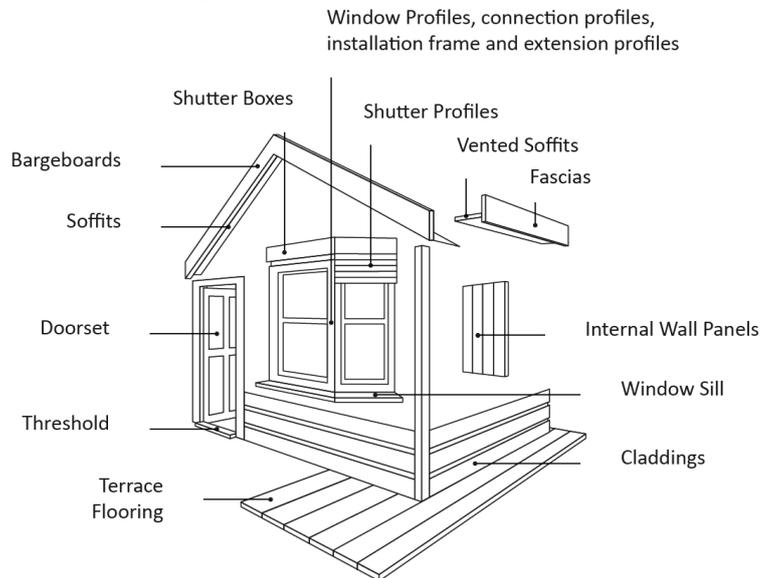


Fig. 5 Graphic display on PVC window profiles and related building products using recycled PVC

6.4.2 Material used (description)

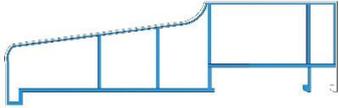
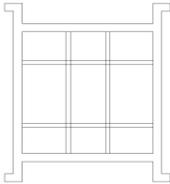
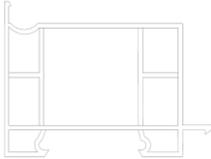
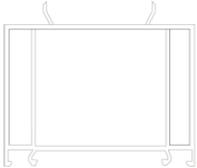
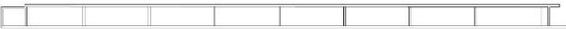
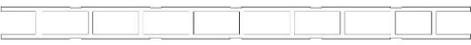
Material in use	Quality references	Product specifics*
"Virgin PVC" PVC-U powder, compound	EN 17410 EN 13245-1,3 hEN 13245-2 prEN 12608-2 – annex C	UVM RUVM NUVM
Recycled PVC, rPVC <ul style="list-style-type: none"> • Pre-consumer • Post-consumer 	EN 15346 EN 17410 EN 13245-1,3 hEN 13245-2	
Natural Fibre Composite (NFC), Wood Plastic Composite (WPC)	EN 15534, Part 1-2 NF 514 (AFNOR Certification) Qualitäts- und Prüfbestimmungen zur Produktionskontrolle von Zaunprofilen aus Holz-Polymer-Werkstoffen ⁶	
Artificial Fibers, glass fibres		

*According to EN 12608-2, annex C.

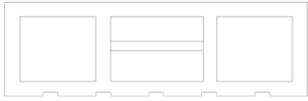
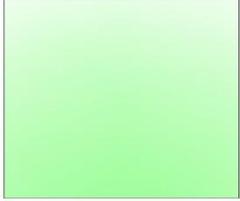
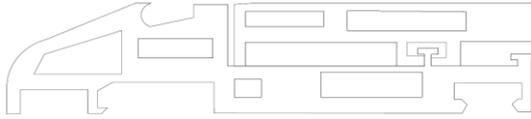
⁶ Qualitätsgemeinschaft Holzwerkstoffe, Berlin

6.4.3 Constructive design elements (drawing)

6.4.3.1 rPVC allocation and recycled content

Product Type		Process	Recycled content (Reference values)
Window Sill		Mono or Co-extrusion*	0-100%
Connection profile		Mono- or Coextrusion	0-100%
Installation frame		Mono or Co-extrusion	0-100%
Extension profile		Mono- or Coextrusion	0-100%
Window Board		Mono or Co-extrusion *	0-100%
PVC-U cladding		Mono or Co-extrusion *	0-100%
WPC and NFC terrace floor-board, fencing and alike		Mono or Co-EX*	0-100 %
WPC cladding, decking		Mono or Co-extrusion *	0-100 %

* If 100% recycled PVC is used the outer layer has to be protected by a cover not made from rPVC

Product Type		Process	Recycled content (Reference values)
PVC Fencing		Mono or Co-extrusion*	0-100%
Fascia soffit or PVC-UE cladding		Mono or Co-extrusion*	0-100%
Sheets			0-100%
Threshold		Mono or Co-extrusion*	0-100%

*The value might vary depending on the size and design of the profile (product).

6.4.4 General design options for profile extensions, building applications etc.

6.4.4.1 When using 100% recycled PVC material

- To fulfil the applicable product standards EN 12608-1, a surface protection is needed for sight surfaces. Specific cover types have to be chosen and must meet the criteria.
- The profile system must be easily to be dismantled and recyclable.

7. Validating recyclability and measuring recycled content

Validating recyclability and measuring recycled content represent core elements of design for recycling. In the following chapters the rules on how this is determined are presented.

7.1 Recyclability criteria of PVC window systems and building related PVC products

In order to assess recyclability already in the design phase the general assessment procedure described in EN 45555 can be used.

7.1.1 End-of-life treatment criteria (EoL)

The end of life of used PVC windows commonly is characterized through the end of its use, hence its replacement in the course of renovation, modernisation or demolition. The collection of used windows and related building products takes place via established schemes. This is followed by sorting of the post-consumer PVC waste and feeding mechanical recycling lines.

7.1.2 Easy to separate into recyclable components, including retrofit

The core of this assessment is to meet criteria that apply specifically to PVC products mentioned in this guideline. The most important criterion is that all parts of which a window is composed of need to be separable, hence dismantlable. After the components are separated from each other they must be able to be fed into their specific waste streams (e.g. glass, metal etc.). The disassembling can be achieved via existing technologies. Main criteria are as follows:

The PVC window can be easily dismantled in

- Retrofit equipment (for example EEE equipment can be separated)
- Metallic hardware
- Insulation pane
- Rubber, TPE and PVC-P joints and gaskets
- Decorative films (optional)
- Reinforcements
- Fibre reinforcements which are not embedded in the polymer matrix

7.1.3 Availability of recycling technologies for components

Recycling technologies for used components must be available for:

- PVC window profiles and related building products: commonly mechanical recycling
- Decorative foils: commonly mechanical recycling
- Gaskets: for residues commonly mechanical recycling applies
- Hardware: commonly recycling of scrap metal
- Pane: commonly recycling of waste glass

7.1.4 Future recycling technology which are currently not available

7.1.4.1 Chemical recycling of difficult to recycle PVC window parts

7.1.4.2 Recycling technologies for man-made-fibre reinforcement

7.1.5 Further items to be regarded/included.

None, so far

7.1.6 Recyclability and Recovery Assessment Scheme (acc. to EN 45555)

To assess, whether PVC window profiles and related building products are recyclable, the method of reference is EN 45555, “General Methods for assessing the recyclability and recoverability of energy related products (ErP)”. Recyclability criteria are adapted to PVC windows. The overall picture of the assessment process is detailed in the flowchart below.

Fig. 6 Flowchart on assessing recyclability acc. to EN 45555: to be adapted to our circumstances

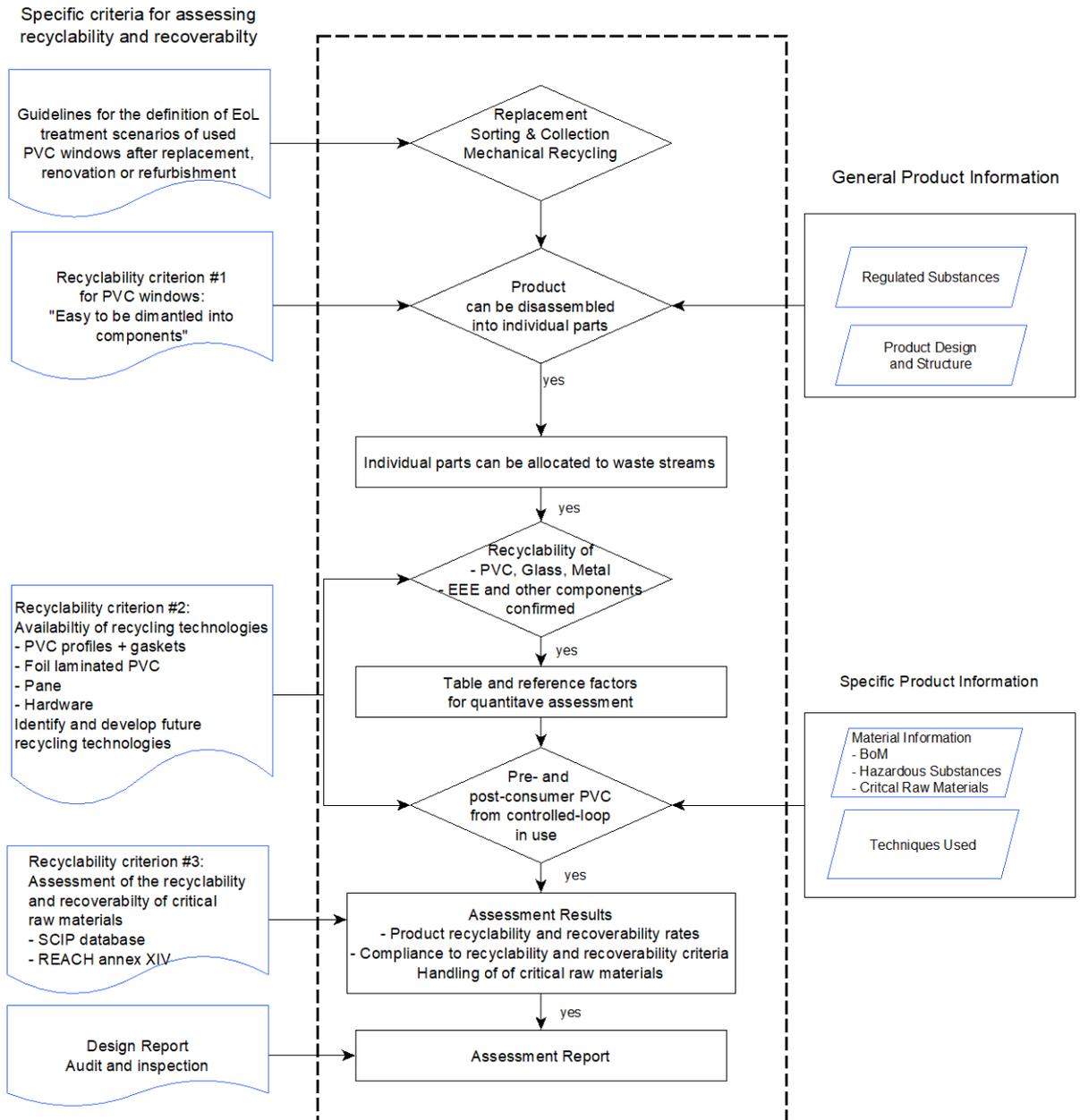


Fig. 7 Assessment of Recyclability acc. to the methodology in EN 45555

7.2 Recycled Content

7.2.1 Definition of recycled content, nominal content and rPVC allocation

How much recyclate is processed can be shown in two ways, either on corporate/enterprise level or product-related.

On a corporate level, the amount of virgin PVC and recycled PVC are recorded in ERP systems according to a mass-balance approach. It figures out how many recyclate PVC the company has processed in a given period.

On a product level, the recycled content is more difficult to assign. In a co-extrusion unit it can be derived from both flow streams, provided there is a continuous flow. In a mono-extrusion unit, it can be derived from the mixing ratio.

In the finished product, usually, the nominal recycled content can be determined by the geometry (cross section) of recycled and virgin part.

To comply with EN 12608-1, chapter 5.1.3., recycled PVC is commonly allocated in the core of a window profile.

See also EN 45557:2020, General method for assessing the proportion of recycled material content in energy-related products

7.2.2 Flowchart of a Generic Design Process, with decision marks regarding to recyclability and recycling content

To determine, whether the product is recyclable and whether recycled content is met, the following flowchart shall be used. It describes a generic design process, where both crucial requirements

- Recyclability, and
- Recycled content

are incorporated as decision points.

When both requirements are met, the product can be referred to as “designed for recycling”. If the requirements are not met, the new product design can be referred to as “out of DfR scope”.

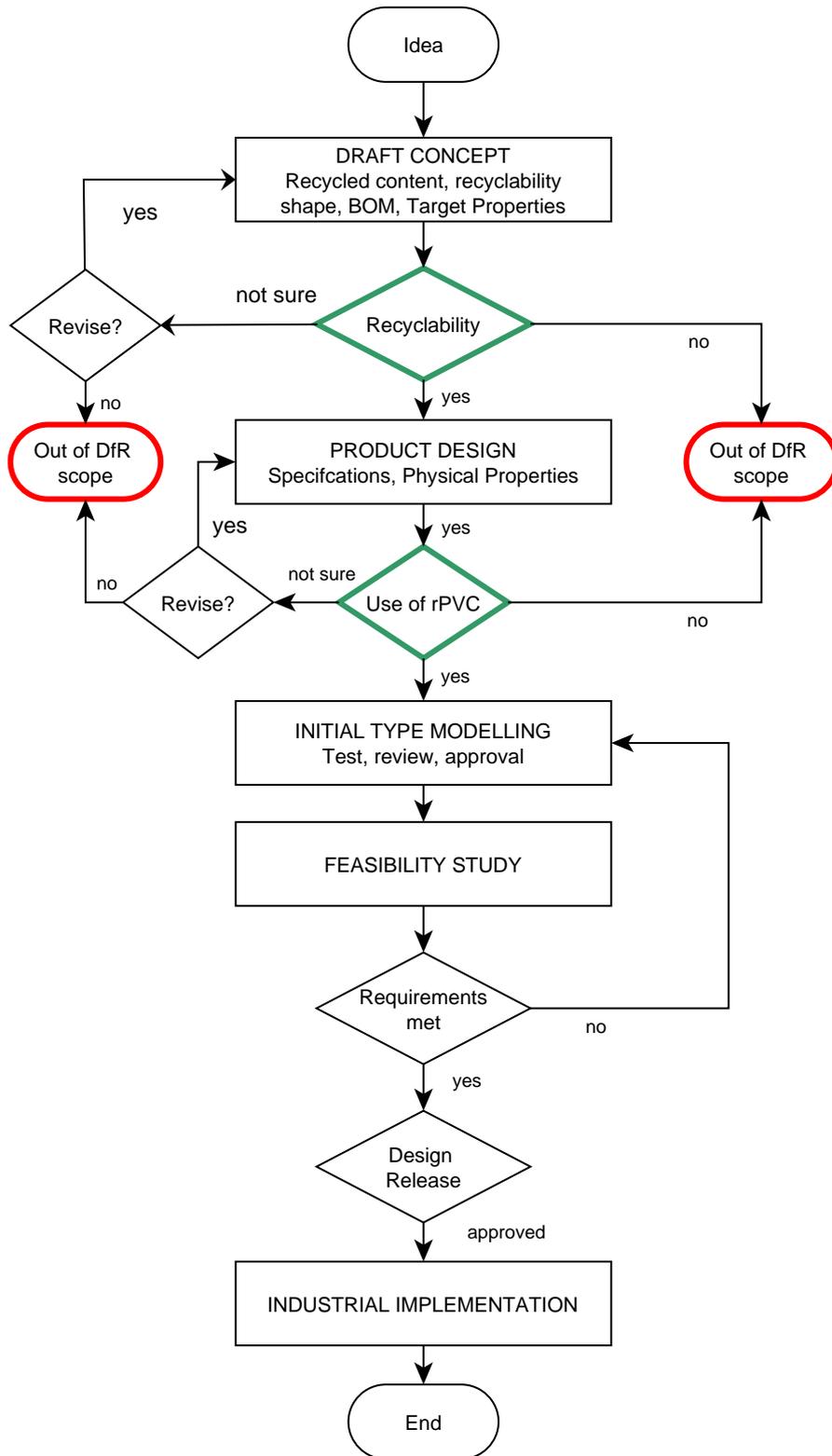


Fig. 8 Design-for-Recycling: Assessment of Recyclability and Recycled Content in the Design Phase

8. Traceability, Reporting

8.1 Referencing state-of-the-art methodologies to trace rPVC waste stream, in particular to monitor the recyclates uptake by PVC window systems and related building products

8.1.1 Post-consumer, pre-consumer rPVC volumes

Data are provided Company-wise to EPPA ivzw, there aggregated and incorporated in the Recovynyl Schemes, or directly inserted in the Recovynyl/RecoTrace^{TM,8} scheme. Recovynyl aggregates all PVC waste tonnages coming from recyclers and converters for the sake of the VinylPlus Annual Report and the Circular Plastics Alliance' Monitoring.

Recovynyl monitors and verifies the recycling of PVC waste and the uptake of PVC recyclate. Recovynyl is used to record how much PVC is being recycled and used in Europe. Recovynyl guarantees the credibility of the recycling achievements, through the strict implementation of an audit protocol.

RecoTrace is a database included in the Recovynyl scheme. It is a database that provides the traceability and transparency of recycled plastics along the entire plastics value chain. The database goes in line with the goals set up by the CPA.

8.1.2 ISO 22095 Chain of custody

The standard serves as reference for the traceability of waste streams.

8.2 Reporting recycled content on product level

By referencing European standards and/or the methodologies described in chapter 6, the nominal recycled content of the product shall be listed in the master data of the window profile system description.

⁸ RecoTraceTM is a data collection system to monitor, verify, and report PVC recycling and uptake in Europe

9. Annex A: Common Raw Material Specification

9.1 Virgin PVC Compound

Company owned formulation.

9.2 Recycled PVC (rPVC)

Recycled pre-consumer and post-consumer waste.

Material properties shall comply with requirements according to

- EN 17410 “Controlled loop recycling of PVC windows and doors”,
- EN 12608-1 “Unplasticized poly(vinyl chloride) (PVC-U) profiles for the fabrication of windows and doors” and series

Features	Test procedure	Common Specifications for light coloured and coloured rPVC
Form (granules, micronized, etc.) Ø, Length		Type A Cylinder shape, e.g. 4-6 mm, 2-4 mm Type B Lens/flakes shape, e.g. 4-7 mm, 1-4 mm
Color	Cielab	Visual inspection or Lab value (EN ISO 11664-4) if spec. of colour is required
Volatile Components	ISO 1269	< 0.4 %
Bulk density	ISO 60, DIN 53466 or EN 15346 annex B	Type A: e.g. 650g/l +/- 30 g/l Type B: e.g. 800 – 850 g/l +/- 30 g/l Other types to be defined
Vicat softening point	ISO 306 B50	≥ 75°C
E modulus	ISO 527-1	≥ 2200 N/mm ²
Notched charpy impact Strength (1eA)	ISO 179/1eA	≥ 20 kJ/m ²
Thermal stability	ISO 182-2	≥ 25 min
Impurities Ø	EN 15346 annex C others	≤ 0.01%, < 0,45 mm

Table 1: rPVC Product features and common specification

9.3 Reduced UV resistant material (RUVM)

Reduced UV-resistant material commonly is used either

- in the core of the profile, or
- solid coloured throughout the profile, together with protection cover (foil)

10. Annex B (informative): Functionality criteria of PVC window profiles containing rPVC-U (PVC-U recyclates)

10.1 Quality Certification Criteria of selected certification schemes for PVC Window Profiles (UV resistant materials except fibre reinforced profiles or PMMA coextruded profiles)

Table 2: Quality criteria as required by various European Quality Certification Schemes (non- exhaustive list)

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Mass per length (EN 12608-1)	≥ 95 % of declared value	≥ 95 % of declared value	≥ 95 % and ≤ 105% of declared value	---	≥ 95 % of declared value
Density (EN ISO 1183-1)	± 0.02 g/cm ³	---	± 0.02 g/cm ³	---	± 0.02 g/cm ³
Vicat softening temperature (EN ISO 306 (B50))	EN 12608-1 5.1 + annex A; average ≥ 75 °C; each value ≥ 73 °C (*); also ERMa (*): ERMb & RMa (test on profile in 100% of this material)	EN 12608-1 5.1 + annex A; average ≥ 75 °C; each value ≥ 73 °C (*); also ERMa (*): ERMb & RMa (test on profile in 100% of this material)	≥ 75 °C; ± 2 °C (*); also ERMa (*): ERMb & RMa (test on profile in 100% of this material or coextruded profile)	---	≥ 78 °C; ± 2 °C; ERMb/b & RMa: ≥ 75 °C
modulus Flexion (ISO 178) Tension (ISO 527-1&2)	EN 12608-1 5.1 + annex A; flexion: average ≥ 2200 N/mm ² ; each value ≥ 2000 N/mm ² (*); also ERMa; (*): ERMb & RMa (test on profile in 100% of this material)	EN 12608-1 5.1 + annex A; flexion: average ≥ 2200 N/mm ² ; each value ≥ 2000 N/mm ² (*); also ERMa (*): ERMb & RMa (test on profile in 100% of this material)	Flexion: ≥ 2200 N/mm ² (*); also on ERMa (*): ERMb & RMa (test on profile in 100% of this material or coextruded profile)	---	Flexion: average ≥ 2200 N/mm ² ; each value ≥ 2000 N/mm ² (*) OR Tension: average ≥ 2200 N/mm ² (*) ERMb/b & RMa: (*)

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Tensile impact strength (EN ISO 8256 type 5)	EN 12608-1 5.1 + annex A;: average ≥ 600 kJ/m ² ; each value ≥ 450 kJ/m ²	EN 12608-1 5.1 + annex A; average ≥ 600 kJ/m ² ; each value ≥ 450 kJ/m ²	average ≥ 600 kJ/m ²	---	average ≥ 600 kJ/m ² ; each value ≥ 450 kJ/m ²
Thermal stability (EN ISO 182-2&3)	EN ISO 182-2 or EN ISO 182-3 ± 15 %	---	EN ISO 182-2 ± 15 %	---	EN ISO 182-2 or EN ISO 182-3 at 190 °C: ≥ 60 min. / ± 15 %; at 200 °C: ≥ 30 min. / ± 20 % ERMa/b & RMa: at 190 °C: ≥ 50 min. / ± 15 %; at 200 °C: ≥ 25 min. / ± 20 %
Ash content	EN ISO 3451-5 (A) ± 15 %	---	EN ISO 3451-5 (A; 2 g) ± 7 %	---	EN ISO 3451-5 (A) ± 15 %
Charpy V-notch impact strength; based on ISO 179-1 type 1fC	---	---	---	---	Wall thickness ≥ 2.8 mm: average ≥ 40 kJ/m ² and min. ≥ 20 kJ/m ² ; Wall thickness ≥ 2.5 and < 2.8 mm: average ≥ 45 kJ/m ² and min. ≥ 25 kJ/m ²
Charpy V-notch impact strength; based on ISO 179-1 type 1fA	See 'Resistance to artificial weathering'	See 'Resistance to artificial weathering'	See 'Resistance to artificial weathering'	---	See 'Resistance to artificial weathering'
Dimensional stability after exposure to heat (EN 479)	main profiles: each value $\leq 2\%$ / $\Delta \leq 0,4\%$; auxiliary profiles: each value ≤ 3 %; glazing beads: each value $\leq 3\%$ (internal use) / each value $\leq 2\%$ (external use)	main profiles: each value $\leq 2\%$ / $\Delta \leq 0,4\%$; auxiliary profiles: each value ≤ 3 %; glazing beads: each value $\leq 3\%$ (internal use) / each value $\leq 2\%$ (external use)	main profiles: each value $\leq 2\%$ / $\Delta \leq 0,4\%$; auxiliary profiles: each value ≤ 3 %; glazing beads: each value $\leq 3\%$ (internal use) / each value $\leq 2\%$ (external use)	---	main profiles: each value $\leq 2\%$ / $\Delta \leq 0,4\%$; auxiliary profiles: each value ≤ 3 %; glazing beads: each value $\leq 3\%$ (internal use) / each value $\leq 2\%$ (external use)

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Behaviour after exposure to heat (150 °C) (EN 478)	<p>no blisters, cavities, cracks, peeling off/delamination (inside, outside and cross-section of the walls); no delamination (co-extruded profiles or <u>coated</u> profiles);</p> <p>In case of foiled profiles: test at min. 120 °C: no separation of the laminated film from base profile or of the protective layer from the carrier film. No delamination or blistering.</p>	<p>no blisters, cavities, cracks, peeling off/delamination (inside, outside and cross-section of the walls); no delamination (co-extruded profiles);</p> <p>In case of coated profiles: only applicable for base profiles</p> <p>In case of foiled profiles: test at min. 120 °C: no separation of the laminated film from base profile or of the protective layer from the carrier film. No delamination or blistering.</p>	<p>no blisters, cavities, cracks, peeling off/delamination (inside, outside and cross-section of the walls); no delamination (coextruded profiles)</p>	---	<p>no blisters, cavities, cracks, peeling off/delamination (inside, outside and cross-section of the walls); no delamination (coextruded profiles);</p> <p>in case of coated profiles: only applicable for base profiles.</p> <p>In case of foiled profiles: test at min. 120 °C: no separation of the laminated film from base profile or of the protective layer from the carrier film. No delamination or blistering.</p>
Heat ageing / thermal resistance (foiled profiles) (EN 13245-1 6.2)	---	---	---	<p>70 ± 2 °C; 24 h ± 5 min OR 150 ± 3 °C or 120 ± 3 °C (in case of failure at 150 °C); 30 +3/-0 min Min. 1 hour cooling down</p> <p>no bubble, no blister, no cracking on covering and no peeling</p>	---

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Heat ageing / thermal resistance (coated profiles) (EN 13245-1 6.2)	---	---	---	70 ± 2 °C; 24 h ± 5 min Min. 1 hour cooling down no bubble, no blister, no cracking on covering and no peeling	---
Impact resistance at low temperature (EN 477)	class I; only applicable for base profiles in case of foiled/coated profiles; coated/foiled <u>surface</u> : failure allowed, no delamination of coating/foiling	Class I/II ; only applicable for base profiles in case of foiled/coated profiles; class II: coated/foiled <u>surface</u> : failure allowed, no delamination of coating/foiling	class I; no delamination (coextruded profiles); class 0: rounded profiles not applicable for coated/foiled profiles	---	class 0/I/II; only applicable for base profiles in case of foiled/coated profiles; not applicable for coated/foiled profiles
Impact resistance at 23 °C (foiled profiles) (EN 477)	---	---	---	1 m; 1 kg 1/10 failures	---
Impact resistance (coated profiles)	---	---	---	---; test on coated plates: EN ISO 6272-1 (7.2) – 500 mm (to be done by coating supplier)	---

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Weldability (EN 514)	<p>Compression bending test: (*) average ≥ 35 N/mm²; each value ≥ 30 N/mm²; If the depth or the overall width of the profile is ≥ 100 mm: average ≥ 28 N/mm²; each value ≥ 24 N/mm²</p> <p>OR</p> <p>Tensile bending test: (*) average ≥ 25 N/mm²; each value ≥ 20 N/mm²; If depth or overall width of the profile is ≥ 100 mm: average ≥ 20 N/mm²; each value ≥ 16 N/mm²</p> <p>(*): EN 12608-1 5.1; ERMa: coextruded profile</p> <p>ERMb & RMa (test on profile in 100% of this material)</p>	<p>Compression bending test: (*) average ≥ 35 N/mm²; each value ≥ 30 N/mm²; If the depth or the overall width of the profile is ≥ 100 mm: average ≥ 28 N/mm²; each value ≥ 24 N/mm²</p> <p>OR</p> <p>Tensile bending test: (*) average ≥ 25 N/mm²; each value ≥ 20 N/mm²; If depth or overall width of the profile is ≥ 100 mm: average ≥ 20 N/mm²; each value ≥ 16 N/mm²</p> <p>(*): EN 12608-1 5.1; ERMa: coextruded profile</p> <p>ERMb & RMa (test on profile in 100% of this material)</p>	<p>Tensile bending test: (*) average ≥ 25 N/mm²; each value ≥ 20 N/mm²; If depth or overall width of the profile is ≥ 100 mm: average ≥ 20 N/mm²; each value ≥ 16 N/mm²</p> <p>(*): ERMa: coextruded profile</p> <p>ERMb & RMa (test on profile in 100% of this material or coextruded profile)</p>	---	<p>Compression bending test: average ≥ 35 N/mm²; each value ≥ 30 N/mm²; If depth or overall width of the profile is ≥ 100 mm: average ≥ 28 N/mm²; each value ≥ 24 N/mm²;</p> <p>test is passed if a measured force ≥ 8000 N is obtained</p> <p>ERMb/a; RMa: coextruded profile</p>

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Resistance to artificial weathering (test) EN 513 – not applicable for foiled/coated profiles	8 GJ/m ² (300-800 nm) (moderate climate M)	8 GJ/m ² (300-800 nm) (moderate climate M)	8 GJ/m ² (300-800 nm) (moderate climate M)	---	8 GJ/m ² (300-800 nm) (moderate climate M) or 12 GJ/m ² (300-800 nm) (severe climate S)
Resistance to artificial weathering (test) (EN 513) – applicable foiled/coated profiles	8 GJ/m ² (300-800 nm) (moderate climate M)	8 GJ/m ² (300-800 nm) (moderate climate M)	---	---	8 GJ/m ² (300-800 nm) (moderate climate M); only applicable for coated profiles
Resistance to artificial weathering (test) (EN 513) – applicable for coating used for coated profiles	---	---	---	basic shades: 3000 hours ± 3 % (± 6 GJ/m ² ; 300-800 nm); secondary shades: 1500 hours ± 3 % (± 3 GJ/m ² ; 300-800 nm)	---
Resistance to artificial weathering (test) (EN 513) – applicable for foils used for foiled profiles	---	---	---	8 GJ/m ² + 12 GJ/m ² (*) (300-800 nm) (moderate climate M) (*): outermost areas and France Overseas Department and Areas (DOM TOM)	20 or 30 GJ/m ² (300-800 nm) (moderate climate M)
Fastness to weathering (EN 513); only applicable for UV resistant profiles and base profiles for foiled/coated profiles in UV resistant material; not applicable for foiled / coated profiles	dE* ≤ 5; db ≤ 3; specified grade of grey scale ISO 105-A02; no visual defects or delamination	dE _{ab} ≤ 3.8; min. grade 3 of grey scale ISO 105-A02; no visual defects or delamination	dE _{ab} ≤ 5; db ≤ 3; specified grade of grey scale ISO 105-A02; no visual defects or delamination	---	min. grade 3 of grey scale EN 20105-A02 (equivalent to dE* ≤ 3.8); no visual defects or delamination

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Fastness to weathering (EN 513); only applicable for coated profiles	$dE^* \leq 3.8$ or specified grade of grey scale ISO 105-A02 or A03; higher dE is allowed; no visual defects or delamination	$dE^* \leq 3.8$; min. grade 3 of grey scale ISO 105-A02; no visual defects or delamination	---	---	Decorative patterns: min. grade 3 of grey scale EN 20105-A02; uniform colours: $dE_{00} \leq 4$ (CIE dE 2000); no visual defects or delamination
Fastness to weathering (EN 513); only applicable for foiled profiles	$dE^* \leq 3.8$ or specified grade of grey scale ISO 105-A02 or A03; higher dE is allowed; no visual defects or delamination	$dE^* \leq 3.8$; min. grade 3 of grey scale ISO 105-A02; no visual defects or delamination	---	---	---
Fastness to weathering (EN 513); only applicable for films used for foiled profiles	---	---	---	$dE^* \leq 5$; $db^* \leq 3$; min. grade 3 of grey scale ISO 105-A02	min. grade 3 of grey scale EN 20105-A02; uniform discoloration; no specs, bubbles, cracks, peeling off
Fastness to weathering (EN 513); only applicable for coating used for coated profiles	---	---	---	$dE^* \leq 5$ (3000h; basic shades) $dE^* \leq 2,5$ (1500h; secondary shades) gloss: $\leq 50\%$ of initial value after 1500h (basic and secondary shades)	---

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Resistance to artificial weathering (EN 513; Charpy impact strength based on ISO 179-1 type 1fA) – not applicable for foiled/coated profiles	Wall thickness \geq 2.8 mm: average \geq 55 kJ/m ² before weathering and reduction max. 40 % after weathering; Wall thickness \geq 2.5 and < 2.8 mm: average \geq 60 kJ/m ² before weathering and reduction max. 30 % after weathering; class C not allowed	Wall thickness \geq 2.8 mm: average \geq 55 kJ/m ² before weathering and reduction max. 40 % after weathering; Wall thickness \geq 2.5 and < 2.8 mm: average \geq 60 kJ/m ² before weathering and reduction max. 30 % after weathering; class C not allowed	Wall thickness \geq 2.8 mm: average \geq 55 kJ/m ² before weathering and reduction max. 40 % after weathering; Wall thickness \geq 2.5 and < 2.8 mm: average \geq 60 kJ/m ² before weathering and reduction max. 30 % after weathering; class C not allowed	---	Wall thickness \geq 2.8 mm: average \geq 55 kJ/m ² before weathering and reduction max. 40 % after weathering; Wall thickness \geq 2.5 and < 2.8 mm: average \geq 60 kJ/m ² before weathering and reduction max. 30 % after weathering; class C not allowed
Resistance to artificial weathering (EN 513; Charpy impact strength based on ISO 179-1 type 1fA) – applicable for coated profiles	Reduction max. 40 % after weathering	Reduction max. 40 % after weathering	---	---	Reduction of max. 30 % after weathering
Resistance to artificial weathering (EN 513; charpy impact strength based on ISO 179-1 type 1fA) – applicable for foiled profiles	Reduction max. 40 % after weathering	Reduction max. 40 % after weathering	---	---	---
Reaction to fire	---	---	---	---	EN 13501-1 class E
Determination of heat build-up; only applicable for coated/foiled /PMMA coextruded profiles	Behaviour between 2 climates (EN 13420) - window	Internal test (BRL 0702)	---	---	RAL test method; heat build-up \leq 66 °C

Features	ATG STS 52.3 (B)	KOMO BRL 0702 + NEN 7034-2 (NL)	QB 34/NF 126 (F)	QB 33 (F)	RAL-GZ 716 (D)
Stress cracking <i>only applicable for PMMA coextruded profiles</i>	---	no cracks in PVC carrier profile/PMMA layer; no separation of PMMA layer from PVC carrier profile	---	---	no cracks in PVC carrier profile/PMMA layer; no separation of PMMA layer from PVC carrier profile
Adhesion of coating (EN ISO 2409) - <i>only applicable for coated profiles</i>	class 0 (ITT: at -10 °C; 20 °C and 50 °C light colour/70 °C dark colour)	class 0 (before and after artificial weathering)	---	class 0	class 0 (before and after artificial weathering)
Foil lamination: Adhesion of foil <i>only applicable for foiled profiles bonded with adhesives</i>	Peel strength \geq 2.5 N/mm (before weathering); \geq 2.0 N/mm (after weathering); test method: deviation from EN 17271	Peel strength \geq 2.5 N/mm (before weathering); \geq 2.0 N/mm (after weathering); test method: deviation from EN 17271	---	Peel strength \geq 2.5 N/mm (before weathering); test method: deviation from EN 17271	EN 17271 Peel strength \geq 2.5 N/mm (23 °C)

11. Glossary

Term	Definition	Source
Adhesion	Union of two materials formed on close contact as a result of the interaction of molecules, electrostatic forces or chemical bonds.	RAL-GZ 716, Appendix 3, p. 109.
Adhesives	Non-metallic materials, which can join solids together through surface adhesion and internal strength without changing their intrinsic structure.	RAL-GZ 716, Appendix 3, p. 109.
Adhesive systems	Adhesives or adhesives tapes, including the necessary components.	RAL-GZ 716, Appendix 3, p. 109.
Co-extrusion	Bonding of several thermo-plastic compounds that are melted on in separate extruders and are permanently bonded in the profile mould without mixing.	RAL GZ-716 Technical Appendix, p. 49.
Co-extruded profile	A profile produced by core or layer co-extrusion, usually consisting of different materials in the core and in the top layer.	RAL-GZ 716, Appendix 3, p. 49.
Cohesion	A form of attraction by which particles of bodies stick together; the force that holds together atoms or molecules in a solid or liquid.	RAL-GZ 716, Appendix 3, p. 109.
Charpy V-notch (The Charpy impact test)	Determined based on EN ISO 179-1.	
Compound for gaskets	Mixture of various components that deliver a gasket material; other terms used synonymously with compound are materials or formulations.	RAL GZ-716 Technical Appendix, p. 103.
EoL (End-of-life) product	Is a product at the end of the product lifecycle, indicating that the product is at the end of its useful life.	
EPD (Environmental product declaration)	An independently verified and registered document that communicates transparent and comparable information about	RAL-GZ 716, Appendix 3, p. 15.

	the life-cycle environmental impact of products in a credible way.	
Gasket, seal profile	Prefabricated material inserted in window/door profiles to achieve a sealing effect.	RAL-GZ 716, Appendix 3, p. 109.
Glazing	Part of a wall or window made of glass.	RAL-GZ 716, Appendix 3, p. 5.
LCA (Lifecycle Assessment)	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.	EN ISO 14044:2006
Monoextrusion	Is an outmoded process of forming the profile from a single material into the desired shape and size?	
Primer	A liquid product which is applied to a substrate before bonding in order to clean the substrate and improve the effectiveness of the adhesive.	RAL-GZ 716, Appendix 3, p. 104.
RFID	Radio-frequency identification. Uses electromagnetic fields to automatically identify and track tags attached to objects.	
T-joints	A tee joint refers to the welded point of two materials that are joined in the same plane at a 180° combined angle with a 90° angle on either side, forming the letter "T".	
Weldability	Determined by a compression bending test on welded corners or T-joint in accordance to EN 514:2018	RAL GZ-716 Technical Appendix, p. 172.
Vicat softening temperature	Is the determination of the softening point for materials that have no definite melting point, such as plastics?	RAL GZ-716 Technical Appendix, p. 155.
VOCs (Volatile organic compound)	Are emitted as gases from certain solids or liquid.	