EPPA European PVC Window Profiles and Related Building Products Association | EPPA ivzw

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ECO-DESIGN GUIDANCE FOR CIRCULAR PVC WINDOW SYSTEMS

Supporting the implementation of the Ecodesign for Sustainable Products Regulation (ESPR)

PART I – INTRODUCTION

Chapter 1 – Purpose

This guidance has been developed by the European Trade Association of PVC Window System Suppliers (EPPA) to support manufacturers, recyclers and other stakeholders in applying eco-design principles to PVC window systems throughout their life cycle.

The transition towards a circular economy requires products to be designed not only for performance and durability, but also to facilitate maintenance, repair, reuse and the recovery of valuable materials at the end of their service life. Eco-design therefore considers the entire product life cycle, balancing product longevity, resource efficiency and end-of-life management.

PVC window systems already demonstrate many characteristics that support circularity. Their long service life, high durability and established collection and recycling systems enable the recovery of valuable secondary raw materials while maintaining high standards of product quality and performance. At the same time, their long lifespan means that the availability of end-of-life material for recycling depends on replacement cycles and building renovation rates. Consequently, improving circularity requires both durable product design and efficient recovery systems once products eventually reach the end of their service life.

This guidance provides practical recommendations for integrating eco-design principles while maintaining product quality, safety, regulatory compliance and market competitiveness. It promotes a balanced approach that considers durability, material efficiency, waste prevention, repairability, recyclability and the responsible use of secondary materials.

The document is intended to promote a common understanding of good practice across the European PVC window industry and to support continuous improvement throughout the value chain. It does not replace legislation or harmonised standards but complements them with practical recommendations based on existing industrial experience.

Chapter 2 – Scope

This guidance applies to PVC window systems and their principal components, including profiles, reinforcement solutions, gaskets and associated materials. It focuses on design decisions that improve durability, repairability, material efficiency, recyclability and the responsible integration of secondary materials throughout the product life cycle.

The guidance addresses the entire circular value chain, from product design and manufacturing to installation, use, refurbishment, collection, recycling and the production of new window systems. It recognises that circularity depends not only on product design but

also on the collaboration of all actors involved in determining how products are maintained, renovated, dismantled and recovered at the end of their service life.

The document focuses primarily on mechanical recycling, which currently represents the most established and environmentally beneficial end-of-life management option for PVC window systems in Europe. It also recognises the importance of waste prevention, efficient use of production materials and the continued optimisation of manufacturing processes to minimise material losses.

Chapter 3 – Regulatory Background

The Ecodesign for Sustainable Products Regulation (ESPR) establishes a framework for introducing sustainability requirements covering durability, reparability, recyclability, material efficiency and product information. Future delegated acts will define product-specific requirements for construction products placed on the European market.

For PVC window systems, eco-design builds upon an already well-established circular economy model. Across Europe, mature collection schemes, advanced mechanical recycling technologies and closed-loop manufacturing systems enable end-of-life PVC windows to be transformed into high-quality secondary raw materials suitable for incorporation into new products.

This guidance should therefore be understood within the broader European regulatory framework, including, where relevant, the Construction Products Regulation (CPR), the Waste Framework Directive, the Waste Shipment Regulation, REACH and other legislation governing the safe use of recycled materials.

The PVC industry has demonstrated that high-quality mechanical recycling can safely recover valuable materials from end-of-life products while complying with applicable legislation. Particular attention is given to the appropriate management of legacy additives contained in historical products, including the application of the existing REACH framework and relevant derogations, which enable the continued recovery and safe use of recycled PVC under controlled conditions.

Eco-design should support the efficient functioning of existing circular systems rather than replacing them. Design decisions should therefore facilitate the recovery of high-quality secondary materials, improve material traceability and remain compatible with established collection, sorting and recycling infrastructure.

At the same time, circular product design should recognise that the availability of recycled material is inherently linked to the volume of products reaching end of life. While eco-design can significantly improve future recyclability and material recovery, it cannot by itself increase the quantity of material available for recycling. Public policies should therefore support efficient collection systems, investment in recycling infrastructure and market demand for secondary raw materials, while recognising the environmental benefits of long product lifetimes and avoiding measures that are disconnected from material availability.

PART II – ECO-DESIGN PRINCIPLES

Chapter 4 – Design for Circularity

4.1 Objective

Eco-design aims to optimise the environmental performance of products throughout their entire life cycle. For PVC window systems, this means designing products that remain durable, safe and energy-efficient throughout decades of use while facilitating maintenance, repair, refurbishment and the recovery of valuable materials once they eventually reach the end of their service life.

Circular product design should consider the entire material cycle, balancing resource efficiency, waste prevention, product longevity and high-quality material recovery. Decisions taken during the design phase have a significant influence on future maintenance requirements, dismantling, recyclability and the efficient use of secondary materials.

The objective is not to maximise one environmental parameter at the expense of another, but to achieve an appropriate balance between long product lifetimes, efficient use of resources and effective end-of-life management.

4.2 Design for Durability

Durability remains one of the most important principles of eco-design.

Extending product service life reduces the demand for virgin raw materials, lowers the frequency of replacement and maximises the environmental value created during manufacturing. PVC window systems are specifically designed to deliver reliable thermal, structural and mechanical performance over several decades and this long service life constitutes one of their principal environmental advantages.

Manufacturers should therefore seek to:

- select materials capable of maintaining their mechanical properties throughout the expected service life;
- minimise degradation caused by UV exposure, moisture and weathering;
- ensure dimensional stability under varying climatic conditions;
- design products capable of maintaining their structural and thermal performance over several decades;
- facilitate inspection, maintenance and repair where technically feasible.

Eco-design should recognise that product longevity and recycling are complementary rather than competing objectives. While longer service lives naturally delay the availability of end-of-life material for recycling, they simultaneously reduce overall resource consumption and environmental impacts. A well-functioning circular economy therefore depends upon both durable products and efficient collection and recycling systems once products ultimately become available for recovery.

4.3 Design for Repair, Maintenance and Refurbishment

Where technically feasible, PVC window systems should facilitate inspection, maintenance, repair and refurbishment in order to maximise product lifetime and minimise unnecessary replacement.

Examples include:

- replacement of gaskets without damaging surrounding components;

- replacement of hardware during refurbishment;
- replacement of glazing where technically feasible;
- replacement of damaged accessories without replacing the complete window system;
- compatibility with refurbishment activities extending product life.

Improved repairability contributes directly to waste prevention and resource efficiency by extending the useful life of products before material recovery becomes necessary.

4.4 Design for Disassembly

End-of-life management should be considered during product development.

Products should be designed so that major components can be separated using conventional dismantling techniques wherever technically and economically feasible.

Manufacturers should consider:

- accessibility of removable components;
- avoidance of unnecessary permanent bonding;
- simplified dismantling sequences;
- minimisation of contamination during dismantling;
- compatibility with existing industrial dismantling and recycling operations.

The objective is not necessarily complete disassembly but the efficient recovery of high-quality material fractions suitable for further processing within established recycling systems.

4.5 Material Efficiency and Waste Prevention

Efficient use of materials contributes directly to resource conservation and forms a central element of eco-design.

Manufacturers should seek to:

- optimise profile geometry;
- minimise unnecessary material consumption;
- reduce manufacturing waste;
- improve production yields;
- maintain product performance using the minimum quantity of material necessary.

Waste prevention should be considered before recycling wherever technically feasible. Efficient manufacturing processes, the optimisation of material use and the recovery of production scrap all contribute to reducing environmental impacts.

The recovery and reprocessing of internally generated production material represents an important component of circular manufacturing. Although such material does not originate from end-of-life products, it contributes significantly to resource efficiency and should be distinguished from post-consumer recycling wherever material flows are reported.

Material efficiency should always remain compatible with durability, product performance and regulatory compliance.

4.6 Design for Future Circular Business Models

Future circular business models may increasingly incorporate refurbishment, component replacement, remanufacturing and closed-loop recycling.

Manufacturers are therefore encouraged to consider product architectures that facilitate:

- refurbishment where appropriate;
- component replacement;
- high-quality material recovery;
- future recycling;
- digital product information supporting circularity.

The technical feasibility of these approaches will depend upon product design, installation methods and building-specific circumstances.

Chapter 5 – Design for Circular Material Flows

5.1 Objective

Eco-design should facilitate the efficient circulation of materials throughout successive product life cycles.

For PVC window systems, this means supporting the recovery of valuable secondary materials through established collection, dismantling, sorting and recycling systems while maintaining product quality and regulatory compliance.

Mechanical recycling currently represents the preferred end-of-life management option for PVC window systems where appropriate collection and treatment infrastructure exists.

Design should therefore facilitate the recovery of secondary raw materials capable of being reintroduced into new products wherever technically appropriate.

5.2 Material Identification and Traceability

Efficient material recovery depends upon accurate identification of product components.

Manufacturers should therefore consider:

- permanent material identification;
- harmonised marking systems;
- digital traceability solutions;
- documentation supporting material composition.

Improved traceability facilitates sorting, supports future Digital Product Passport requirements and increases transparency regarding material origin and composition.

5.3 Material Compatibility

Material combinations significantly influence future recyclability.

Manufacturers should minimise combinations that:

- are difficult to separate;
- contaminate recyclable material streams;
- reduce the quality of secondary raw materials;
- create operational challenges during recycling.

Where mixed materials remain necessary, consideration should be given to their compatibility with established recycling technologies.

5.4 Facilitating End-of-Life Recovery

Efficient recycling begins with efficient dismantling.

Manufacturers should therefore consider:

- accessibility of hardware;
- removable reinforcement where technically feasible;
- simplified component separation;
- minimising unnecessary fasteners;
- compatibility with industrial dismantling operations.

Design decisions should facilitate practical recovery without compromising product performance during use.

5.5 Supporting Existing Circular Systems

Europe already possesses mature collection and recycling systems for PVC window profiles.

Eco-design should therefore build upon existing infrastructure by ensuring compatibility with:

- collection systems;
- sorting technologies;
- mechanical recycling processes;
- quality requirements for secondary raw materials.

Strengthening existing circular systems enables higher-quality material recovery while supporting continued investment in recycling infrastructure.

5.6 Legacy Materials and Regulatory Compliance

Historical PVC products may contain legacy additives, including lead stabilisers, reflecting regulatory frameworks applicable at the time of manufacture.

The recycling of such materials is carried out within the applicable European regulatory framework, including REACH and the relevant derogations governing the safe use of recycled PVC.

Eco-design should facilitate the safe management of legacy materials by improving material identification, traceability and compatibility with existing recycling technologies.

5.7 Design Challenges

Certain product characteristics may create additional challenges for material recovery.

Examples include:

- complex multi-material assemblies;
- inseparable bonded components;
- contamination resulting from demolition activities;
- inadequate dismantling practices.

Where technically feasible, these challenges should be addressed during product development to improve future recovery and recycling.

Chapter 6 – Secondary Materials and Circular Resource Management

6.1 Objective

The responsible use of secondary materials contributes significantly to resource efficiency and the circular economy.

Secondary materials may include post-consumer recycled materials, pre-consumer recycled materials and, where appropriate, internally recovered production material.

The use of secondary materials should always maintain product performance, durability, safety and compliance with applicable legislation.

Eco-design should therefore facilitate the technically appropriate integration of secondary materials while recognising differences in material origin, composition and quality.

6.2 Principles for the Use of Secondary Materials

Manufacturers are encouraged to:

- optimise the technically appropriate use of secondary materials;
- maintain equivalent product performance;
- ensure robust quality assurance;
- cooperate with recyclers to improve material quality;
- promote transparent reporting of material origin where appropriate.

The availability of post-consumer recycled material depends upon the quantity of products reaching end of life and the effectiveness of collection and recycling systems. Eco-design can improve future recyclability but cannot, by itself, increase material availability.

Accordingly, circular economy policies should support efficient collection, recovery and market demand for secondary materials while recognising the environmental benefits associated with long product lifetimes.

6.3 Quality Assurance

The successful integration of secondary materials depends upon robust quality management.

Quality assurance should include:

- incoming material inspection;
- material characterisation;
- contamination control;
- process monitoring;
- finished product verification.

High-quality secondary materials are essential for maintaining confidence throughout the value chain.

6.4 Transparency and Traceability

Manufacturers should maintain appropriate traceability of secondary materials throughout production.

This may include:

- supplier documentation;
- batch identification;
- quality records;
- declarations distinguishing, where appropriate, post-consumer recycled material, pre-consumer recycled material and other secondary material streams.

Transparent reporting contributes to market confidence and supports future regulatory reporting requirements.

6.5 Cooperation Across the Circular Value Chain

Effective circularity depends upon cooperation across the entire value chain.

This includes:

- recyclers;
- compounders;
- profile manufacturers;
- window manufacturers;
- raw material suppliers;
- architects and designers;
- planners;
- contractors;

- demolition companies;
- building owners and asset managers;
- waste management operators.

Each actor influences the ability of products and materials to remain within the circular economy. Decisions regarding renovation, dismantling, collection and demolition are particularly important in determining whether valuable materials are successfully recovered.

6.6 Continuous Improvement

The PVC industry continues to invest in improved collection systems, sorting technologies, recycling processes and product innovation.

Manufacturers should periodically review product designs to identify opportunities to:

- improve material efficiency;
- facilitate future recycling;
- optimise the use of available secondary materials;
- reduce manufacturing waste;
- support waste prevention throughout the product life cycle.

Continuous innovation remains essential for strengthening Europe's circular economy while maintaining the long-term competitiveness of the PVC window industry.

PART III – IMPLEMENTING ECO-DESIGN PRINCIPLES

Chapter 7 – From Principles to Practice

7.1 Introduction

Eco-design is not a single design decision but a continuous process that extends throughout the entire product life cycle. Successful implementation requires environmental considerations to be integrated into product development, manufacturing, installation, maintenance, refurbishment, end-of-life management and the production of new products.

The European PVC window industry has developed mature circular systems based on long product lifetimes, efficient collection, high-quality mechanical recycling and continuous innovation. These existing practices provide a strong foundation for implementing future eco-design requirements under the Ecodesign for Sustainable Products Regulation (ESPR).

The purpose of this chapter is to summarise the practical considerations that manufacturers and other stakeholders should integrate into their product development and business strategies.

7.2 Integrating Eco-design into Product Development

Eco-design should be considered from the earliest stages of product development rather than being addressed after technical solutions have already been defined.

Manufacturers are encouraged to:

- integrate durability, repairability and recyclability into product design from the outset;
- consider the entire product life cycle during material selection;
- minimise unnecessary material complexity while maintaining technical performance;
- optimise profile geometry to improve material efficiency;
- ensure compatibility with existing recycling technologies.

Early design decisions have a significant influence on future environmental performance, material recovery and resource efficiency.

7.3 Supporting Circular Material Flows

PVC window systems already operate within well-established circular value chains that enable valuable materials to remain in productive use over multiple life cycles.

Manufacturers should therefore seek to:

- support existing collection and recycling systems;
- improve the quality and recoverability of secondary materials;
- facilitate efficient dismantling and sorting;
- cooperate with recyclers to improve future material recovery;
- encourage the responsible use of available secondary materials.

Circularity should focus on maintaining materials within productive use for as long as possible while preserving their technical value.

7.4 Balancing Durability and Circularity

One of the defining characteristics of PVC window systems is their long service life.

Extending product lifetime reduces resource consumption, delays replacement and delivers significant environmental benefits. At the same time, longer service lives naturally postpone the availability of materials for recycling.

Eco-design should therefore recognise that durability and recycling are complementary elements of the circular economy rather than competing objectives. Efficient collection, dismantling and recycling systems become increasingly important once products ultimately reach the end of their service life.

Circular economy policies should support this balanced approach and recognise that the availability of recycled material depends upon the quantity of products reaching end of life.

7.5 Transparency and Continuous Improvement

Manufacturers are encouraged to continuously review their products and processes in order to improve environmental performance.

Continuous improvement may include:

- improving material efficiency;

- reducing manufacturing waste;
- enhancing traceability;
- facilitating future recycling;
- improving the quality of secondary materials;
- investing in innovation and digital solutions supporting circularity.

Transparency regarding material composition and material origin contributes to market confidence and facilitates future regulatory reporting obligations.

7.6 Key Recommendations

The implementation of eco-design for PVC window systems should be guided by the following principles:

- Prioritise product durability and long service life.
- Design products to facilitate maintenance, repair and refurbishment.
- Optimise material efficiency while maintaining product performance.
- Prevent waste wherever technically feasible.
- Support established collection and recycling systems.
- Facilitate the recovery of high-quality secondary materials.
- Promote transparency regarding material composition and origin.
- Cooperate across the entire value chain.
- Continue investing in innovation, digitalisation and circular product development.

Together, these principles support the transition towards a competitive, resource-efficient and circular European PVC window industry.

PART IV – STAKEHOLDER COLLABORATION

Chapter 8 – Stakeholder Collaboration

8.1 Introduction

The transition towards a circular economy requires cooperation across the entire construction value chain. Eco-design can only deliver its full environmental benefits if products are designed, manufactured, installed, maintained, renovated, dismantled, collected and recycled in a coordinated manner.

Each stakeholder contributes to keeping valuable materials within productive use and improving the overall performance of circular systems.

EPPA therefore encourages collaboration between manufacturers, recyclers, suppliers, planners, architects, contractors, building owners, demolition companies, waste operators, policymakers, standardisation bodies and research organisations.

8.2 Manufacturers

Manufacturers play the central role in integrating eco-design into product development.

They should:

- incorporate circularity considerations from the earliest design stages;
- optimise durability, repairability and material efficiency;
- facilitate future material recovery;
- improve traceability;
- cooperate with recyclers and suppliers;
- monitor legislative and standardisation developments.

8.3 Recyclers

Recyclers provide practical expertise regarding dismantling, sorting and material recovery.

Their experience supports:

- improved product design;
- better dismantling practices;
- higher quality secondary materials;
- contamination control;
- continuous optimisation of recycling technologies.

8.4 Suppliers

Suppliers contribute through innovation in materials, additives and processing technologies.

They should support:

- compatibility between virgin and secondary materials;
- improved recyclability;
- quality assurance;
- material traceability;
- resource efficiency.

8.5 Construction Sector

Architects, designers, planners, contractors, demolition companies and building owners play an essential role in determining the environmental performance of PVC window systems.

Their decisions influence:

- product selection;
- maintenance strategies;
- refurbishment opportunities;

- demolition practices;
- collection of end-of-life windows;
- the availability of materials for recycling.

Early consideration of circularity throughout construction and renovation projects significantly improves future material recovery.

8.6 Policymakers

Public authorities should establish regulatory frameworks that encourage innovation while remaining technically feasible and proportionate.

Future policy should:

- recognise the environmental benefits of durable products;
- support efficient collection and recycling systems;
- encourage investment in recycling infrastructure;
- facilitate markets for secondary raw materials;
- promote evidence-based policymaking founded on technical expertise.

Policy measures should recognise that the availability of recycled materials depends upon the quantity of products reaching end of life and should therefore avoid requirements that cannot be supported by actual material availability.

8.7 Standardisation and Research

European standards, research organisations and innovation projects support the continuous improvement of circular product design.

Priority areas include:

- harmonised terminology;
- common testing methodologies;
- digital product information;
- advanced recycling technologies;
- material characterisation;
- life-cycle assessment methodologies;
- resource-efficient product design.

8.8 Conclusions

PVC window systems already contribute significantly to Europe's circular economy through their long service life, well-established collection systems and mature mechanical recycling infrastructure.

Eco-design should build upon these existing strengths by promoting durable product design, efficient resource use, waste prevention, high-quality material recovery and continuous innovation.

Achieving these objectives requires cooperation across the entire value chain and a regulatory framework that supports practical, evidence-based solutions. By combining durability, circular design and responsible resource management, the European PVC window industry can continue to deliver sustainable, high-performance products while contributing to Europe's transition towards a competitive circular economy.

Annex A – Recommended Terminology

Purpose

This guidance does not establish new technical or legal definitions. The terminology used throughout this document is intended solely to promote consistency and readability.

Where applicable, terminology should be interpreted in accordance with relevant European legislation, harmonised standards and the terminology agreed within the EPPA Working Groups. As terminology continues to evolve, particularly in relation to circular economy policies and the Digital Product Passport, users are encouraged to refer to the latest agreed industry terminology and applicable regulatory definitions.

Circular Economy

An economic system that aims to maintain the value of products, components and materials for as long as possible through durability, maintenance, repair, refurbishment, reuse and recycling, thereby reducing waste generation and the consumption of virgin resources.

Circularity

The ability of products and materials to remain in productive use throughout successive life cycles while maintaining their technical performance and value.

Eco-design

The integration of environmental considerations into product design with the objective of improving environmental performance throughout the product life cycle while maintaining functionality, safety, durability and regulatory compliance.

Material Efficiency

The efficient use of materials throughout the product life cycle by optimising product design, reducing unnecessary material consumption and minimising material losses while maintaining technical performance.

Waste Prevention

Measures taken before a material or product becomes waste that reduce waste generation through improved product design, durability, maintenance, repair, refurbishment and efficient manufacturing processes.

Secondary Material

Material that has already been used or recovered and is reintroduced into manufacturing processes, including recycled materials and other recovered material streams where appropriate.

Throughout this guidance, the term **secondary material** is used as the overarching concept covering different categories of recovered materials.

Post-Consumer Recycled Material

Material recovered from products that have completed their intended use and entered waste management systems before being processed into material suitable for use in new products.

Pre-Consumer Recycled Material

Material recovered during manufacturing processes before reaching the end user and subsequently reintroduced into production after appropriate processing.

Internally Recovered Production Material

Production scrap or off-cuts generated and reprocessed within the manufacturing process.

Although this material contributes to resource efficiency and waste prevention, it should be distinguished from post-consumer recycled material where material flows are reported.

Recycled Content

The proportion of a product that consists of recycled material.

Where appropriate, transparency should be provided regarding the origin of recycled content, distinguishing between post-consumer and pre-consumer recycled material.

Design for Circularity

A design approach that facilitates durability, maintenance, repair, refurbishment, material recovery and recycling while supporting efficient use of resources throughout the product life cycle.

Design for Recycling

The incorporation of design features that facilitate the efficient collection, dismantling, sorting and recycling of products at the end of their service life.

Mechanical Recycling

A recycling process in which recovered PVC is mechanically processed into secondary raw material without significantly changing the chemical structure of the polymer.

Mechanical recycling represents the preferred end-of-life management option for PVC window systems where appropriate collection and treatment infrastructure exists.

Closed-loop Recycling

A recycling system in which recovered PVC from end-of-life products is processed into secondary raw material and incorporated into the manufacture of new PVC products while maintaining appropriate quality standards.

Traceability

The ability to identify and follow the origin, composition and movement of materials throughout the value chain using appropriate documentation or digital information systems.

Legacy Additives

Substances incorporated into products under historical regulatory frameworks that may still be present in end-of-life materials entering recycling processes.

Their management is governed by the applicable European regulatory framework, including relevant provisions under REACH.

Value Chain

The network of stakeholders involved in the design, manufacture, installation, maintenance, refurbishment, collection, dismantling, recycling and production of PVC window systems.

Digital Product Passport (DPP)

A digital record providing structured information on the composition, sustainability characteristics and circularity-related information of a product in accordance with applicable European legislation.

Final note

The terminology presented in this annex is intended solely to facilitate a common understanding of the concepts used throughout this guidance. It should not be interpreted as establishing new legal definitions or replacing terminology contained in applicable European legislation, harmonised standards or future terminology agreed within EPPA Working Groups.