International Olympic Committee

ENVIRONMENTAL IMPACT EVALUATION OF BRANDING AND SIGNAGE SOLUTIONS FOR EVENTS

March 2021

FOREWORD

The International Olympic Committee (IOC) and the Union of European Football Associations (UEFA) have made great strides in integrating sustainability into their events, and have recently been investigating improvement opportunities in the area of branding and signage.

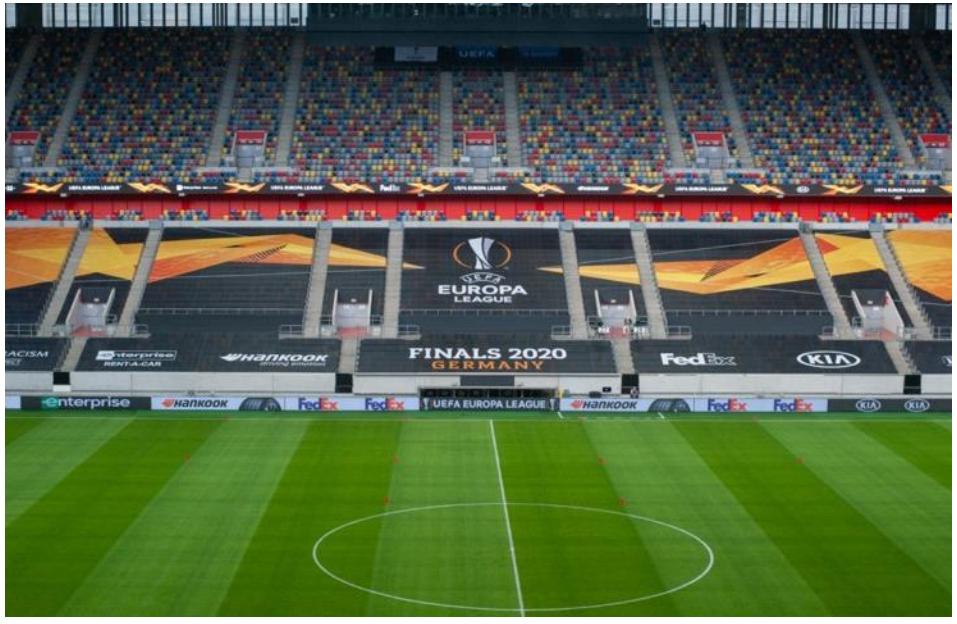
Among the various sustainability topics associated with event delivery, reducing the environmental impact of branding and signage solutions has proved a challenging task to date. Few commercially available solutions meet the needs of event organisers in terms of quality, ecology and cost. Besides, ecological claims are rarely supported by credible data based on product lifecycle evaluations, and few products are certified according to recognised ecolabels.

Branding and signage materials are not only a very visible aspect of events; they are often the number one source of single-use plastic, a large part of which is still being landfilled or incinerated. The impact of single-use plastics on ocean pollution has gained significant public attention over the last few years. The IOC, together with several major sporting bodies, joined the UN Environment Clean Seas campaign in 2018, recognising the need to take urgent measures to stop ocean pollution by plastics, and in 2020 published a guide entitled "Plastic Game Plan for Sports" to help the sports community address plastic pollution. UEFA also recently signed the Memorandum of Understanding to join forces on the UN Sustainable Development Goals.

In this context, the IOC and UEFA commissioned Anthesis, an independent consultancy specialising in environmental impact assessment, to compare lifecycle impact data for a range of branding and signage materials and develop guiding principles to help decision-making.

The present document is the result of this work. It covers over 40 materials, both commonly used materials as well as more innovative ones, and is a first attempt at improving the knowledge base on this topic. It provides:

- A framework to compare conventional products with alternative products marketed as more sustainable, across five main categories (hardboards, flexible graphics, structural materials, flooring, and self-adhesive decals and films);



- A comparative analysis of the environmental impacts of materials, with detailed results per lifecycle stage;
- A summary of key observations and recommendations for sourcing;
- Comprehensive information on the actual recyclability of the materials and their overall circularity score (using the circularity indicator of the Ellen McArthur Foundation) and guidance on end-of-life management in different contexts; and
- Case studies describing some of the more advanced solutions to reduce the lifecycle impacts of materials.

The findings of this study are being used to review and improve procurement criteria for branding and signage.
As leading sports organisations, the IOC and UEFA also wish to share these findings with other interested parties.
Our ambition is to raise awareness on this topic, while encouraging improvements in the quality and transparency of information available to event organisers.

We recognise that the findings of this study will change and evolve as new materials are developed, new products reach the market, and waste management facilities improve. We therefore welcome feedback from all stakeholders (event organisers, product manufacturers, signage specialists, procurement managers, etc.) in order to improve this knowledge base.

ENVIRONMENTAL IMPACT EVALUATION OF BRANDING AND SIGNAGE SOLUTIONS FOR EVENTS

FINAL VERSION

Prepared for the International Olympic Committee (IOC) and Union of European Football Associations (UEFA)

Anthesis

01

INTRODUCTION

Anthesis

PURPOSE OF THIS DOCUMENT

This document aims to compile and compare **lifecycle impact data** for a range of **branding, signage and overlay materials**, in order to **help guide decisions** regarding the **sustainability of sourcing and end-of-life management** of such materials.

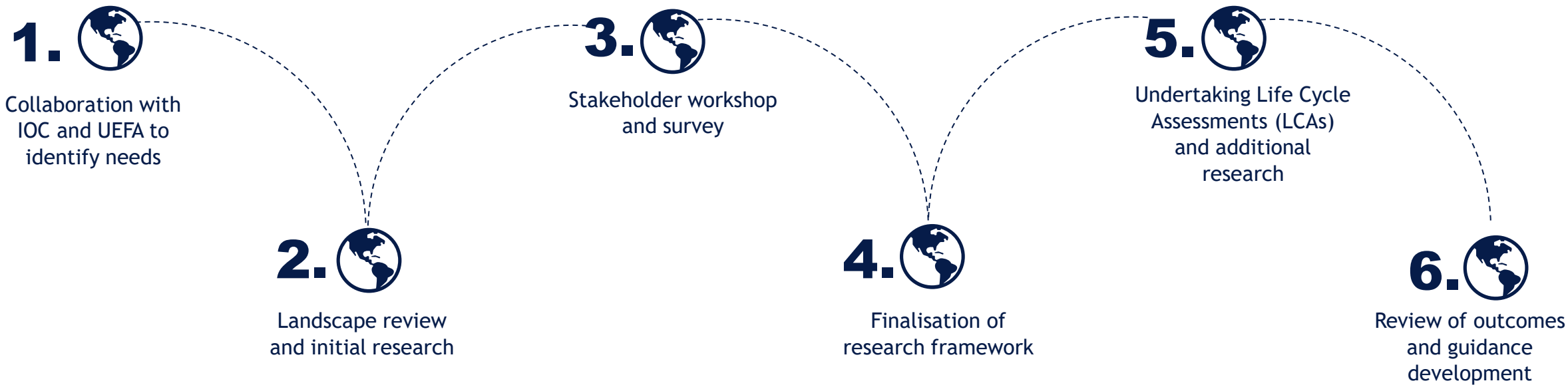
Following this introduction, Section 02 of this document presents **guiding principles** that should be followed to reduce environmental impacts associated with the sourcing and end-of-life management of event branding and signage.

Section 03 presents the **outcomes of life-cycle assessments (LCAs)** for over 40 different material types. For each material type, the environmental impacts of a **conventional** option are compared with those of an **alternate commercially available** option and a **new innovation**. This is complemented by **case studies** describing some of the more advanced solutions to reduce environmental footprint.

Links to project contacts are provided in Section 04, and project references are included in Section 05.

OVERVIEW OF APPROACH

Anthesis took the following approach to this environmental assessment.



INDEX

Hyperlinks to pages included

INDEX OF BRANDING, SIGNAGE & OVERLAY ELEMENTS IN STUDY

Type	Category (product format)	Product
Signage boards	Signage boards (hardboards)	Fluted plastic boards
		Foamboards
		Wood & fibre boards
		Transparent boards
		Durable signage boards
Flexible graphics	Banners	PVC banners
		Non-PVC banners
	Graphic textiles	Graphic textiles
Structures	Structural materials	Structural materials
Flooring	Flooring	Flooring
Self-adhesive decals and films	Self-adhesive decals and films	Standard decals
		Specialist decals

This document refers to different branding, signage and overlay elements.

This index has been hyperlinked to help create an easy navigation route for users to access the most relevant information quickly.

HOW TO USE THIS REPORT: OVERVIEW

This document has been developed to address three different needs: procurement policy development, product procurement and environmental impact assessment. Each section below contains hyperlinks to the parts of the document that are most useful to readers for each discipline.

For procurement policy development

- Guiding principles outline key supply chain stewardship considerations and aim to clarify terminology used around end-of-life and "recyclability".
- Summary ratings (qualitative results) allow user to browse between all product types
- These ratings can be used to give an overview of environmental considerations across different products
  - These can aid policy setting for events
  - Use as a reference for justifying environmental policies

For product procurement

- General guidance is provided on
  - end-of-life definitions
  - key procurement questions
  - transport impacts
  - printing and flame retardants
  - impacts of PVC
  - digital signage
- Summary ratings (qualitative results) across product types allows user to browse between all categories and identify trade-offs for different products
- The detailed analysis gives quantitative environmental footprint information and detailed guidance on end-of-life and circularity at a product level

For environmental assessment

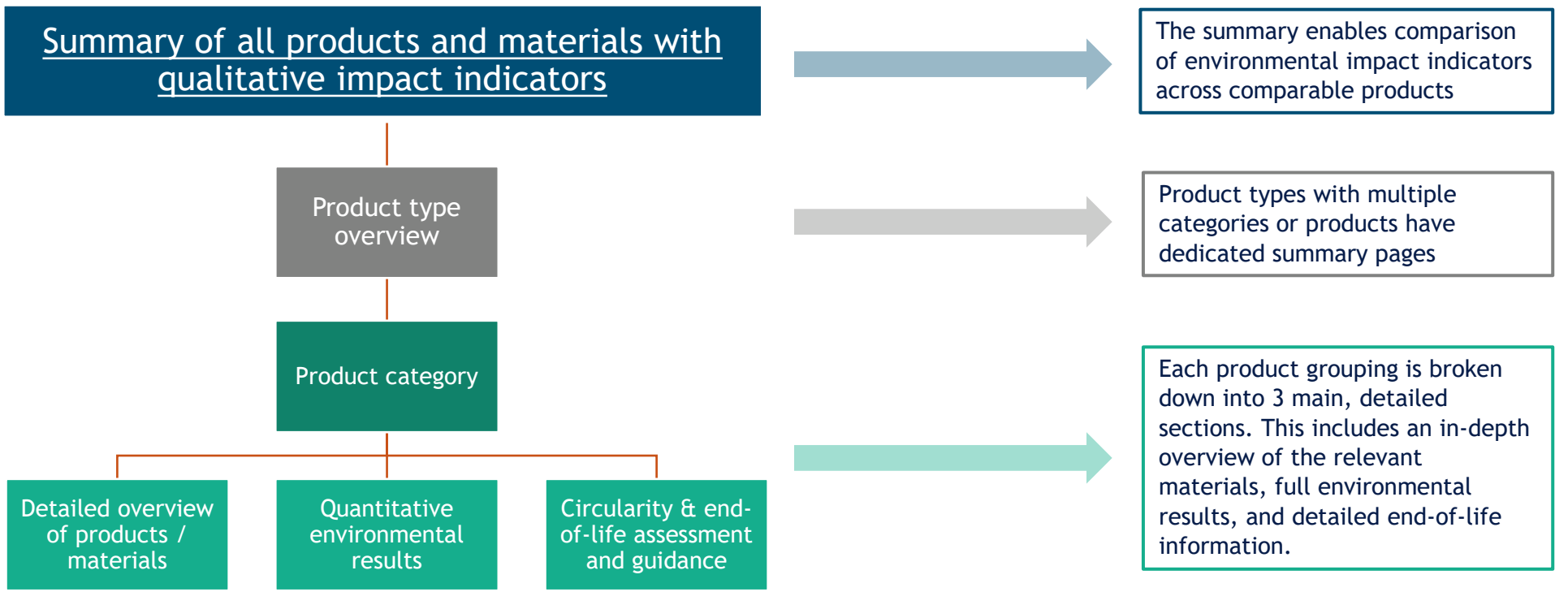
- The footprint summary compares environmental impacts across the product categories
- The detailed analysis sections give quantitative environmental footprint information at a product level

To understand the approach we have taken:

- Life cycle assessment methodology
- Sources and reference library

HOW TO USE THIS REPORT: STRUCTURE OF REPORT INFORMATION

Product/material information and environmental impact results are structured in several layers and use both qualitative and quantitative indicators



HOW TO USE THIS REPORT: EXAMPLE USE CASES

Information in this report may be used in many different ways, from strategic prioritisation of material usage to tactical product-specific decisions (e.g. how to manage a particular product at end-of-life)

Use case	Key sections	Example
Identifying best-in-class products across all sustainability indicators (based on single use)	Summary of all products and materials with qualitative impact indicators	• Use of qualitative indicators to identify the best performing products or materials across all environmental impact categories
Identifying best performing products within one priority area, e.g. climate or end-of-life	Summary of all products and materials with qualitative impact indicators	• Use of qualitative indicators to review performance across a single environmental impact, e.g. if one area is being prioritised by your organisation.
Understanding key issues with a particular material/product type	Detailed overview of products / materials and issues	• Reviewing information in product overview to better understand the materials themselves and the alternative materials available
Understanding the key differences in environmental impact between different products of the same type	Product quantitative environmental impact results	• Using quantitative information to better understand the overall impact of a material or product, and where or why these emissions occur in the supply chain.
Developing end-of-life management plans for a particular product	Product circularity & end-of-life assessment guidance	• Using detailed recyclability or circularity guidance to inform choice of material, or to better understand how waste service providers handle material at end-of-life
Investigating single use vs. reuse cases for a particular product	Product quantitative environmental impact results Product circularity & end-of-life assessment guidance	• Evaluate suitability of a product for single use through its environmental impact and recyclability • Estimate potential environmental impact reduction through reuse of a material

02

GUIDING PRINCIPLES

WHAT TO EXPECT FROM THIS SECTION

This section provides:

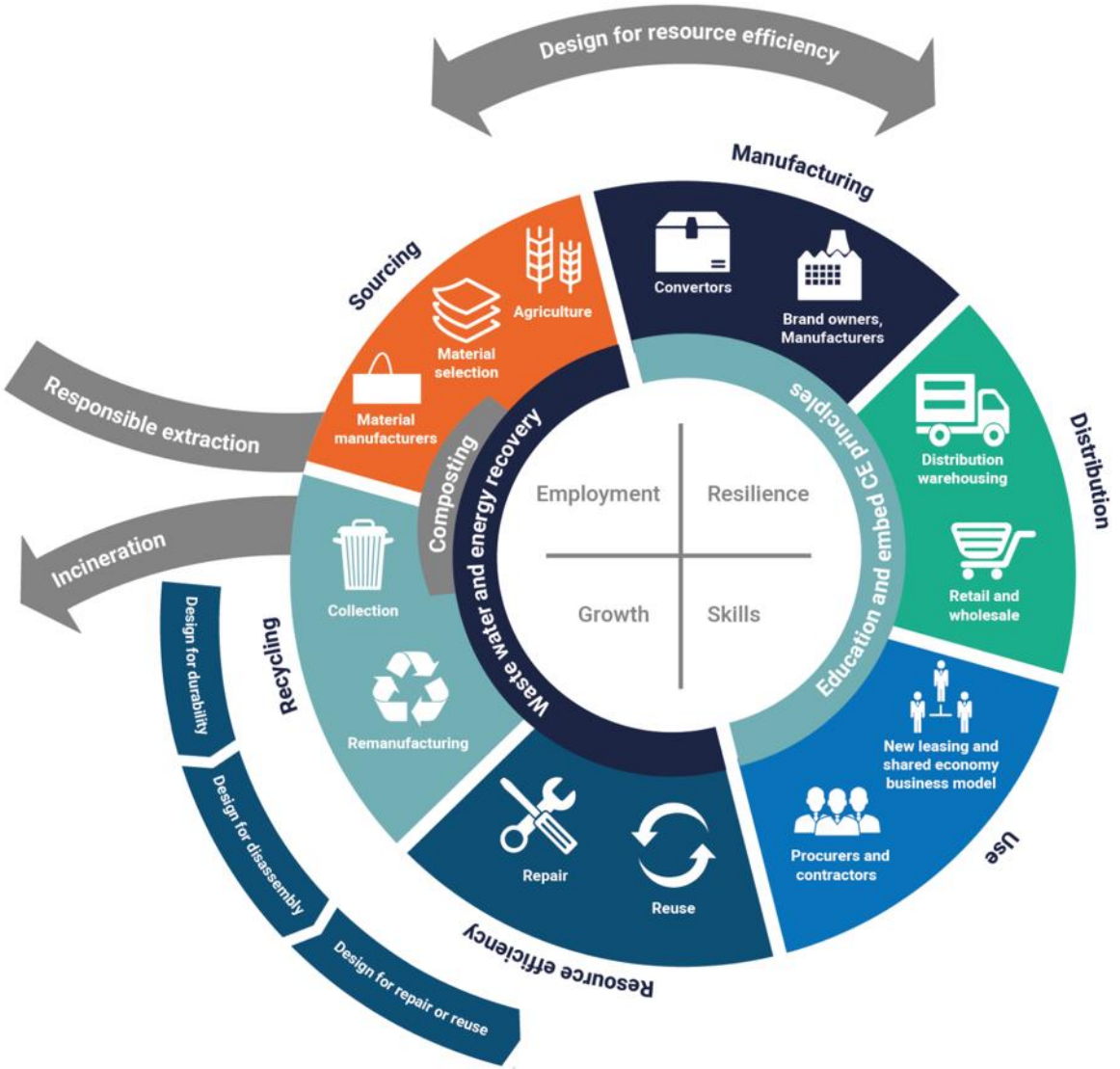
- An introduction to sustainability guiding principles.
- The environmental principles for consideration when procuring event branding, signage or overlay elements.
- A close-up on the circular economy, waste hierarchy, and supply chain stewardship.

It is intended to help guide decisions on procurement policies as well as individual procurement activities.

THE CIRCULAR ECONOMY

A traditional economy is linear, it relies on a model of ‘take, make, dispose’. However, this is not sustainable, and global economies are therefore making the shift towards a more circular approach to production and consumption.

A circular economy aims to keep material at its highest value for as long as possible. Products are extracted for their maximum value during usage, recovered, and regenerated at end of life.



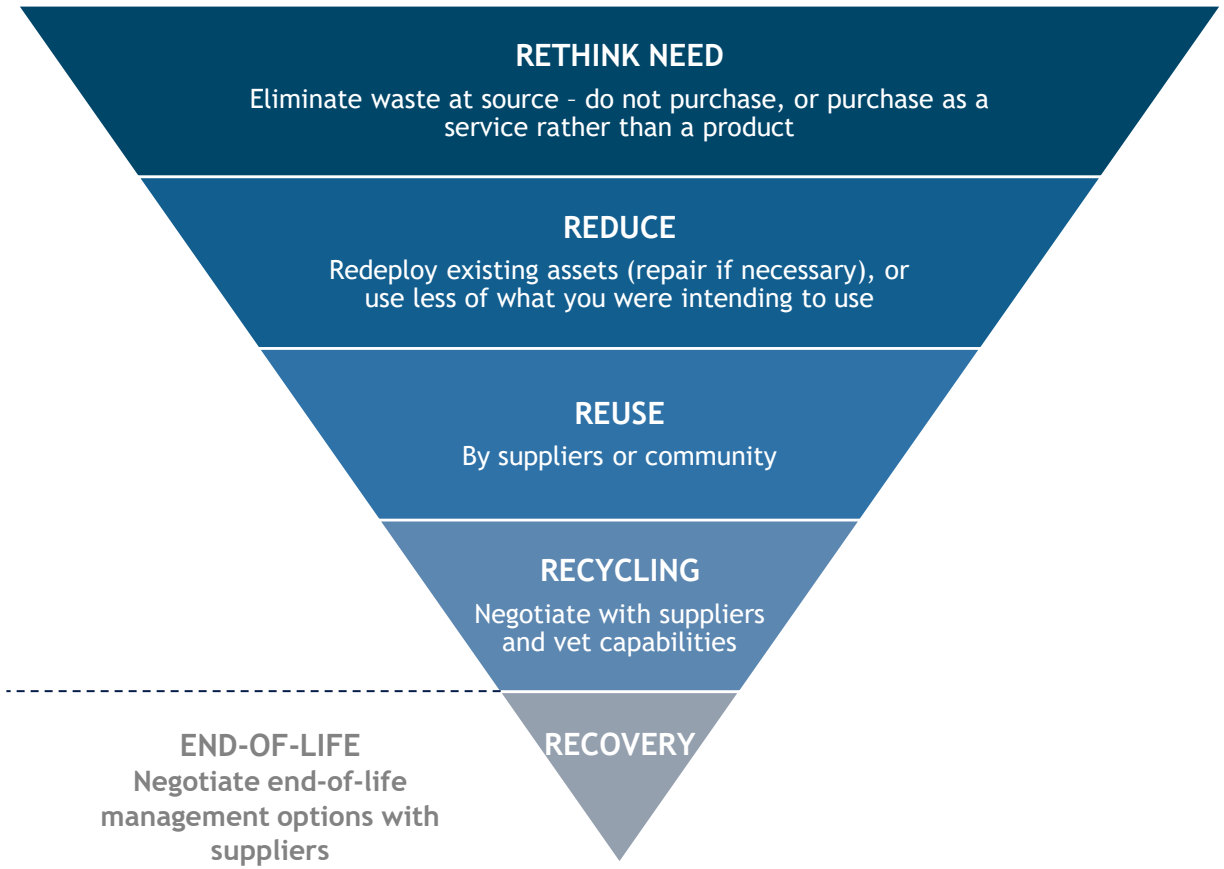
> *“I realised that on land we don't see things as precious anymore. We take what we want. And it started to make me think. I was looking at plans for the future and it hit home to me. This world, that I thought as a child was the biggest, most adventurous place you could imagine, is not that big. And there's an awful lot of us on it. And we're not managing the resources that we have as you would on a boat because we don't have the impression that these resources are limited.”*
>
> Dame Ellen MacArthur, 2009

THE WASTE HIERARCHY

The waste hierarchy provides a best practice framework for how materials used in production and consumption cycles should be managed.

The most preferable option is to prevent waste arising in the first place and the least preferable option is disposal without energy recovery.

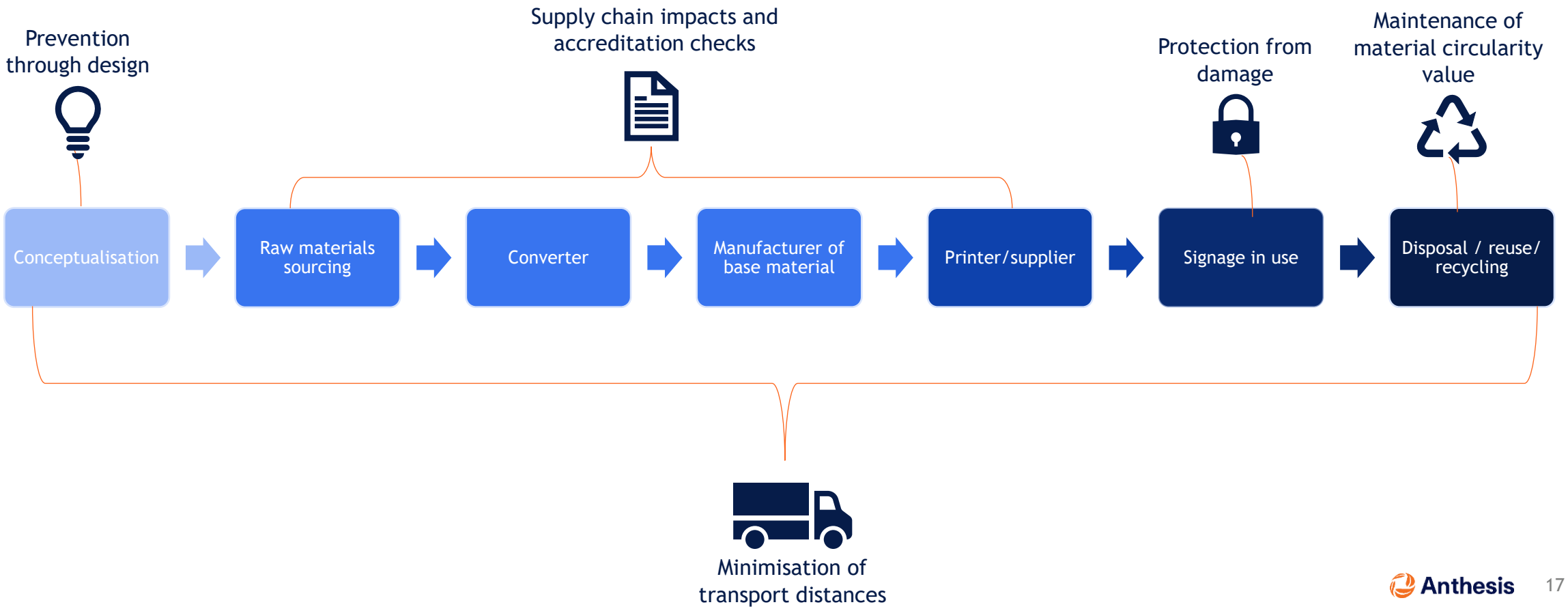
The waste hierarchy is used as a basis for action on waste around the world and is reflected in much of the world's environmental legislation. It forms the basis of the procurement hierarchy (pictured right) which encourages procurement teams to challenge business need for materials and avoid/reduce consumption, identify more sustainable alternatives and revise specifications to improve outcomes (further information in the Olympic Games Guide on Sustainable Sourcing)



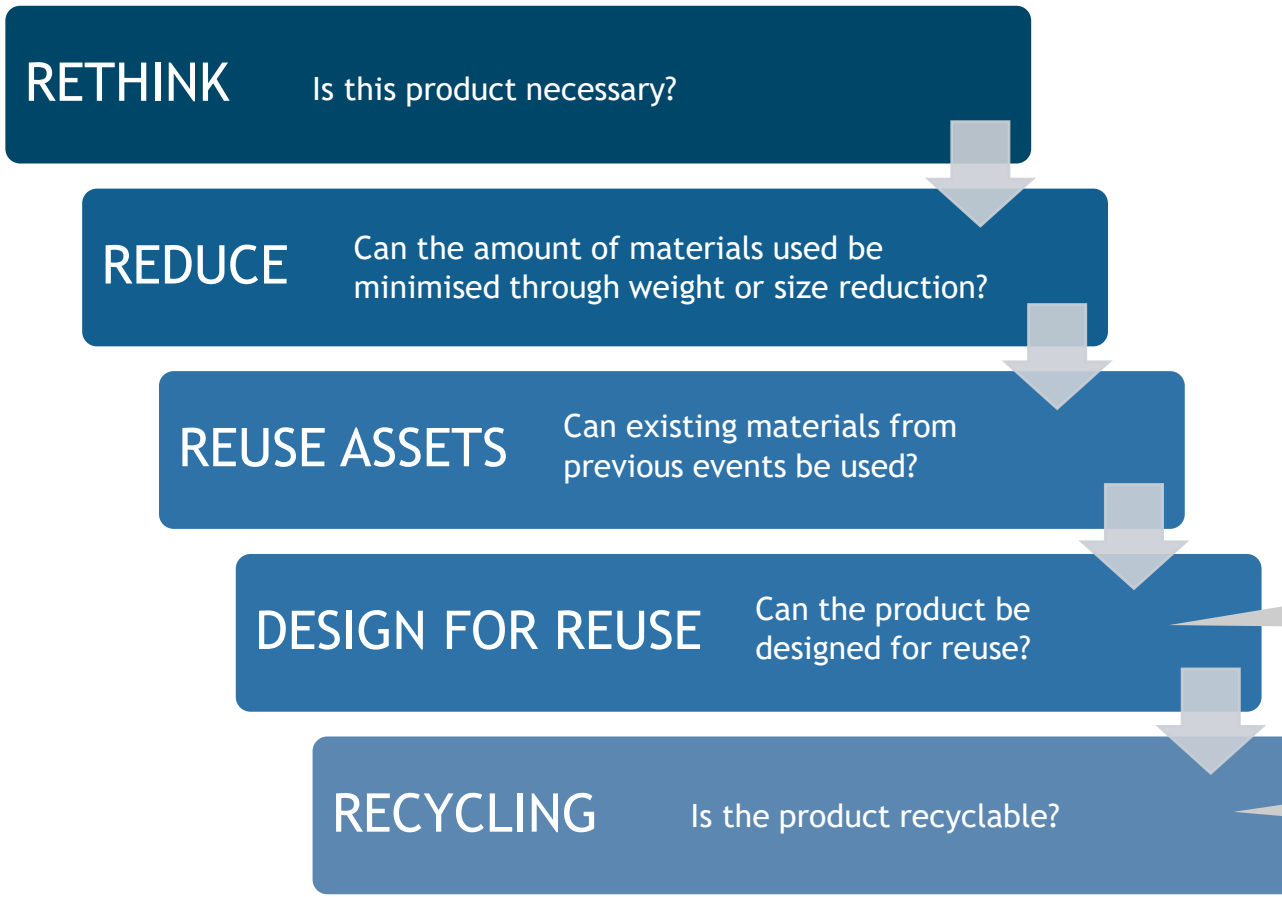
SUPPLY CHAIN STEWARDSHIP

When taking decisions about which product to use it is important to **consider stewardship of the full supply chain from the point of material sourcing to the point of disposal** - identifying where sustainability impacts arise and where interventions to improve environmental sustainability can be made.

Some key questions you should consider in relation to supply chain stewardship are provided on the following pages.



SUPPLY CHAIN STEWARDSHIP: REDUCTION, REUSE AND RECYCLING



The waste hierarchy should be applied in the first stages of conceptualisation and design.

- Achieving optimal outcomes can be much harder if lifecycle aspects are considered later in the procurement process
- The term “100 % recyclable” does not guarantee that a material can be recycled at end-of-life. Recyclability assessments are included for different products and materials throughout this report.

Other considerations include:

- Identification of reuse partners
- Branding implications and management
- Storage and transport to prevent damage

Key queries include:

- Can service provider accept the product (including inks & adhesives)?
- Where will material be recycled?
- What are the output products from recycling?

SUPPLY CHAIN STEWARDSHIP: UNDERSTANDING RECYCLABILITY

"Recyclability" or "100 % recyclable" claims do not guarantee that a material can be recycled in a given location.

It is important to ensure that materials procured can be recycled in practice. Ideally, the location of the recycling facility, the process used and the final product produced should be clearly described and evidenced.

- The three-tier recyclability definitions (below) are becoming more widely recognised.
- Most materials reviewed in this study meet the "technically recyclable" definition. In practice, there will be significant variation in recycling capability from region to region, and materials may need to be transported to another region to be recycled.
- Be aware that some waste collectors may include incineration as a "recycling" process.
- Some labels/certifications can add confusion:
  - "Recycled content" does not indicate recyclability
  - The German Green Dot logo ( ) indicates compliance with German packaging regulations, not the product's recyclability

Technically Recyclable	Collected for recycling	Actually recycled at scale
Recycling a product (separation, sorting, dismantling, and reprocessing) is technically feasible Collection and recycling infrastructure may not exist meaning products still end up in incineration or landfill. Many marketing materials for signage/overlay use this definition of recycling	Systems are in place in a given marketplace to collect and sort a product for recycling Collected product may not be actually recycled if there are infrastructure capacity constraints, or products can be exported for recycling.	Product is technically recyclable and is collected and recycled at scale. The item is mostly (e.g. >95 %) recyclable and is recycled widely in a majority of localities.

SUPPLY CHAIN STEWARDSHIP: RECYCLING AND RECOVERY PROCESSES

"Recycling" is a catch-all term for many different processes. While most people think of recycling as material-to-material (e.g. glass bottles used to make new glass bottles), this is not always the case in practice.

Energy recovery

Also called: *incineration, thermal recycling, energy from waste*

Energy recovery is one of the main end-of-life processes used as an alternative to landfill, where materials are burned to generate energy, and is particularly common in Europe and East Asia.

Although sometimes referred to as "recycling" as energy is generated, **material value is lost and significant CO_2 is generated in the process**.

Wood, plastic, and textile products are most sought after for energy recovery.

Downcycling

Also called: *recycling, cascading*

Downcycling, often just referred to as "recycling", is creating materials from waste which are lower quality than the original material. Often, downcycled products are not recyclable.

Examples

- Using waste plastic bottles as a plasticiser for road asphalt
- Textile recycling to make shoddy, a mixed fabric material filler
- Using waste timber to make MDF
- Waste automotive steel processed to make lower grade steel rebar

Recycling

Also called: *material-to-material recycling*

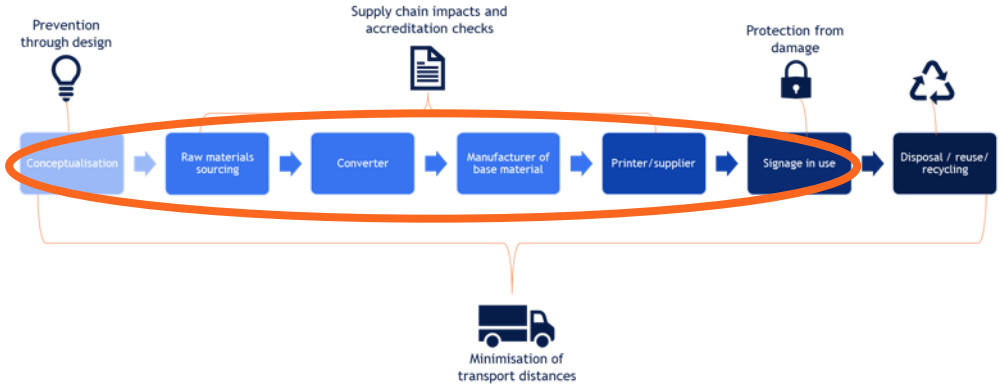
This refers to using waste to make a material of the same or similar quality as the original waste material. **This includes plastic-to-plastic recycling**, where waste plastic is used to make new plastic products. In practice, material recycling often leads to a slight decreased material quality.

Examples

- Using polyolefin films to make recycled plastic composite materials
- Use of waste glass cullet in glass production
- Metal recycling in most cases
- Chemical recycling of PET textiles (by decomposition) to create recycled PET which is indistinguishable from virgin.

SUPPLY CHAIN STEWARDSHIP: SUPPLIER CREDENTIALS & SOURCING

- Environmental standards are highly variable across the globe, and a significant proportion of manufacturing is undertaken in countries with relatively lower environmental standards.
- While procurement is often driven by product specification and cost, vetting suppliers' environmental and social credentials is key to ensuring better sustainability outcomes.
- Manufacturing supply chains can be complex, and not all suppliers will have full visibility of their upstream suppliers (i.e. their suppliers' suppliers), which can make verification difficult.
- ISO 20400:2017 provides further guidance on implementing sustainable procurement frameworks.



Key questions for material sourcing and supply

- What evidence can the supplier provide of environmental certifications or accreditations, including case studies?
    - Organisational accreditations include ISO 14001, BCorp etc.
    - Product credentials may include LCA studies, Environmental Product Declarations (EPDs), or third-party certified Type I eco-labels such as Cradle-to-Cradle, GECA, OEKO-Tex Standard 100 and Blue Angel.
- Can the supplier provide a materials datasheet for the product showing the chemicals, water, energy and other resource inputs?
- Where is the material manufactured? Does the supplier have visibility on its upstream suppliers?
- What are the impacts of sourcing raw materials?
    - Are environmentally certified raw materials used?
    - Can recycled content be incorporated?
- What are the manufacturing processes used and how is environmental damage minimised?
- Where is final product produced and what are the transport distances at each stage of the supply chain? How could the transport distances be minimised?
- What additives, flame retardants, inks, dyes and adhesives are used and what impact do they have on the environment and recycling process?

SUPPLY CHAIN STEWARDSHIP: CERTIFICATION & LABELS

- Ecolabels and green claims are used to declare products' green credentials. The majority of ecolabels are voluntary.
- It can sometimes be challenging to sort marketing claims from verified or certified products.
- There are three main classes of eco-label (as set out in ISO 14024, ISO 14021, and ISO 14025).
    - **Type I**: third party certified product based on the fulfilment of multiple criteria, defined by independent experts. **This is the most rigorous ecolabel type**. *Examples include: Cradle to Cradle Certified, Blue Angel, GECA, and FSC*[1]
    - **Type II**: self-declared product characteristic made by producer or seller. Usually focusses on a single aspect. Claims should be backed by evidence, but this is not always the case. *Examples include "compostable", "100% recyclable", "recycled content"*
    - **Type III**: Environmental Product Declarations (EPD), which are voluntary declarations of a product's lifecycle. To conform to ISO 14025, EPDs must follow LCA methodologies set down in ISO 14040. While EPDs are often 3rd-party verified, this is not always the case.

ISEAL Alliance: Challenge the Label

Eco-labels and sustainability certifications have become more popular over the last 20 years. However, in the absence of standards or regulation, many "green" marketing claims or labels are used on products which can be confusing or misleading.

The ISEAL Alliance, a global membership association for credible sustainability standards, has developed guidance to help **'Challenge the Label'** and help buyers identify what is behind a sustainability claim.

Four key questions about sustainability claims are covered:

1. **What product or service does the claim cover?**
2. **What type of claim is being made?**
3. **What sustainability attributes does the claim cover?**
4. **How is the claim verified?**

The full guidance is available here

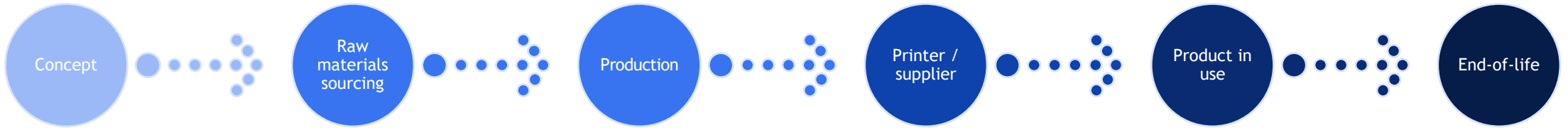
International Trade Centre: Standard Map

The International Trade Centre has developed a 'Standards Map' which provides information on standards for environmental protection, worker and labour rights, economic development and business ethics. It can be accessed here

[1] While FSC is seen as a Type I ecolabel, this does not fully conform to the ISO standard as it is a single-issue label (i.e. forestry).

SUPPLY CHAIN SUMMARY: KEY PROCUREMENT QUESTIONS

Lifecycle thinking should be incorporated as early on as possible in the design process. These are some questions which relate to environmental impacts across a product's lifecycle and production supply chain.



Concept

- Are hire services available instead of purchase?
- Is the overlay element necessary? Can it be replaced by a lighter alternative?
- Do any suppliers offer a take back service in the region?
- What is the whole-of-life perspective of the overlay element?
- Can the element be reused for multiple events?
- Are there potential reuse partners in the region?

Raw materials sourcing

- Is the material REACH[1] compliant?
- Is a recycled content product available?
- Is a product containing material from renewable sources available?
- Is raw material certified (e.g. timber sourcing)?
- For PVC products, is the manufacturing process mercury-free?
- What is the lowest possible carbon footprint over the lifecycle of the element (based on this study, or data provided by supplier)?

Production

- How far will materials need to be transported?
- What fillers, adhesives and additives will be used in production and what impact will this have on recycling?
- Does the product need to conform to fire safety regulations? Are non-chlorinated or non-brominated flame retardant additives available which meet specifications?
- Is the product single material or multi-material?

Printer / supplier

- What inks or finishes will be used and are these compatible with the recyclers requirements?
- Are low-impact dyes or inks (e.g. natural based) available and suitable?
- For solvent-based printing, are low-impact solvents (low VOC) available?
- Ensure that printing and cutting are done to minimise off-cuts and wastage

Product in use

- Can the product be protected from damage to enable reuse?
- For assemblies (e.g. structures or flooring), are these modular, allowing partial replacement of damaged parts?
- Is it possible to use non-adhesive and reusable fittings to aid recycling?
- For metal fixtures (e.g. steel cable), ensure that these can be used long term to mitigate their impact.

End-of-life

- Can the element be reused at end of life?
- Can material be repurposed/upcycled?
- Which are the most suitable local recyclers?
- Which processes are end-of-life providers using, and what materials come out of the process?
- If no suitable recyclers are available in the region, is it possible to ship material to a location which does (preferably via sea or rail)?

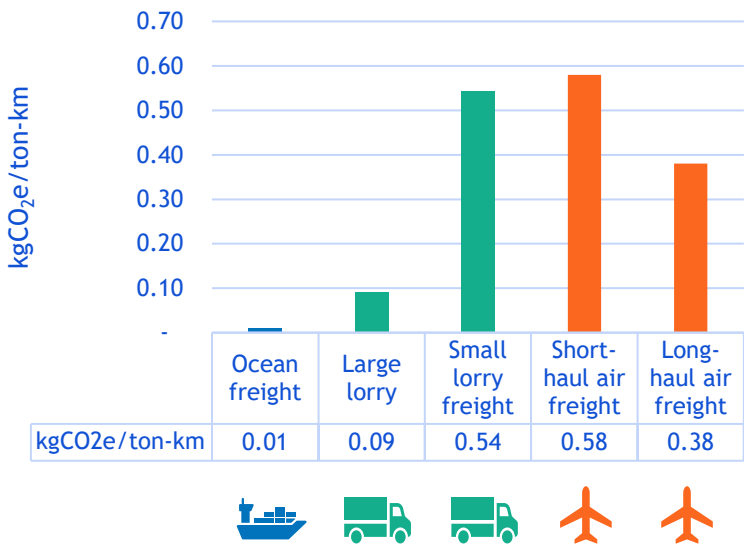
[1] REACH refers to EU regulations for managing environmental and human health impacts of chemicals.

TRANSPORT

Key principles for choosing transport options

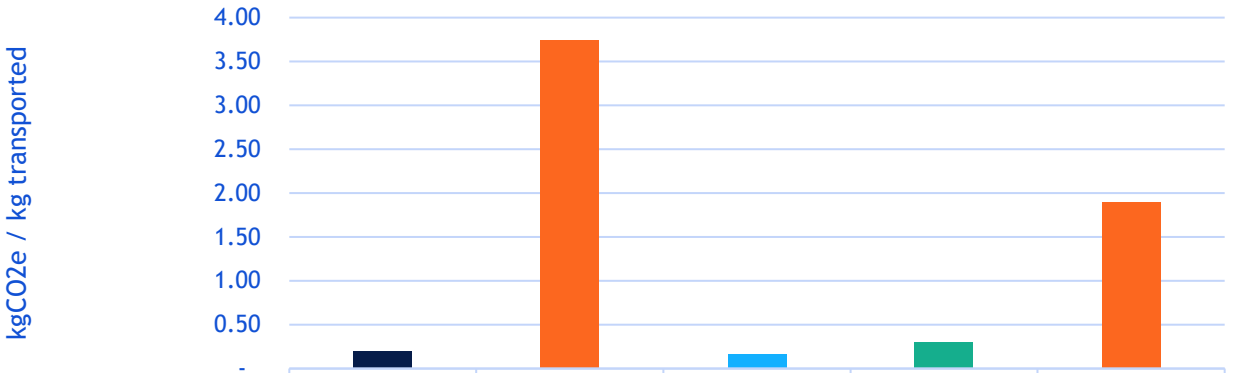
- Avoid air shipping as much as possible
- If available, ocean freight tends to have a lower impact than road or air.
- The heavier your product, the higher the transport impact.

Comparative emissions per ton-km for different transport modes



	Ocean freight	Large lorry	Small lorry freight	Short-haul air freight	Long-haul air freight
kgCO2e/ton-km	0.01	0.09	0.54	0.58	0.38

Impact of alternative transport choices compared to the default assumption



	East Asia to Europe, ocean freight	East Asia to Europe, air freight	Turkey to Paris, train freight	Turkey to Paris, road freight	Turkey to Paris, air freight
kgCO2e / kg transported	0.20	3.75	0.16	0.30	1.90

Default assumption used in this report

In this report, transport is modelled based on an **average**, equivalent to ocean & road shipping route from Taipei to Paris.

A number of other transport scenarios are presented here to illustrate the difference for shipping a tonne of material using different modes.

- For longer journeys, air freight can be around 20x higher-impact than ocean freight
- Air freight can be 6.5x higher impact than road transport

PRINTING

There are many different types of printing techniques and inks available. Suitability depends on the substrate and application. Printing has a small contribution to signage footprint; however, there are some environmental considerations, especially around potentially hazardous volatile organic compounds.

- **Eco-solvent inks** are available which can have a smaller hazard profile than conventional solvent inks, especially for indoor applications.
- **Water-based inks** eliminate VOC hazards associated with solvent-based inks. These tend to be best suited to indoor applications.
- **Natural-based inks and dyes** can be used for printing on paper or fabrics.
- **UV inks** tend to have a lower footprint than other methods which use heat. However, UV inks **can affect recyclability of paper-based products and potentially some plastics.**

FLAME RETARDANTS

Flame retardant (FR) properties are often required for signage, especially when deployed indoors. Further information on FRs should be requested from suppliers in order to assess potential human or environmental health risks.

While FRs usually don't have a significant impact on the material footprint, they may negatively influence recyclability. Additionally, there are potential health and environmental concerns over some types of FRs, especially those containing bromine and chlorine. There are a large number of different FRs which may be used for different materials. Broadly, these include:

Inorganic FRs: include aluminium trihydroxide or magnesium dihydroxide, zinc borate, antimony trioxide (used in combination with chlorinated FRs). Inorganic FRs are generally considered to be non-hazardous, but can affect material properties and recyclability of plastics depending on concentration

Chlorine- and bromine-containing FRs: the most controversial group of FRs as some are environmentally persistent and may have negative health impacts.

Phosphate FRs: considered to degrade more readily in the environment than other FRs. These are sometimes used in combination with chlorinated or brominated FRs.

IMPACTS OF PVC

Many organisations have implemented procurement policies shifting away from the use of PVC. Despite PVC's usefulness and versatility as a material, there are multiple environmental and human health concerns associated with it.

Production: some PVC production routes involve processes which emit significant amounts of mercury. While this has declined in recent years (the EU has banned these processes), this is not the case in all countries.

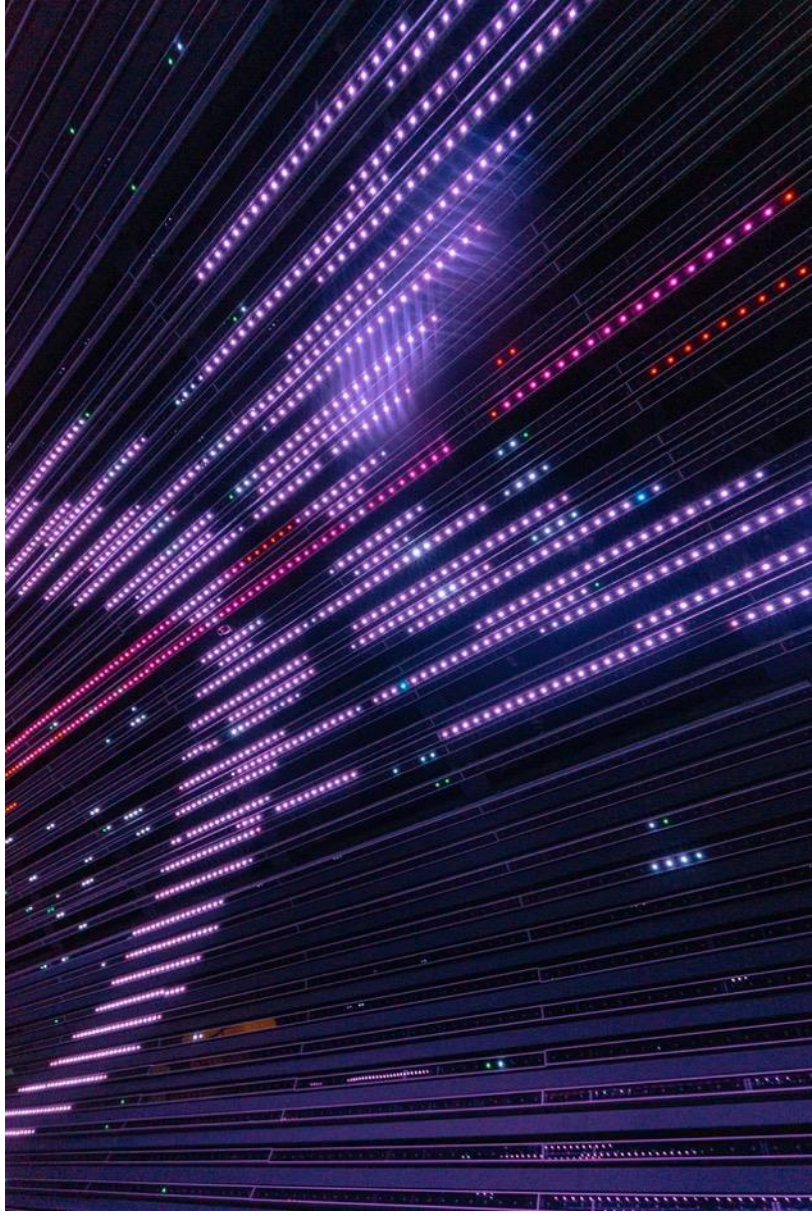
PVC additives: PVC is often compounded with plasticisers and other additives. Due to the properties of PVC, these can leach out of the material over time. While many toxic additives have been phased out of production via the implementation of stricter chemicals regulations in many countries (e.g. REACH), there are concerns over some of those currently used.

End-of-life: PVC is difficult to recycle and can hinder recycling of other plastic types such as PET. Its chlorine content also introduces the risk of dioxin and furan formation (pollutants with human and environmental health risks) when burned – incineration of these materials is controversial.

While this study assesses the environmental impact of PVC products, it should be noted that all of the potential impacts may not be captured due to the variability in PVC production and limitations of the methodology.

DIGITAL SIGNAGE

- Digital signage options have become a popular alternative to static signage in the last 15 years due to their versatility.
- Digital signage options include LCD-type displays (e.g. TV screens or screen-type advertising panels) and LED arrays (e.g. digital traffic signage or advertising hoardings).
- Digital signage is reusable and may deployed over a relatively long-time, barring equipment malfunction.
- **While we have not calculated the impacts of digital signage in this report, there are several aspects to consider and power consumption should be estimated in planning:**
    - Digital displays have a significant manufacturing impact which needs to be factored in in addition to use. For screens on let on a hire basis, a typical asset lifecycle is 3 years.
    - Use of digital signage needs to factor in both standby and operational power draw.
    - Power source will have a significant effect on footprint. Use of electricity will tie the footprint to the local power grid which will vary from region to region.
    - Diesel generators are often used to power display – as well as the carbon footprint, these also generate local pollution (e.g. NO_x and particulate emissions). Renewable or hybrid generators may help to lower emissions.
- Displays are a problematic waste stream in countries with limited e-waste processing infrastructure. Informal e-waste processing can put workers at risk from hazardous materials.
- Displays should comply with EU RoHS (restriction of hazardous substances) regulations to limit heavy metal content. Additionally, we recommend that mercury-free displays are specified.



03

LIFE CYCLE ASSESSMENT OUTCOMES

Anthesis

WHAT TO EXPECT FROM THIS SECTION

This section provides:

- An overview of the Life Cycle Assessment (LCA) methodology
- A summary of the products and materials included in the study
- Comparison of environmental impacts across formats (Section A)
- The outcomes of the lifecycle assessment for each product type (Sections B - F)

Both quantitative and qualitative indicators are used to help readers assess the environmental impact of products.

It is intended to help guide procurement activities for different product types.

APPROACH TO THE LIFECYCLE ASSESSMENT

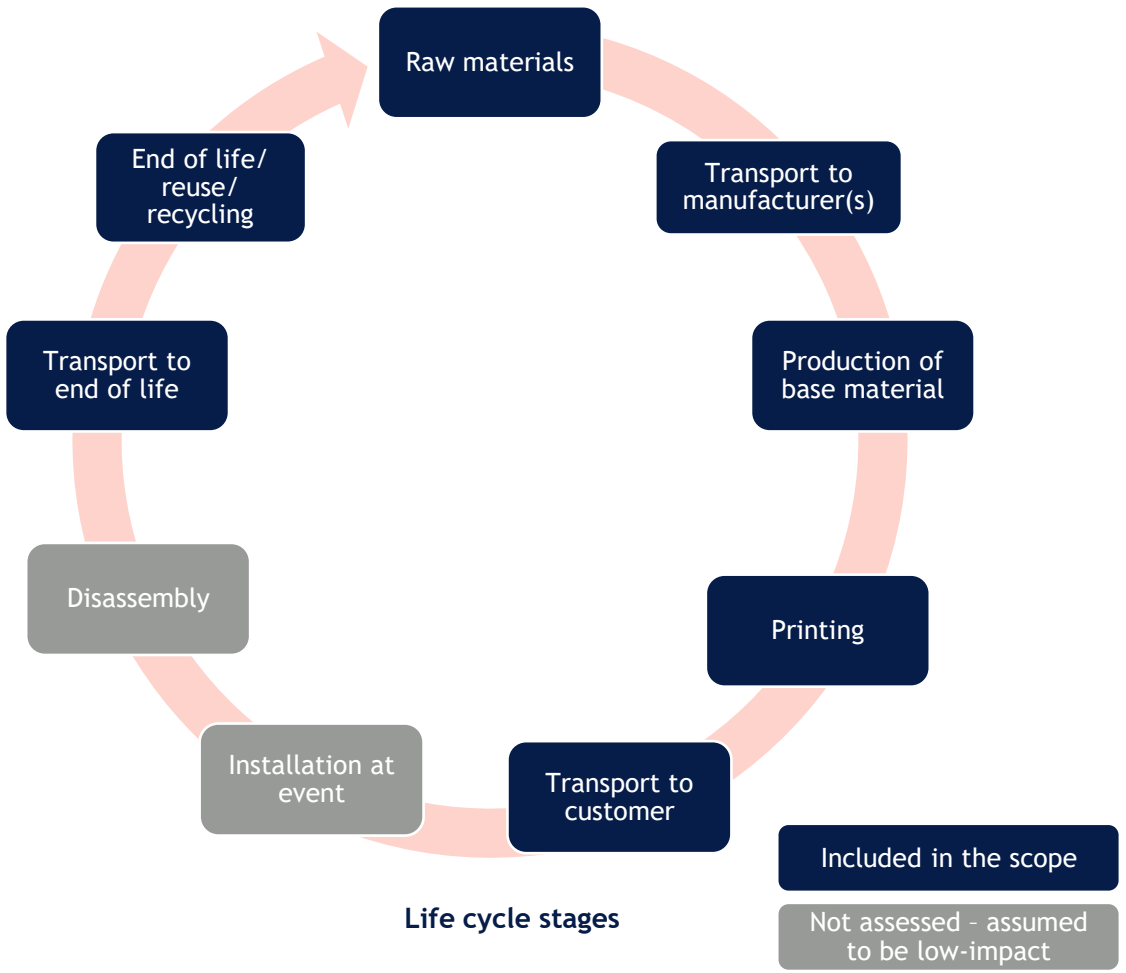
Quantification of life-cycle impacts has been carried out comparing the environmental impact of different material options from the point of raw material extraction to end of life disposal. For ease of comparison outputs are provided **per square metre** of material.

The following environmental indicators were used in the assessment:

- Greenhouse gas emissions (assessed as carbon dioxide equivalent emissions)
- Water usage (cubic metres)
- Materials circularity potential (Ellen MacArthur Material Circularity Indicator)

Key sources of data were:

- Supplier technical data and Life Cycle Assessment (LCA) studies
- Findings from Ocean Race report and Innovation Workshop (May 2020)
- Existing Anthesis data and research
- Third party databases – e.g. Ecoinvent



Life cycle stages

APPROACH TO THE LIFECYCLE ASSESSMENT

Key assumptions

Since the individual circumstances will differ from case to case, a number of key assumptions have been made to calculate some average impacts per product type. These are summarised here:

- **Transport** is modelled based on an **average,** equivalent to ocean & road shipping route from Taipei to Paris, applied per tonne of material shipped. Therefore if your product is heavier it will have a higher transport impact. Further notes on comparative transport options may be found here.
- **End of life** is assumed to be landfill in all cases.
- **Number of uses** is assumed to be one – it's understood that in many cases, branding assets are reused, but it was not possible to derive an average lifetime or number of uses.
- **Printing** is modelled as solvent printing. Comparative impact of printing options are discussed here.

FURTHER SUSTAINABILITY CONSIDERATIONS

This report uses carbon and water as the main indicators for the assessment of environmental impacts.

However, there are other sustainability impacts which should be considered in procurement decisions, as they may be significant for some of the products or materials in this report.

Biodiversity and land-use

Biodiversity has become a major topic in sustainability over the past few years. Biodiversity and land-use are particularly important for natural materials (e.g. wood or natural fibres) as the types of cultivation or forestry can have a significant impact on biodiversity, particular where monoculture is used. Biodiversity can also be affected by mining and oil extraction, both of which supply raw materials to most signage and overlay products.

Human health impacts

Specific human health risks may arise from substances or chemicals generated during material processing, or from materials and additives themselves. While product stewardship legislation such as REACH in the EU aim to reduce known human health risks of chemicals, this field is relatively nascent and a large number of suspected substances of concern are still used regularly. Eliminating these substances and managing exposure risks are key considerations.

Air and water pollution

Air and water pollution affect ecosystems, as well as having health impacts on flora, fauna, and communities. The majority of air pollution (e.g. PM2.5, NO_x, SO_x) and water pollution (e.g. pH, dissolved oxygen, nitrogen) are generated from power sources and manufacturing processes. Air and water pollution can have significant local impacts, as well as spreading across regions.

Labour impacts

Labour concerns have become a major issue over the past 30 years, especially as supply chains have become more complex. This has been highlighted in the textile industries, but is an area of concern for most agricultural, material extraction, and manufacturing industries. Some of these aspects are partially addressed through Modern Slavery legislation, although this is only one part of a wider issue.

PRODUCT TYPES IN STUDY

SUMMARY

- Products have been categorised as per the table.
- Each product grouping contains 3-4 individual products or materials which have undergone environmental assessment.
    - In each case, at least one **industry standard product** type has been included.
    - The other products studied are alternative materials or products which are usually **marketed as sustainable alternatives**.
- A full summary of these materials and categories is provided on the next page.

Table includes hyperlinks to each product section

Type	Format	Product
Signage boards	Signage boards (hardboards)	Fluted plastic boards
		Foamboards
		Wood & fibre boards
		Transparent boards
		Durable signage boards
Flexible graphics	Banners	PVC banners
		Non-PVC banners
	Graphic textiles	Graphic textiles
Structures	Structural materials	Structural materials
Flooring	Flooring	Flooring
Self-adhesive decals and films	Self-adhesive decals and films	Standard decals
		Specialist decals

PRODUCTS & MATERIALS COVERED BY THE STUDY

Type	Format	Product	Description & application examples	Materials covered	Common industry names
Signage boards	Signage boards (hardboards)	Fluted plastic boards	Fluted / corrugated plastic boards for wayfinding, advertising hoarding, etc.	Polypropylene (PP), recycled polyproplyene Polypropylene with biobased filler	Akyprint, Corex, Corflute
		Foamboards	Alternative to fluted boards, similar applications	PVC foam PP foam Cardboard	Foamex, DISPA, Re-board
		Wood & fibre boards	Used for particular outdoor applications. Often hand-painted for high-quality graphics. *Ex. golf distance markers.*	Plywood Bamboo Fibreboard composite (agriwaste)	
		Transparent boards	High quality transparent sheets, *Ex. end-of-match media boards*	Acrylic (PMMA) Laminated safety glass	Acrylic, Perspex, Plexiglas, Lucite
		Durable signage boards	Long-term wayfinding signage, especially for strong outdoor conditions *Ex. signpost totems or traffic-like signage*	Aluminium composite Aluminium Plastic composite	Dibond, Raybond, Dilite, ACM
Flexible graphics	Banners	PVC banners	Multipurpose – section covers 4 different banner types (standard, blockout, mesh, flexible graphics)	PVC coating on PET textile	PVC banner
		Non-PVC banners	Multipurpose – section covers 4 different banner types (standard, blockout, mesh, flexible graphics) using PVC alternative materials	Polyolefin or polyacrylic acid coating on PET or PP textiles	PVC-free banners
	Graphic textiles	Graphic textiles	Printed fabrics *Ex. flags, drapes, table skirts, etc.*	PET, recycled PET Hemp	Polyester
Structures	Structural materials	Structural materials	Supports used to hold signage, basis for exhibition stands, etc.	Steel, aluminium, timber, plastic composite	
Flooring	Flooring	Flooring	Different flooring types including carpet, floor tiles, and paper covering	PP carpet PP tiles Paper floor	
Self-adhesive decals and films	Self-adhesive decals and films	Standard decals	General purpose decals, including indoor and outdoor variants.	PVC Polyolefin Paper Textile	SAV, vinyl, Phototex
		Specialist decals	Decals for specific applications – mirrored film, blockout, flooring (all-in-one decal, 2-part flooring system)	PVC, PVC with filler Metallised BOPET film	

CLIMATE CHANGE, WATER & TOXICITY ASSESSMENT

Each product is assigned an assessment indicator, based on the environmental impacts.
Product scores have been calculated according to their groupings. Hardboards and structural materials are in separate groups as they are heavier.

Climate Change

- Global warming potential
- Measured in CO_2e, carbon dioxide equivalent
- Calculated based on impact factors for different materials and processes
- Making product production and use less carbon-intensive

Lower impact – in the lowest decile.

Medium-low impact - in the lowest 40%

Medium-high impact - in the lowest 70%

High impact – in the top 30%

Water

- Water depletion
- Measured in m^3
- Calculated based on impact factors for different materials and processes
- Making product production less water-intensive.

Lower consumption – in the lowest decile.

Medium-low consumption - in the lowest 20%

Medium-high consumption - in the lowest 70%

High consumption – in the top 30%

Toxicity

- Calculated based on factors for freshwater and marine ecotoxicity
- This describes the potential for chemicals in the material supply chain or end of life to have toxic effects.

"Red flag" assigned where a product scores in the top 20% of its group for marine or freshwater toxicity. **This does not necessarily infer it is a toxic product, just that there is a higher risk of toxicity in its manufacture.**

RECYCLABILITY, CIRCULARITY & END-OF-LIFE ASSESSMENT

Each product is assigned an overall circularity & end-of-life assessment indicator, based on the recyclability, potential circularity, and ease of enabling circular practices for the product.

Recyclability

Recyclability is assessed based on whether the material or product is easy to recycle, and how widespread material recycling is globally. The assessment is based on material-to-material recycling, rather than downcycling.

- Material recycled in most regions worldwide.
- Material can be recycled in many regions but not all.
- Limited material recycling – typically materials require specialist processors, and recycling capacity is limited geographically.
- Little to no recycling. May include materials only recycled on pilot scale, or in only one or two locations globally.

Circularity

Circularity indicators used in this project use the methodology outlined in Ellen MacArthur Foundation's Circularity Indicators Project.

The indicators give a value between **0.00** and **1.00**, based on variables including:

- Use of recycled or reused material as material in production
- Proportion of product reused
- Proportion of the product recycled at end-of-life
- Efficiency of recycling process

For each product grouping, we use circularity metrics for two scenarios:

Typical circularity: based on typical end-of-life outcomes

Optimal circularity: best case scenario, assuming ideal conditions (e.g. reuse is possible, suitable offtake partners available)

Overall circularity & end-of-life assessment

The end-of-life assessment is based on both the recyclability assessment and circularity metrics.

This also considers the ease of implementing pro-circularity practice and potential barriers, e.g. recycling capacity only available in a different geographical region.

- Material or product is readily recycled in standard material collections or designed for reuse
- Reuse and/or recycling achievable with some small changes to practice.
- Reuse and/or recycling are achievable, but there may be some challenges (e.g. securing offtake partners in a different region).
- No reuse or recycling potential at end-of-life, or potential challenges in securing end-of-life partnerships

END-OF-LIFE ASSESSMENT GUIDANCE

In the following sections, each product grouping will contain end-of-life guidance cards with circularity and recycling information to help users identify the best ways of handling these products at end-of-life.

Overall circularity and end-of-life indicator

Red/Orange/Yellow/Green indicator flagging potential issues with printing and end-of-life

Material circularity indicator (MCI): score of 0.00 to 1.00

Aluminium composite material

ACM materials can be used for several years - these are commonly used for permanent traffic signage.

Recyclability: while manufacturers claim that ACM is 100% recyclable, it requires specialist recycling equipment, and ACM recyclers are not present in all regions.

Information on material recyclability

Information on printing considerations

Graphic considerations		None
Typical circularity	0.35	ACM landfilled or incinerated at end of life
Optimal circularity	0.69	ACM signage reused long-term, then sent to an ACM recycler at end-of-life
Reuse		Boards are durable and reused many times, particularly if temporary graphics (e.g decals) used
Repurposing		After removing graphics, boards could be repurposed for use by other organisations, e.g. exhibitions
Recycling		ACM recyclers are much less common than aluminium sheet recyclers, and largely operate in Europe
Downcycling		None

Typical circularity outcome: circularity score and description of a typical end-of-life scenario for the material

Optimal circularity outcome: circularity score and description for optimal usage and end-of-life treatment of the material

Details of potential reuse and recycling routes and barriers for the product or material

A

Comparison of environmental impacts across formats

A1

Guide to branding, signage and overlay materials

Anthesis

DESCRIPTION OF COMMON BRANDING, SIGNAGE & OVERLAY MATERIALS (PART 1 OF 3)

Branding, signage and overlay covers a diverse range of products and materials. Industry terminology for different products can refer to trade names, material types, or product types – this can cause confusion in the types of materials that these different products contain.

The tables on this page and the next ones show common industry names for product formats, the materials they are composed of and common considerations for recyclability.

Industry name(s)	Overlay/signage format	Materials used for production	Recyclability	
Akyprint (Corflute, Corex) *Trade name*	Fluted (or bubble structure) plastic sign boards	Polypropylene (PP)		PP is easy to recycle, but many countries (notably the US) lack a developed recycling market for the material as virgin oil-derived prices are usually low.
Foamex (Forex, Foamalite) *Trade name*	Foamboard sign boards	Polyvinyl chloride (PVC)		Some processors take PVC foam, but printed materials are very unlikely to be recycled.
Perspex (Plexiglas, Lucite) *Trade name* **Acrylic sheet** *Generic name*	Transparent sign boards	Polymethyl methacrylate (PMMA)		While not widely recycled, some PMMA sheet manufacturers run takeback programmes and chemically recycle PMMA sheet.
Dibond (Raybond, Dilite, 3A) *Trade name* **Aluminium composite material** *Generic name*	Durable sign boards	Aluminium sheet + Polyethylene (PE)		Frequently claimed to be 100% recyclable, ACM requires specialist machinery to separate aluminium from polymer core. ACM is landfilled in many countries due to a lack of capable processors.

DESCRIPTION OF COMMON BRANDING, SIGNAGE & OVERLAY MATERIALS (PART 2 OF 3)

Industry name(s)	Overlay/signage format	Materials used for production	Recyclability	
Paperboard *Product type*	Sign boards	Paper		Paperboard is generally widely recyclable. Some inks – notably UV-cured ones – may inhibit the recycling process.
Timber *Material name*	Structural materials	Timber (softwood)		Like plywood, timber can be recycled or downcycled in several markets; however, treatments such as varnish and paint can make it hard to recycle.
Plywood *Material name*	Wood and fibre based boards	Wood veneers and resin		Plywood can be recycled or downcycled in several markets. However, treatments such as varnish and paint can make it hard to recycle, and plywood is often used for fuel rather than material.
Fibreboard *Material name*	Wood and fibre based boards	Wood fibre and resin		Fibreboard is not readily recyclable due to the short fibre lengths in the material and the binding resin. While there are a few recyclers who process fibreboard, most fibreboard will be landfilled or used as a fuel.
Aluminium *Material name*	Durable sign boards Structural materials	Aluminium		Standalone aluminium products are generally easy to recycle, with many remelters able to process surface finishes without difficulty. Aluminium is readily recycled worldwide.
Steel *Material name*	Structural materials	Steel		Steel and steel products are some of the most widely recycled in the world, with almost all grades of steel suitable for use as scrap.

DESCRIPTION OF COMMON BRANDING, SIGNAGE & OVERLAY MATERIALS (PART 3 OF 3)

Industry name(s)	Overlay/signage format	Key materials used in production			Recyclability	
PVC banner *Product type*	Banners	Polyvinyl chloride (PVC)		Polyethylene terephthalate (PET) textile		All banners are hard to recycle due to their multi-material construction. Of the handful of processors, most downcycle them, with very few doing true plastic-to-plastic recycling
PVC-free banner *Product type*	Banners	* Polyolefin (PO) * Polyurethane (PU) * Polyacrylic acid (PAA) * Ethyl vinyl acetate (EVA)	+	* Polyethylene terephthalate (PET) textile * Polypropylene (PP) textile		
Polyester textiles *Generic name*	Graphic textiles	Polyethylene terephthalate (PET) textile				Most textile recycling is downcycling: very few fibre-to-fibre recyclers exist. There are several promising pilot phase technologies in this space which can separate fibres and dyes.
Carpet *Product type*	Flooring	* Polypropylene (PP) * Polyamide (PA, nylon)	+	Synthetic rubber (SBR)		Carpet is usually hard to recycle. The majority of carpet recycling is downcycling, although a few manufacturers offer takeback and recycling options.
Vinyl (self-adhesive vinyl, decals) *Product type*	Self-adhesive decals and films	* Polyvinyl chloride (PVC) * Polyethylene (PE) * Polyolefin (PO) * Polyethylene terephthalate (PET)	+	Adhesive (usually MMA acrylic) + Silicone-coated paper liner		Decals are not recycled due to the high adhesive-to-film ratio and inks.
PhotoTex *Trade name*	Self-adhesive decals and films	Polyethylene terephthalate (PET) textile	+	Polymer coating (various)		Similar product to banners and have similar issues when it comes to recycling.

* Single product will contain one of these materials

A2 Summary of environmental impact analysis results

Anthesis

RED FLAG SUMMARY OF SIGNAGE & OVERLAY ELEMENTS (PART 1 OF 3)

The environmental impact indicators **assume single-use of products/materials** - see detailed results for information on multiple use

Signage / overlay element		Climate change	Water footprint	Toxicity	Recyclability	Circularity & end-of-life assessment
Hardboard signs		Rows in grey are considered to be the industry standard in their class				
Plastic fluted boards	PP board (Akyprint-type)	🟡	🟡		🟡	🟡
	Recycled PP board	🟢	🟡		🟡	🟢
	PP board with seaweed-based filler §	🟢 §	🔴 §	◇ §	🟡	🟡
Foamboards	PVC foamboard (Foamex-type)	🟡	🟡		🔴	🔴
	PP foamboard	🟡	🟡		🟠	🟠
	Paper-based board (DISPA-type)	🟢	🟢		🟢	🟢
Wood and fibre-based boards	Plywood board	🟢	Data unavailable		🟠	🟠
	Bamboo board §	🟢 §	Data unavailable		🟠	🟠
	Fibreboard made from agricultural waste §	🟢 §	🟡 §		🔴	🟢
Transparent boards	PMMA sheet (Perspex-type)	🟠	🟠	◇	🟠	🟡
	Recycled PMMA sheet	🟡	🟠	◇	🟠	🟢
	Laminated safety glass	🟠	Data unavailable		🟠	🟡
Durable signage boards	Aluminium composite board (Dibond-type)	🟠	🟡	◇	🟠	🟡
	Aluminium sheet	🔴	🟠	◇	🟢	🟢
	Recycled plastic composite board	🟡	🟡		🟡	🟢

§ We recommend that additional environmental information is obtained for these products prior due to variability in material sourcing or manufacturing processes

RED FLAG SUMMARY OF SIGNAGE & OVERLAY ELEMENTS (PART 2 OF 3)

The environmental impact indicators **assume single-use of products/materials** - see detailed results for information on multiple use

Signage / overlay element		Climate change	Water footprint	Toxicity	Recyclability	Circularity & end-of-life assessment
Flexible graphics				Rows in grey are considered to be the industry standard in their class		
PVC banners	Standard banner	●	●		●	●
	Blockout / building wrap banner	●	●		●	●
	Mesh banner	●	●		●	●
	Coated textile graphic banner	●	●		●	●
Non-PVC banners	Standard banner	●	●		●	●
	Blockout / building wrap banner	●	Data unavailable	◇	●	●
	Mesh banner	●	●	◇	●	●
	Coated textile graphic banner	●	●		●	●
Graphic textiles	PET textile (polyester)	●	●		●	●
	Recycled PET textile	●	●		●	●
	Hemp fabric §	● §	● §		●	●
Structural materials						
Structural materials	Steel	●	Data unavailable	◇	●	●
	Aluminium	●	●	◇	●	●
	Timber §	● §	● §		●	●
	Recycled plastic composite	●	●		●	●

§ We recommend that additional environmental information is obtained for these products prior due to variability in material sourcing or manufacturing processes

RED FLAG SUMMARY OF SIGNAGE & OVERLAY ELEMENTS (PART 3 OF 3)

The environmental impact indicators **assume single-use of products/materials** – see detailed results for information on multiple use

Signage / overlay element		Climate change	Water footprint	Toxicity	Recyclability	Circularity & end-of-life assessment
Flooring				Rows in grey are considered to be the industry standard in their class		
Floor coverings	PP carpet	🟡	🟡		🔴	🟠
	Paper-based floor covering §	🟡 §	🟡 §	◇ §	🟢	🟢
Functional flooring	Recycled PP tile system	🔴	🔴		🟡	🟢
Decals						
Standard decals	PVC decals	🟡	🟡		🔴	🔴
	PVC-free decals	🟢	🟡		🔴	🔴
	Paper decals	🟢	🟡		🔴	🔴
	Textile decals (PhotoTex type)	🟡	🟡		🔴	🔴
Specialist decals	Blockout decals	🟡	🟡		🔴	🔴
	Mirror films	🟢	🟢	◇	🔴	🔴
	All-in-one floor decals	🟠	🟡	◇	🔴	🔴
	Two-part floor graphic system	🟠	🟡	◇	🔴	🔴

§ We recommend that additional environmental information is obtained for these products prior due to variability in material sourcing or manufacturing processes

KEY OBSERVATIONS – GENERAL PRINCIPLES

Material weight

- Overall environmental impact is heavily dependent on weight of product
- **In general, the lighter the product, the lower the environmental impact.**
- For **single-use elements**, product weight should be minimised and care should be taken to avoid overspeccing the material or product.
- For **longer lasting products**, there are tradeoffs between the impact of the material and durability.
  - For example, **recycled polypropylene (PP) floor tiles** have a much higher impact than **single-use PP carpet** due to their weight; however, they are designed to be used for 10+ years, which spreads the impact over a longer timeframe

Using circularity to reduce footprint

- **Extending the lifetime** of products is the most effective way to reduce the lifecycle impact of the material. **Single-use products should be eliminated** wherever possible.
- **Using products with recycled content** can also significantly reduce the raw material impact, especially for single-use products.
- End-of-life management of material can be difficult to navigate, especially if end-of-life solutions need to be found under time pressure. **End-of-life planning needs to be considered as early as possible (ideally during conception or design).**
- In most cases reviewed, **transport** and **end-of-life** stages have a lower contribution to the overall lifecycle impacts than **raw materials' extraction** and **manufacturing** stages.

Managing plastics

- Plastics have become a hot topic in consumer-facing products over the last two years, with several sectors making a push to reduce or eliminate plastics use.
- Despite being manufactured from fossil resources, plastics often have a better overall environmental impact than other materials, partially due to their **light weight and functionality.**
- **End-of-life management of plastics remains a huge issue, with a lack of recycling capacity globally** to address the volume of plastic waste produced.
- Understanding the different materials and end-of-life options available is key to managing plastics more effectively and reducing reliance on landfill and incineration. **This report provides detailed guidance on end-of-life options for the main types of plastic materials.**

KEY OBSERVATIONS – MATERIAL-SPECIFIC INSIGHTS

Metals

- Metals are coming back into popularity, partially due to their recyclability at end-of-life.
- Due to their durability and large manufacturing footprint, it is recommended that metals are only used in multi-use applications.
- Most steel and aluminium products include some recycled content, which lowers their footprint. However, recycled content often varies depending on the manufacturing source as well as other factors (such as market prices of metal ores), and **very few metal products are sold with indications of their recycled content**.
- We recommend that further environmental data, either **EPDs* or LCA** studies**, are obtained for specific metal products due to the variability in manufacturing impact.
- **Aluminium composite material** requires specialist recycling equipment and may not be processed by many metal scrap operators.

Timber

- **Structural timber has a much higher CO_2 footprint than expected**, predominantly due to the **emissions from kiln-drying**. This may vary significantly with different kiln drying technologies.
- We recommend that **product-specific LCAs**** are obtained if using timber products as there is significant variability is processing impact, as well as material sourcing. Additionally, it is recommended that timber is sourced from **sustainably managed forests, backed by certification**.
- We have not taken carbon sequestration into account here as the lifetime of the product is not guaranteed.
- **Avoiding incineration and landfill** are recommended to achieve full carbon benefits. Timber is durable and may be reused or repurposed in many different ways.

PVC vs non-PVC alternatives

- From a **climate and water perspective**, PVC and non-PVC materials tend to have **similar impacts**
- However, **moving away from PVC does have environmental benefits** which are not reflected in the results including **reduced human health risks from PVC additives.**
- **Banners** are one of the main areas for PVC usage. These are **challenging to recycle due to their multimaterial construction** (usually PVC coating a PET textile layer). **Non-PVC banners face the same recycling challenges** as these tend to have the same construction with just the PVC replaced.
- Although incineration is not a recommended end-of-life route, **incineration of non-PVC banners is safer than incineration of PVC banners.**

* EPD: Environmental Product Declaration
**LCA: Life Cycle Assessment

KEY OBSERVATIONS – INNOVATIVE & BIO-BASED MATERIALS

Innovative product	Analysis	Recommendations
Polypropylene board with seaweed-based filler	Production of seaweed derivative may have significant water footprint, while the carbon impact does not differ greatly from a recycled PP board.	Obtain further environmental information from suppliers if considering using this product as impact may change depending on processes used.
Bamboo board	Bamboo has a slightly higher impact than standard plywood; however, this will depend heavily on the bamboo source	Like all wood-based products, bamboo's impact may vary, and obtaining further environmental data on specific products is recommended to aid decision making.
Fibreboard from agricultural waste	Waste-based fibreboard has a much lower material and manufacturing impact than products based on virgin materials; however, products need to be used long-term to maximise carbon sequestration benefits.	Impact may vary with processes used for compacting board and for different resin types – this should be confirmed with the supplier. Reuse is recommended, and landfill and incineration should be avoided if possible.
Non-PVC banners	Non-PVC banners have similar carbon and water impacts as PVC, but pose fewer human health risks. Even for non-PVC banners, true recycling remains uncommon.	While using non-PVC alternatives may not have a huge impact on carbon footprint reduction, continuing a shift away from PVC is recommended. Recyclability claims should be challenged.
Hemp fabric textiles	Hemp fabric may have a higher environmental impact than recycled PET textile due to its weight and processing of the material.	Obtain further environmental information from suppliers as impact of hemp may vary depending on crop growth and processing.
Paper-based floor covering	Paper-based flooring may have significant advantages over carpet, especially for single-use.	Obtain further environmental information from suppliers – different flame retardant additives may have different impacts.

Biobased alternative materials

- **Biobased materials can be environmentally beneficial, but impacts need to be weighed up**. For biomaterials made from **purpose-grown crops**, other aspects such as **land-use** and **biodiversity** need to be reviewed.
- Materials from **bio-wastes** or **recycled biomass (e.g. paper)** can have **significantly lower impacts**
- **Water footprint** can be significant for crop growth. This becomes more critical in water-stressed areas.
- Although biomass-based materials may act as a CO_2 sink, we have not included this in the footprint as the end-of-life of the product is not guaranteed. Incineration of products releases CO_2 while landfilling them may generate significant quantities of methane.
- **We recommend that further data beyond this report is obtained for all biobased products, preferably comprehensive, 3rd-party verified LCA.**

B Signage boards

- B1 Fluted plastic boards
- B2 Foamboards
- B3 Wood & fibre-based boards
- B4 Transparent boards
- B5 Durable signage boards

B

SIGNAGE BOARDS OVERVIEW

There is a diverse range of different signage board types designed for different applications and use cases (indoor, outdoor, longevity etc.)

While plastic-based signage boards are the most widely used, there are a huge number of options which are marketed as sustainable, including recycled content and bio-based materials.

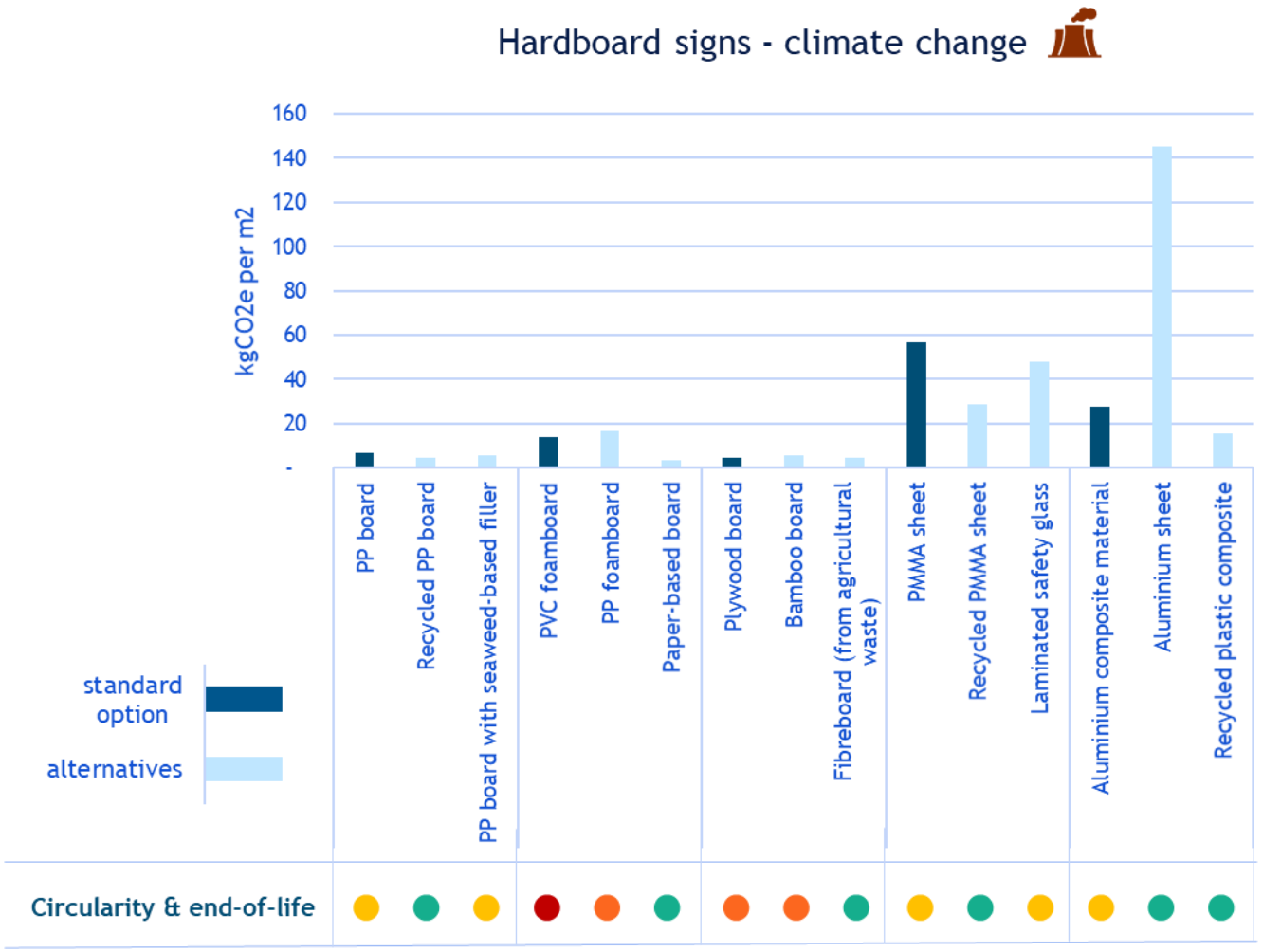
Section number	Signage format	Products included in study	Common industry names
B1	Plastic fluted hardboards	PP board	Akyprint, Corex, Corflute
		Recycled PP board	
		PP board with seaweed-derived filler material	Algoboard
B2	Foamboards	PVC foamboard	Foamex, Forex
		PP foamboard	Polyline
		Paper-based board	DISPA, Re-board, Dufaylite
B3	Wood & fibre based boards	Plywood board	
		Bamboo board	
		Fibreboard made from agricultural waste	
B4	Transparent boards	PMMA sheet	Acrylic, Perspex, Plexiglas, Lucite
		Recycled PMMA sheet	
		Laminated safety glass	
B5	Durable signage boards	Aluminium composite board	Dibond, Dilite, Raybond
		Aluminium sheet	
		Recycled plastic composite board	

B

SIGNAGE BOARDS: IMPACT SUMMARY

There is significant variation in impact between the different product types in the category.

Fluted plastic hardboards and foamboards generally have a lower impact, but typically have a shorter potential lifespan than wood, transparent, and durable boards.



B1 PLASTIC FLUTED HARDBOARDS: OVERVIEW

Fluted plastic boards consist of thin, rigid outer walls sandwiching a corrugated “core” structure, making the board light. There are numerous applications for board signage (such as wayfinding and advertising hoardings) which means its is produced in a large range of sizes and thicknesses.

The industry standard PP hardboard is supplied under the trade names Akyprint®, Corflute®, and Correx® and commonly referred to by these names in industry.

The PP-based board with seaweed-derived filler is available under the material name Algoblend®.

Materials

- **Industry standard plastic hardboards** are made from virgin polypropylene (PP).
- While the majority of board is produced using fossil-fuel based PP, some manufacturers offer boards with recycled PP content.
- Fillers such as calcium carbonate can be added to PP to increase rigidity.
- One innovative supplier uses PP compounded with a seaweed-derived filler material to replace some of the oil-based PP material, and helps to make the product lighter.

End-of-life

- Polypropylene signage can be recycled at PP recycling facilities.
- PP recycling is fairly widespread, although it is not established in all developed markets (for example, only a handful of PP recyclers operate in the US).
- Some PP fluted board manufacturers offer takeback services directly.
- When securing recycling partnerships, check with the recycler that the signage materials are compatible.
  - Filler materials can present problems for PP recycling as they affect the material’s density.
  - Some coatings, adhesives, optical brighteners and inks can also adversely affect recycling.
- The Association of Plastic Recyclers has developed a design guide which covers PP. The guidance, while aimed at packaging, is also applicable to some signage types.

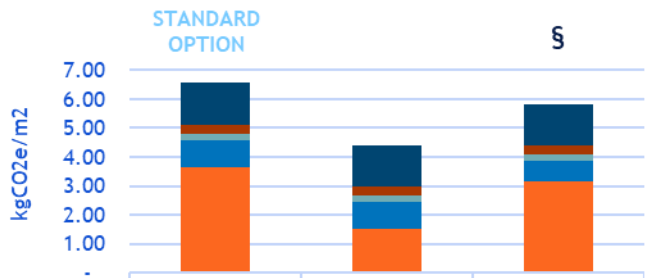
B1 PLASTIC FLUTED HARDBOARDS: ENVIRONMENTAL IMPACT

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	Fluted PP board, 100 % virgin plastic	●	●	-	●	●
Alternative	Fluted PP board, 100 % recycled plastic	●	●	-	●	●
Alternative	Fluted PP board, virgin plastic with seaweed-derived filler §	● §	● §	◇ §	●	●

Key factors:

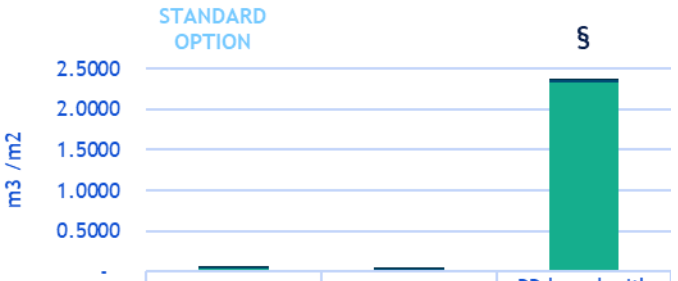
- Using recycled PP board likely has a lower impact than virgin material.
- Per m^2 impacts for climate change do not differ greatly between options studied.
- Impact of materials & manufacturing is more important than end of life.
- Similar profile for water impact, although much higher for the board with seaweed derived material.
- Toxicity flag for the board with seaweed derived material arises from the processing the seaweed, although this may vary depending on the processing conditions used.
- § - we recommend obtaining further data on the PP board with seaweed-based filler as this is an innovative material and processing may differ

Plastic hardboards - climate change



	PP board	Recycled PP board	PP board with seaweed-based filler
	Plastic hardboards		
End of life	1.43	1.43	1.43
Transport	0.32	0.32	0.32
Printing	0.22	0.22	0.22
Manufacturing	0.91	0.91	0.71
Raw materials	3.66	1.52	3.14

Plastic Hardboards - water consumption



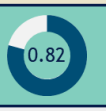
	PP board	Recycled PP board	PP board with seaweed-based filler
	Plastic hardboards		
End of life	0.0012	0.0012	0.0012
Transport	0.0003	0.0003	0.0003
Printing	0.0001	0.0001	0.0001
Manufacturing	0.0291	0.0291	0.0226
Raw materials	0.0293	0.0067	2.3300

B1 PLASTIC FLUTED HARDBOARDS: CIRCULARITY & END-OF-LIFE

All PP-based fluted & bubble hardboards

Fluted plastic board will usually be accepted by polypropylene recyclers, although these are not present in every region globally, and incineration or landfill are common end-of-life routes. Some PP board suppliers offer takeback and recycling programmes.

Recyclability: most PP recycling is plastic-to-plastic, although PP can be used in alternative applications such as road asphalt plasticiser.

Graphic considerations		Some direct printing inks and strong adhesives can be problematic for material recycling
Typical circularity		Limited recycling, significant proportion sent for incineration or landfill
Optimal circularity		100 % recycled content product, product sent to PP material recycler at end-of-life
Reuse		Some reuse can be planned, depending on purpose and printing.
Repurposing		Limited repurposing opportunities, e.g. use as a packaging material, or using a decal to cover print.
Recycling		PP plastic-to-plastic recycling is fairly well established in many regions.
Downcycling		Some recyclers will use PP outputs for other applications, e.g. asphalt or cement additives.

Plastic fluted hardboards	Circularity & end-of-life assessment
PP hardboard, 100 % virgin	
PP hardboard, 100 % recycled content	
PP hardboard, virgin PP with seaweed-derived filler	

B1 PLASTIC FLUTED HARDBOARDS: CASE STUDIES

Corex signage recycling programme

Australian based firm Corex, provides within its range some products that incorporate recycled content and offers clients access to its recycling scheme.

Two products incorporating recycled content are offered, ‘Encore’ a twin wall flute-board and ‘Rebound’, a solid polypropylene sheet. The company states that both these products have 100% recycled content generated from manufacturing offcuts and packaging and signage returned by clients after use.

Corex Recycling manages the recycling process at its Melbourne based plastic facility. Materials are checked for contamination and shredded before being melted, filtered, extruded and pelletised ready to be turned into new signage.

Further details on the enviro-range products are available here and further details of the recycling process are available here.

Vanden Recycling of plastic signage

Vanden Recycling is a plastic trader which buys and sells secondary plastic across the world. As part of its operations it has a specialist plastic recycling site in Peterborough UK.

The facility accepts a wide range of plastic packaging and products for recycling including Corex signage. The plastics are reground at the site and sold to manufacturers to be made into new products.

The company has created a number of videos for its YouTube channel that demonstrate the recycling process at its UK site and further details about the company are provided on its website.

Other European companies such as Kaysersberg also offer PP sign recycling.

B2 FOAMBOARDS: OVERVIEW

Plastic foamboard signs are rigid plastic boards made from compressed closed-cell foam, usually PVC. Despite being foam-based, these boards are more rigid than fluted plastic boards and usually heavier per unit.

The industry standard PVC foamboard is supplied under tradenames such as Foamex® and Forex® and referred to by these names, or as “PVC foamboard” or “PVC board”.

A paper (cardboard) alternative has been included in the analysis as a non-plastic comparison. This is available under trade names such as DISPA® and Re-board®. Other manufacturers include Dufaylite and Oppboga.

Materials

- PVC foamboard is the **industry standard** foamboard material. Impacts of PVC are covered previously.
- Non-PVC alternatives are becoming more common, with PP foamboards now offered by some manufacturers.
- Paper-based board alternatives are also becoming more popular in some applications (especially indoors), although these are typically lighter weight than plastic foams.

End-of-life: PVC foamboard

- There are very few recyclers for PVC foamboard – most focus on clean production scrap or offcuts, rather than printed signage.
- In practice, most foamboard will be sent to landfill or incinerated.
- PVC foamboard is a cheap material to produce, making recycling it unattractive. Additionally, some printing inks will bleed into the PVC which can cause issues for recyclers.

End-of-life: PP foamboard

- Generally, PP foamboard should be accepted by many PP recyclers.
- PP recycling is fairly widespread, although it is not established in all developed markets (for example, only a handful of PP recyclers operate in the US).
- When securing recycling partnerships, check that the printing inks used are compatible with the recycling process.

End-of-life: paper-based board

- Paper recycling is one of the most widely established recycling industries globally, and paper-based signage should be accepted in most regions.
- While most inks can be removed in the process by deinking, UV-cured inks have been shown to be problematic for some recycling processes.

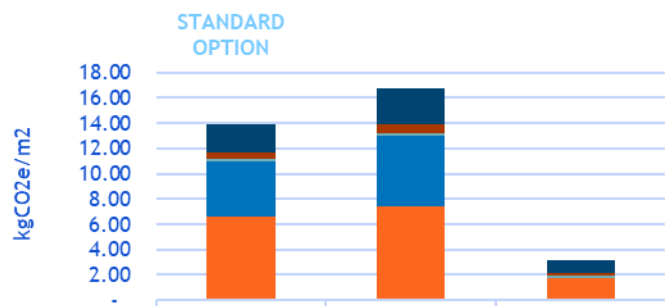
B2 FOAMBOARDS: ENVIRONMENTAL IMPACT

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	PVC foamboard, 100 % virgin plastic	●	●	–	●	●
Alternative	PP foamboard, 100 % virgin plastic	●	●	–	●	●
Alternative	Paper-based board, recycled content in paper core material	●	●	–	●	●

Key factors

- PP foamboard has a slightly higher impact.
- Foaming / blowing agents are a significant contributor to the climate change impact.
- Paperboard has much lower impact due to its lighter weight and recycled content.
- PVC and foaming / blowing agents have higher freshwater, marine, and human toxicity scores.
- Additional impacts of PVC need to be considered. Incineration of PVC at end-of-life is not recommended.

Foamboards - climate change



	PVC foamboard	PP foamboard	Paper-based board
	Foamboards		
End of life	2.24	2.91	0.97
Transport	0.50	0.65	0.22
Printing	0.22	0.22	0.22
Manufacturing	4.31	5.60	-
Raw materials	6.62	7.41	1.70

Foamboards - water

	PVC foamboard	PP foamboard	Paper-based board
	Foamboards		
End of life	0.0019	0.0025	0.0008
Transport	0.0005	0.0006	0.0002
Printing	0.0001	0.0001	0.0001
Manufacturing	0.1355	0.1761	-
Raw materials	0.0893	0.0617	0.0394

B2 FOAMBOARDS: CIRCULARITY AND END-OF-LIFE

PVC foamboard

PVC foamboard will usually be sent to landfill or incineration as few recyclers will accept it

Recyclability: unprinted PVC foamboard is recyclable, but most printed PVC foamboards will be rejected by recyclers

Graphic considerations		As PVC foamboard is not recycled in practice, printing ink considerations are less important
Typical circularity	0.11	Landfill / incineration
Optimal circularity	0.33	Boards in good shape are reused, with the remainder landfilled or incinerated
Reuse		PVC foamboard is durable and can be reused multiple times
Repurposing		Foamboard is versatile and could be repurposed informally (e.g. used as packing material)
Recycling		Very few PVC recyclers will accept printed foamboard
Downcycling		Limited or none

PP foamboard

PP foamboard may be processed by some recyclers, but may also end up in landfill or incineration

Recyclability: PP foamboard should be accepted by PP recyclers, but this should be checked with service providers

Graphic considerations		Some direct printing inks and strong adhesives can be problematic for material recycling
Typical circularity	0.16	Limited recycling, significant proportion sent for incineration or landfill
Optimal circularity	0.37	Boards in good shape are reused with some recycling of boards which cannot be reused
Reuse		Some reuse can be planned, depending on purpose and printing.
Repurposing		Limited repurposing opportunities, e.g. use as a packaging material, or using a decal to cover print.
Recycling		PP plastic-to-plastic recycling is fairly well established in many regions.
Downcycling		Some recyclers will use PP outputs for other applications, e.g. asphalt or cement additives.

Paper based board

Paper-based boards should be readily collected and recycled in most territories

Recyclability: paper-based boards should be reprocessed back to paper, although some may be burned for energy

Graphic considerations		UV-cured inks may cause issues for some recyclers
Typical circularity	0.59	Most paper board recycled through normal paper waste collections
Optimal circularity	0.69	All paper board recycled through normal paper waste collections
Reuse		Paperboard is typically less durable and suited to reuse than plastic foamboards
Repurposing		Paperboard can be informally repurposed, e.g. used as a packing material
Recycling		Paper-based board will be recyclable in most regions through normal paper collections
Downcycling		None

B3 WOOD & FIBRE BOARDS: OVERVIEW

Rigid boards made from wood or fibre are used in many applications which require durable, high quality signage, particularly outdoors. These can typically be used over a long period of time.

While wood products certified under FSC or PEFC are often specified for signage, furniture, and building products, these materials typically rely on timber harvesting (1, 2). There is a growing segment of products made from agricultural or other waste fibres to replace “new” lumber.

Waste-based fibreboards are made by a few suppliers, including EcoBoard International and ECOR Global.

Materials

- Plywood, rather than solid timber sheets, is the **industry standard** material used due to its versatility and relatively low cost.
- Bamboo-based board are gaining popularity as sustainable alternatives, although the sustainability of bamboo depends on management of bamboo plantations. Construction is similar to plywood, in that they are multilayer products bound by adhesives.
- Fibreboard made from waste fibres can be made by compacting and binding the fibres (e.g. from agricultural or paper waste) with a resin, similar to MDF.

End-of-life

- Generally, wood-based signage is highly durable and can be used for several years. Additionally, wooden boards are versatile and can be repurposed many different ways.
- Engineered wood products such as plywood and MDF can be recycled in some places, but this heavily depends on location.
    - Painted woods or treated woods are generally lower grade and often not processed by wood recyclers.
    - In practice, many wood recyclers will shred woodboard for use as a fuel source
    - In many regions, engineered wood boards will be landfilled. These will generate methane as they break down, significantly increasing their impact.

B3 WOOD & FIBRE BOARDS: ENVIRONMENTAL IMPACT

Key factors

- Energy consumed in the process of manufacturing plywood comes from use of wood products from forestry waste.
- Wood-based boards are durable and can be redeployed long-term which can substantially mitigate the manufacturing impact.
- For virgin wood products, it is recommended that the material is sourced from sustainably managed forests, ideally with certification. Biodiversity and land-use impacts may also be major considerations for these materials.
- Landfill of wood products usually leads to the production of methane which will substantially increase the climate impact.
- § - we recommend obtaining further data on these products as the overall impact can vary depending on material source and production process.

Temporary carbon storage

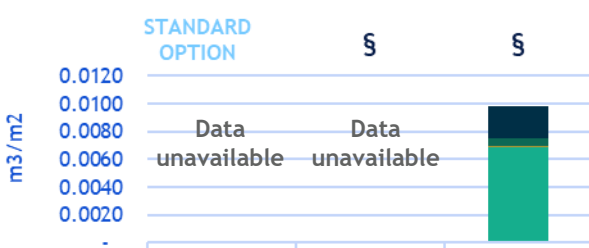
- Straw (used in the innovative alternative waste fibres) and bamboo (a fast-growing crop), and plywood (also fast-growing) absorb CO_2 during the growth period. As long as the product is in use this carbon is stored in the product.
- **This temporarily stored CO_2 is not included in the results here since we cannot guarantee a lifetime for the product.**

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	Plywood	●	Data unavailable	-	●	●
Alternative	Bamboo-based board §	● §	Data unavailable	-	●	●
Alternative	Fibreboard made from agricultural waste §	● §	● §	-	●	●

Wood-based boards - climate change

	Plywood board	Bamboo board	Fibreboard (from agricultural waste)
End of life	-	-	2.69
Transport	-	-	0.60
Printing	0.22	0.22	0.22
Manufacturing	-	-	-
Raw materials	4.11	5.22	0.80

Wood-based - water



	Plywood board	Bamboo board	Fibreboard (from agricultural waste)
End of life	-	-	0.0023
Transport	-	-	0.0006
Printing	0.0001	0.0001	0.0001
Manufacturing	-	-	-
Raw materials	-	-	0.0068

EPD data was used so no water impacts are available

B3 WOOD & FIBRE-BASED BOARDS: CIRCULARITY & END-OF-LIFE

Plywood & bamboo boards

Wood products are durable and can be repurposed easily. These products are often landfilled or burnt at end of life, although some recyclers will take plywood & fibreboard.

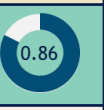
Recyclability: wood recycling is fairly common but generally focusses on lumber rather than engineered wood products. Some of this material could be used to make fibreboard.

Graphic considerations		Paint finishes can create problems for wood recycling
Typical circularity		Landfill / incineration with small proportion recycled
Optimal circularity		Long term re-use of boards
Reuse		Wood products are durable and should be suitable for reuse for several years
Repurposing		Wood-based panels are versatile, and may be repurposed for internal use in many different ways
Recycling		Almost all wood recycling is downcycling to lower grade products or fuel. Some plywood may be recycled into fibreboard.
Downcycling		

Fibreboard from agricultural waste

Wood products are durable and can be repurposed easily. These products are often landfilled or burnt at end of life, although some recyclers will take plywood & fibreboard.

Recyclability: wood recycling is fairly common but generally focusses on lumber rather than engineered wood products. This fibreboard would most likely be used as a fuel.

Graphic considerations		Paint finishes can create problems for wood recycling
Typical circularity		Landfill / incineration with small proportion recycled
Optimal circularity		Long term re-use of boards
Reuse		Wood products are durable and should be suitable for reuse for several years
Repurposing		Wood-based panels are versatile, and may be repurposed for internal use in many different ways
Recycling		Almost all wood recycling is downcycling to lower grade products or fuel. Some plywood may be recycled into fibreboard.
Downcycling		

B4 TRANSPARENT BOARDS: OVERVIEW

Transparent, high quality boards are sometimes used for long-term signage, or niche applications such as mediaboards. These boards are constructed from rigid plastic sheet, and therefore are much heavier and require more material than may other forms of signage. This also makes these boards suitable for long term use.

The industry standard PMMA sheet is supplied under tradenames such as Plexiglas®, Perspex®, and Lucite® and commonly referred to by these names in industry, or as the generic name Acrylic*.

Materials

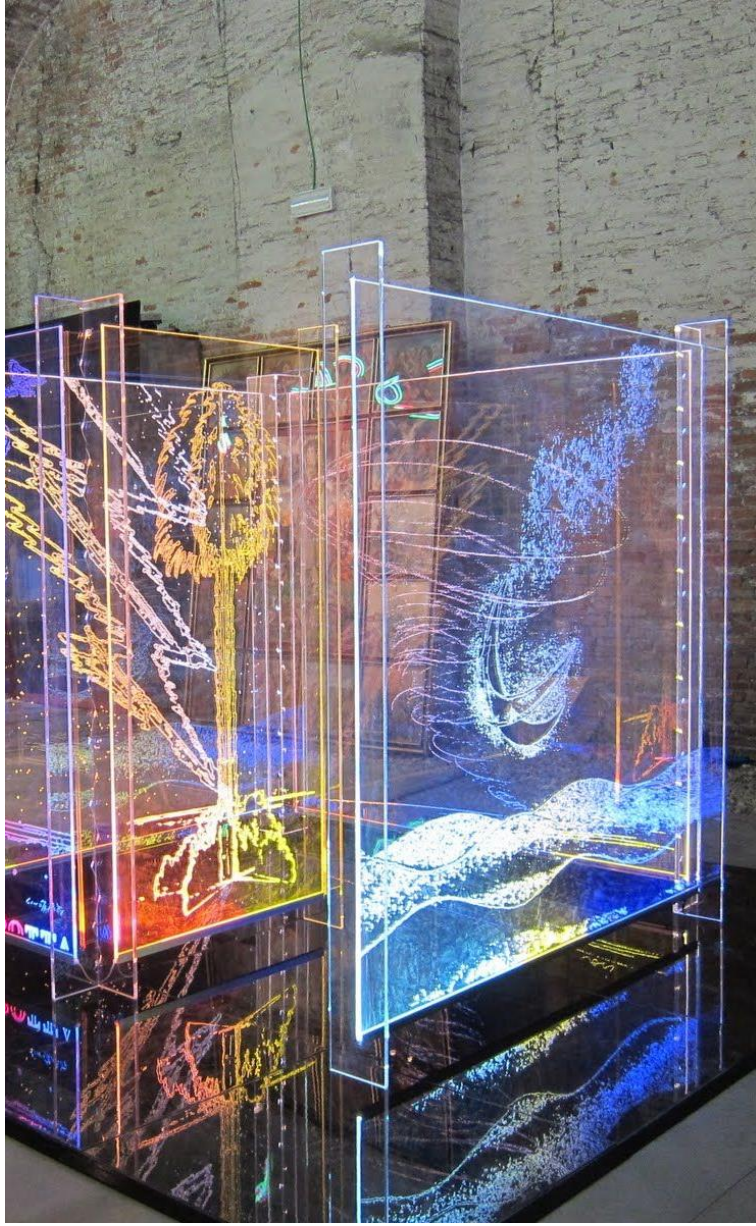
- PMMA is the **industry standard** material of choice for high quality, transparent plastic boards.
- Some manufacturers offer boards made from recycled PMMA (rPMMA) which use both production waste and some post-consumer waste to make new boards.
- Acrylic has largely replaced glass in these applications due to its lighter weight and due to safety considerations. We have included a comparison with laminated safety glass (which contains a PVB plastic interlayer) as an alternative.

End-of-life: PMMA (acrylic sheet)

- PMMA sheeting can be recycled chemically and fed back into the manufacturing process.
- Some manufacturers offer takeback schemes for PMMA sheeting
- PMMA recycling is not established in all regions, and significant quantities still end up in landfill or incineration.
- If possible, decals should be removed before sending sheeting for recycling as these can be problematic for the recycling process.

End-of-life: laminated safety glass

- Glass sheet cannot be recycled in regular glass recycling systems for food and drinks bottles and containers.
- While sheet glass recyclers are present in most regions, landfilling is still common.
- Laminated safety glass is harder to recycle than normal glass sheeting due to the plastic interlayer; however, there are now recyclers who can process the material by separating glass from plastic due to the common use of the material in the automotive industry.



* PMMA acrylic sheeting is a completely different material to acrylic textiles (polyacrylonitrile) and somewhat different to the acrylic resins used for some non-PVC banners (polyacrylic acid)

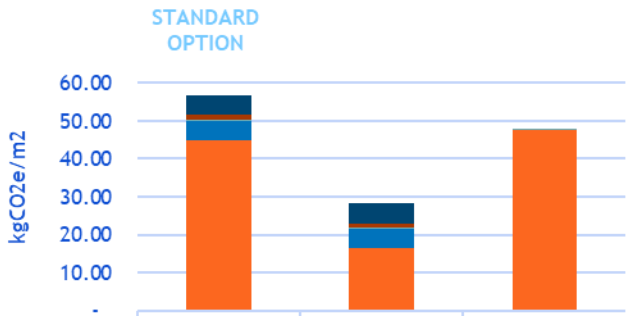
B4 TRANSPARENT BOARDS: ENVIRONMENTAL IMPACT

Key factors

- Using a recycled PMMA alternative could significantly reduce material impacts.
- This would have the same impact for water as well, reducing the relatively high water consumption of PMMA.
- PMMA sheet is durable and should be used long-term to mitigate the high manufacturing impact. This can be facilitated by careful storage to reduce scratching and use of reversible vinyl decals (if decals are required). Note that PMMA is sensitive to many solvents (which may be used for cleaning), whereas glass is resistant to almost all cleaning agents.
- Laminated safety glass may be a viable non-plastic alternative to PMMA. However, LSG has a higher density than PMMA, and will likely be heavier. Additionally, there may be additional safety risks with glass on breakage.

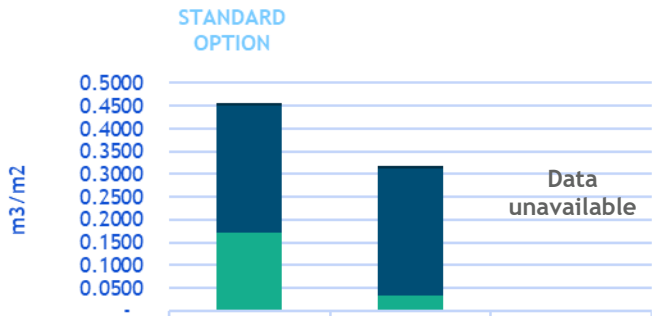
Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	PMMA sheet	●	●	◇	●	●
Alternative	PMMA sheet, 100 % recycled content	●	●	◇	●	●
Alternative	Laminated safety glass	●	Data unavailable	-	●	●

Transparent boards- climate change



	PMMA sheet	Recycled PMMA sheet	Laminated safety glass
End of life	5.34	5.34	-
Transport	1.20	1.20	-
Printing	0.22	0.22	0.22
Manufacturing	5.22	5.22	-
Raw materials	44.92	16.44	47.58

Transparent boards - water



	PMMA sheet	Recycled PMMA sheet	Laminated safety glass
End of life	0.0046	0.0046	-
Transport	0.0012	0.0012	-
Printing	0.0001	0.0001	0.0001
Manufacturing	0.2776	0.2776	-
Raw materials	0.1724	0.0341	-

EPD data was used so no water impacts are available

B4 TRANSPARENT BOARDS: CIRCULARITY & END-OF-LIFE

PMMA board

Recycled PMMA board

PMMA boards are durable and can be used for a long time. A few panel manufacturers offer takeback programmes.

Recyclability: PMMA boards can be recycled chemically – this is sometimes done by manufacturers

Graphic considerations		Consider using reversible tack decals to minimise adhesive residue left behind
Typical circularity		Virgin PMMA sheet, landfilled or incinerated at end of life
Optimal circularity		100% recycled content board reused, then recycled at end of life via manufacturer takeback
Reuse		Boards are durable and can be used for a long time
Repurposing		After removing graphics, boards could be repurposed for use by other organisations, e.g. exhibitions
Recycling		PMMA boards can be recycled, usually by board manufacturers. However, this is not available in all regions.
Downcycling		None

Laminated safety glass

Laminated safety glass is accepted by some recyclers but will frequently be landfilled at end of life.

Recyclability: LSG must be recycled by specialist sheet glass recyclers who are able to separate the glass from the middle plastic layer

Graphic considerations		None
Typical circularity		Glass is landfilled at end of life
Optimal circularity		Glass is reused, then recycled at end of life
Reuse		Glass is durable and can be used for a long time
Repurposing		After removing graphics, glass could be repurposed for use by other organisations, e.g. exhibitions
Recycling		LSG requires specialist recyclers: these are only available in a few locations
Downcycling		Some glass recyclers will use waste as an aggregate material, e.g. as a sand replacement in road base

B4 TRANSPARENT BOARDS: CASE STUDY

Madreperla recycled PMMA sheeting

Madreperla is a producer of cast acrylic sheets based in Italy. It has produced a product range called Green Cast, cast acrylic sheet made from 100% recycled polymethyl methacrylate.

The company worked with universities to develop a depolymerisation process (chemical recycling) that enables the material to be recycled numerous times while retaining the same mechanical and visual properties as that of virgin material.

Used signage can be taken back by the company for recycling. Details of the products available and further information about productions are available from Madreperla's website.

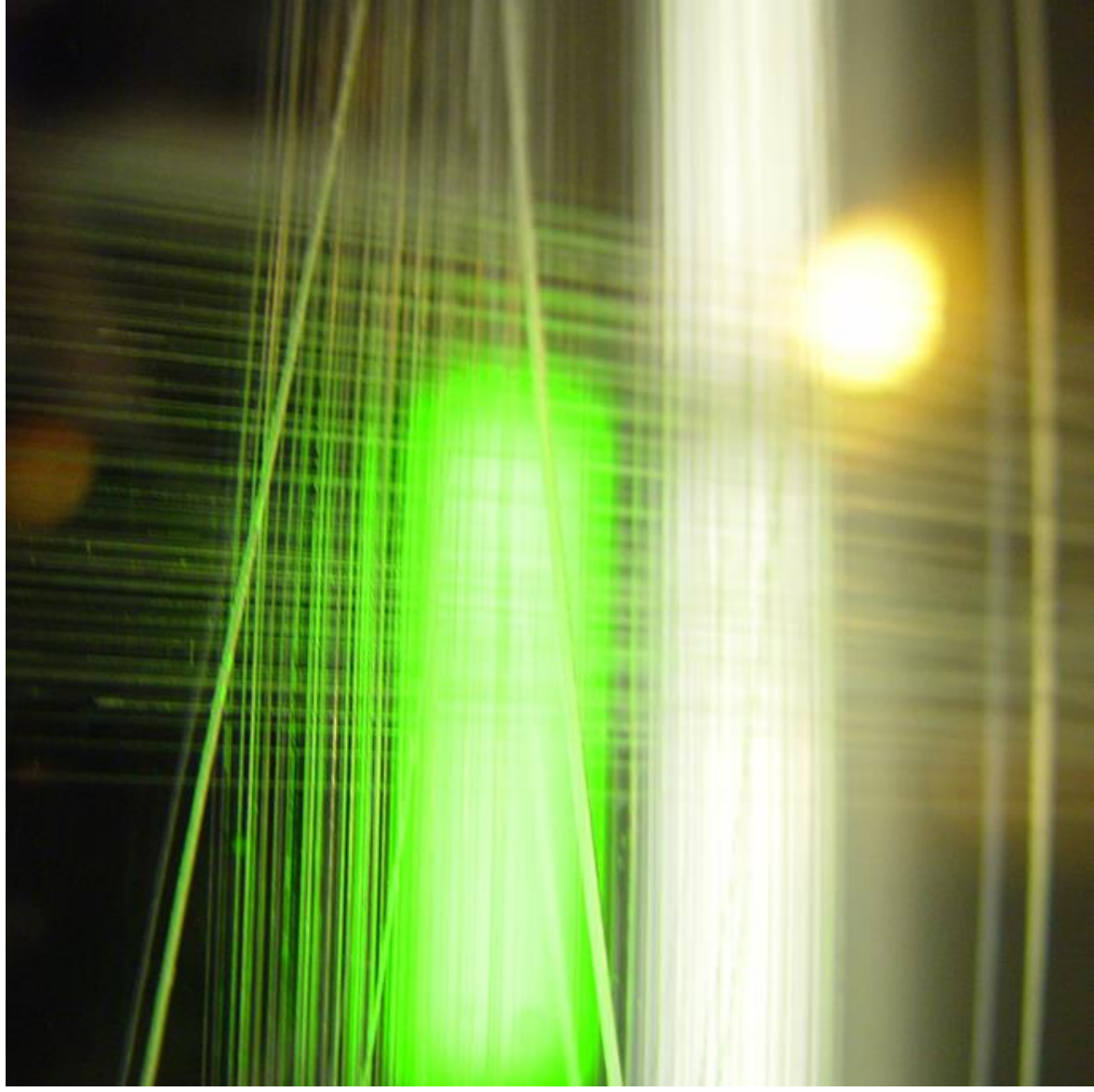


Photo credit: Leon Brooks

B5 DURABLE SIGN BOARDS: OVERVIEW

Durable, hardwearing signboards are mainly used in outdoor applications and are best suited to long term usage, e.g. as signpost totems or traffic signage. While these signs can be finished using direct printing, self-adhesive decals are often used to apply graphics.

The industry standard aluminium-polyethylene composite (otherwise abbreviated to ACM) is supplied under trade names including Dibond®, Dilite®, and Raybond® and commonly referred to by these names in industry.

Materials

- **Aluminium composite material (ACM)** has replaced aluminium sheet as the **industry standard**. ACM consists of two thin sheets of aluminium sandwiching a PE core, making it lighter than aluminium sheet.
- **Aluminium sheet** is still used instead of ACM in some applications.
- **Recycled plastic composite** materials are made from PP and PE waste and are becoming increasingly popular for outdoor applications, e.g. street furniture, plastic “lumber”, and signposts.

End-of-life: aluminium and ACM

- Despite claims of 100% recyclability, recycling ACM is not straightforward and not usually accepted by aluminium recyclers. ACM recycling requires specialist equipment to separate the aluminium from the plastic. ACM is often sent to landfill or incineration.
- Specialist ACM recyclers exist – notably in Europe – but not in all regions.
- Aluminium sheet will generally be accepted by all aluminium recyclers

End-of-life: recycled plastic composite

- As a mixed plastic material, plastic composite may not be accepted by many recyclers, and may end up in landfill or incineration.
- Manufacturers of these products – particularly if integrated with recycling facilities – may be able to accept these products, and some may operate takeback schemes.

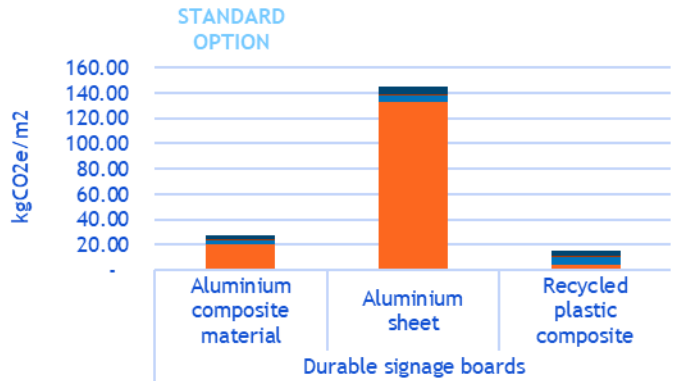
B5 DURABLE SIGN BOARDS: ENVIRONMENTAL IMPACT

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	Aluminium composite (Al-PE) material	●	●	◇	●	●
Alternative	Aluminium sheet	●	●	◇	●	●
Alternative	Recycled plastic composite (mixed polyolefin)	●	●	-	●	●

Key factors

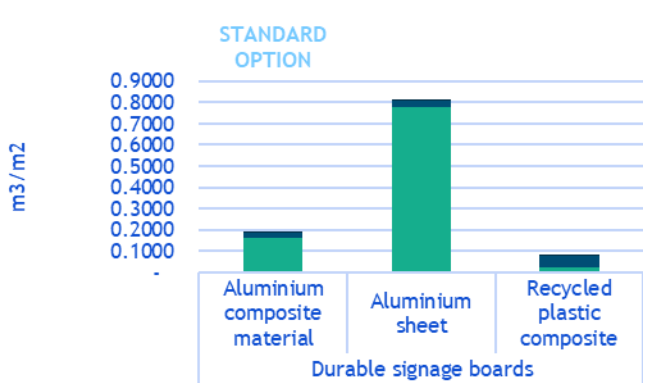
- Focus on re-use to reduce impact as all products in this category are durable and designed to last for several years.
- Pure aluminium is heavier as well as higher impact per kg, which gives the higher overall impact.
- Water impact follows a similar profile, according to the weight of the board.
- Primary aluminium production has a high impact. This can vary depending on where the aluminium is manufactured and how emissions are controlled.
- The assessment uses an industry average for recycled aluminium content. While higher recycled content lowers the impact of aluminium products, the recycled content will often vary depending on the manufacturers' feedstock, and few products are available which state the level of their recycled content.

Durable signage boards - climate change



	Aluminium composite material	Aluminium sheet	Recycled plastic composite
End of life	3.41	6.07	4.15
Transport	0.76	1.36	0.93
Printing	0.22	0.22	0.22
Manufacturing	3.09	4.38	5.83
Raw materials	19.95	133.01	4.15

Durable signage boards - water



	Aluminium composite material	Aluminium sheet	Recycled plastic composite
End of life	0.0030	0.0053	0.0036
Transport	0.0007	0.0013	0.0009
Printing	0.0001	0.0001	0.0001
Manufacturing	0.0204	0.0322	0.0561
Raw materials	0.1640	0.7756	0.0228

B5 DURABLE SIGN BOARDS: CIRCULARITY & END-OF-LIFE

Aluminium composite material

ACM materials can be used for several years - these are commonly used for permanent traffic signage.

Recyclability: while manufacturers claim that ACM is 100% recyclable, it requires specialist recycling equipment, and ACM recyclers are not present in all regions.

Graphic considerations		None
Typical circularity	0.35	ACM landfilled or incinerated at end of life
Optimal circularity	0.69	ACM signage reused long-term, then sent to an ACM recycler at end-of-life
Reuse		Boards are durable and reused many times, particularly if temporary graphics (e.g decals) used
Repurposing		After removing graphics, boards could be repurposed for use by other organisations, e.g. exhibitions
Recycling		ACM recyclers are much less common than aluminium sheet recyclers, and largely operate in Europe
Downcycling		None

Aluminium sheet

Aluminium sheet can be used for several years and is easy to recycle at end of life

Recyclability: Aluminium recyclers are present in almost every region globally

Graphic considerations		None
Typical circularity	0.58	Aluminium sheet is recycled at end of life
Optimal circularity	0.77	Aluminium is reused, then recycled at end of life
Reuse		Boards are durable and reused many times, particularly if temporary graphics (e.g decals) used
Repurposing		After removing graphics, boards could be repurposed for use by other organisations, e.g. exhibitions
Recycling		Aluminium recycling is established in almost all regions globally
Downcycling		None

Recycled plastic composite

Recycled plastic composite is designed to be used for several years

Recyclability: Plastic composite is not universally accepted by recyclers. However, it is likely to be accepted by recyclers who specialise in producing plastic composite material

Graphic considerations		Some paints or inks may disrupt recycling process at end of life
Typical circularity	0.57	Some recycling of plastic composite with majority landfilled or incinerated at end of life
Optimal circularity	0.92	Plastic composite reused, then returned to manufacturer for recycling at end of life
Reuse		Plastic composite is durable and can be reused for several years
Repurposing		Boards are versatile and potentially could be deployed in other applications
Recycling		Not accepted by all recyclers, but recyclers which produce plastic composite may offer takeback
Downcycling		None

B5 DURABLE SIGN BOARDS: CASE STUDIES

Aluminium composite recycling

Recyclapak is a UK based recycler of a range of materials including polyethylene, polystyrene and aluminium composite. Used aluminium composite signage is recycled using specialist machinery which strips the aluminium from the plastic. After stripping the aluminium is baled and plastic is granulated to get both material streams ready for recycling.

Replas plastic recycler and manufacturer

Replas is an Australian based plastic recycler and supplier of recycled content plastic products.
Its product range includes recycled sheeting (suitable for signage), bollards, posts and benches (pictured below is a sign and post supplied by the company in use at Glen Waverley Golf Course).
The company also accepts a wide range of rigid plastics and films for recycling. Further details are available on its website.

C Flexible graphics

- Banners
  - C1 PVC-based banners
  - C2 Non-PVC banners
- Textiles and fabrics
  - C3 Graphic textiles

C

FLEXIBLE GRAPHICS OVERVIEW

Flexible banners cover printable textile based materials.

Banners are exceptionally versatile forms of signage and a key part of event overlay, and are available in several different formats depending on the use case. Primarily made from PVC-coated PET (polyester) fabric which provides a smooth surface for printing, there has been a significant push for PVC-free materials due to the toxicity of some PVC additives.

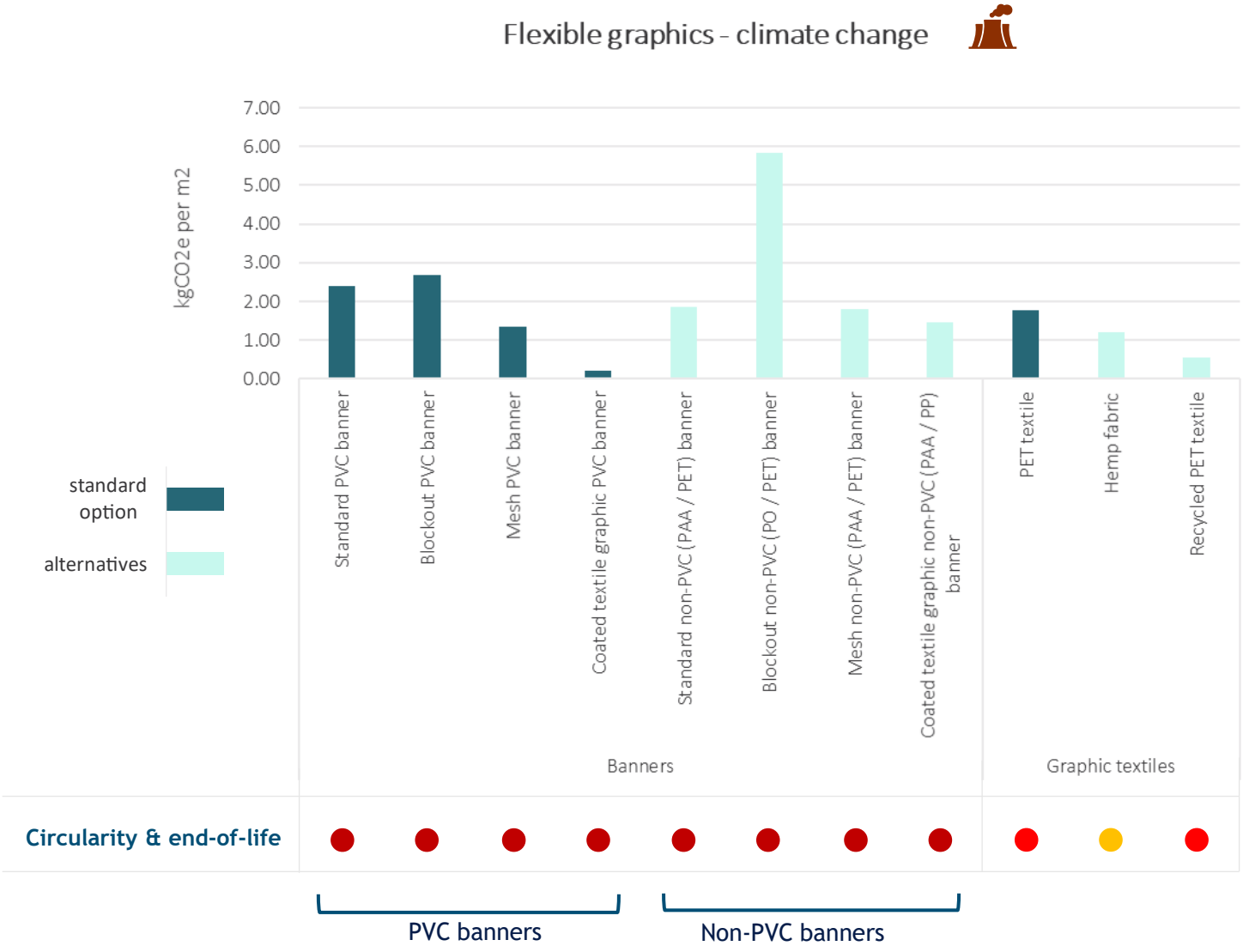
Graphic textiles are printed fabrics - primarily polyester - which are deployed as flags, backdrops, table coverings etc.

Section number	Signage format	Products included in study	Materials
Banners			
C1	PVC banners	Standard single-sided banners	PVC coated PET fabric banners
		Blockout banners	
		Mesh banners	
		Coated textile graphic banners	
C2	Non-PVC banners	Standard single-sided banners	Polyacrylic acid (“acrylic resin”) polymer on PET fabric
		Blockout banners	Polyolefin coated PET fabric
		Mesh banners	Polyacrylic acid (“acrylic resin”) polymer on PET fabric
		Coated textile graphic banners	Polyacrylic acid (“acrylic resin”) polymer on PP fabric
Textiles and fabrics			
C3	Graphic textiles	Printed textiles	PET textile (“polyester”)
			Recycled PET textile (rPET)
			Hemp fabric

C

FLEXIBLE GRAPHICS: IMPACT SUMMARY

- The impacts across the flexible graphics category are fairly similar. While there are a variety of different functional banner types (as well as non-PVC coating materials), the construction is almost the same for most of them.
- Banners and graphic textiles are available in a range of different weights depending on application – the lighter the material gsm, the lower the impact.
- All flexible graphics are challenging from an end-of-life perspective due to their low recyclability. Reuse and repurposing offer the most effective route for these materials.



C1 PVC BANNERS: OVERVIEW

PVC banners consist of two materials – a textile core (not made from PVC), and a number of PVC coating layers. The thickness and finishes (e.g. ink type, fireproof coatings etc) vary depending on the banner application. Common variations within banner types are:

- **Standard single-sided banners,** including frontlit and backlit versions which consist of the same basic materials and structure, but vary in translucency.
- **Block-out banners** which have an extra interlayer of opaque material to help block out light. These can also be used as heavy duty building wraps, e.g. for stadium branding.
- **Mesh banners**, designed to let light and wind pass through, and can be used as building wraps and fence & barrier scrim
- **Coated textile graphic banners** which are lighter weight and possess a smooth face finish for high quality print and are primarily used indoors, e.g. in lightboxes or as a wall covering.

Although there is a huge range of different banner types and weights, they are largely similar in terms of structure and materials used. **PVC banners (PVC coated PET textile) are currently the industry standard products.**

Materials

Textile layer

The majority of banners use a woven PET textile or mesh layer. A few coated textile banner options use PE or PP.

Coating layers

PVC is blended with pigments (e.g. stabilisers or UV-protection) and coated on the textile, either by knife-coating or lamination. Some formats, such as blockout banners, will be coated with multiple layers of PVC.

End-of-life

Due to the multimaterial, bonded construction of most banners and textile layers, they are **inherently difficult to recycle at the present time regardless of the materials used**.

It is recommended that PVC-based products are not incinerated at end-of-life.

If a plastic-to-plastic recycling partnership is secured, check with the recycler that intended printing inks are compatible with the recycling process.

Terry George, August 7 2012 via Flickr, Creative Commons Attribution

C1 PVC BANNERS: ENVIRONMENTAL IMPACT

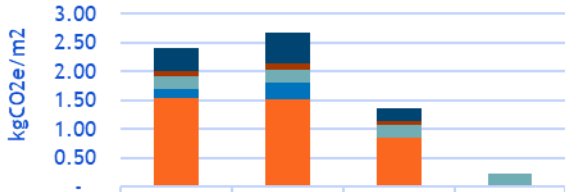
Key factors

- These results do not cover all of the major human and environmental health concerns associated with PVC and its additives. These need to be taken into account in procurement decisions.
- All PVC / PET based options have a comparatively high carbon impact.
- There is a wide range of banner product weights which can have a significant effect on the environmental impact of the material. Therefore, it is recommended that lighter materials are selected where possible, unless the banner is due to be used for a longer time and requires better durability.

All-PVC banners here are considered to be industry standard products

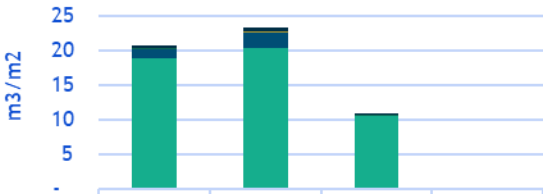
Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	**Standard banner** PVC coated PET textile	●	●	-	●	●
Industry standard	**Building wrap / blockout banner** PVC coated PET textile	●	●	-	●	●
Industry standard	**Mesh banner** PVC coated PET mesh textile	●	●	-	●	●
Industry standard	**Coated graphic textile** PVC coated PET textile	●	●	-	●	●

PVC banners - climate change



	Standard PVC banner	Blockout PVC banner	Mesh PVC banner	Coated textile graphic PVC banner
End of life	0.40	0.52	0.22	-
Transport	0.09	0.12	0.05	-
Printing	0.22	0.22	0.22	0.22
Manufacturing	0.17	0.30	-	-
Raw materials	1.53	1.51	0.86	-

PVC banners - water



	Standard PVC banner	Blockout PVC banner	Mesh PVC banner	Coated textile graphic PVC banner
End of life	0	0	0	-
Transport	0	0	0	-
Printing	0	0	0	0
Manufacturing	1	2	-	-
Raw materials	19	20	11	-

C1 PVC BANNERS: CIRCULARITY & END-OF-LIFE

Despite there being several different types of PVC banner with different functionality, they generally have similar constructions, and therefore similar end-of-life characteristics.

PVC Banners

*All banners are **inherently difficult to recycle** due to their bonded multilayer/multimaterial construction, requiring specialist processors.*

Recyclability: most banner recyclers downcycle, shredding them with other materials such as carpet to create equestrian surfaces. Very few recyclers are able to do plastic-to-plastic recycling.

Graphic considerations		Some direct printing inks and strong adhesives can be problematic for material recycling
Typical circularity	0.12	Landfill / incineration: most geographies do not have local capacity to process banners
Optimal circularity	0.46	Reuse / repurposing of banner material with landfill or incineration of remainder
Reuse		Banners are typically designed for long-term use and can easily be redeployed
Repurposing		Banners can be repurposed into saleable products or donated for use in schools etc.
Recycling		Currently no material-to-material recycling for PVC banners
Downcycling		**Soyang (UK)** are partnered with Blue Castle* in the UK to downcycle PVC banners into equestrian surfaces

* Blue Castle are currently looking to scale up PVC reclamation technology, but unclear when/if this will be integrated into their service

C1 PVC BANNERS: CASE STUDIES

Reusing banners at Arizona State University

In 2010 Arizona State University started to turn its promotional banners into reusable tote bags which are sold in the University's book store. The University is currently working with a local non-profit fashion incubator called FABRIC to produce the bags.

The bags have proved popular, often selling out, and the University feels that the scheme helps demonstrate innovation, generate value in the community and help deliver the University's Zero Waste goal.

A video and further information about the programme is available on the University's website.

Soyang Europe and Blue Castle banner recycling

Soyang Europe, a printable material manufacturer and distributer partnered with waste management specialists, Blue Castle to develop a recycling solution for PVC banners.

Through the partnership Blue Castle has established a recycling facility in Lancashire, UK. The site has shredders that can separate PVC and polyester layers of banners. Currently, Blue Castle downcycle banners, selling the shredded material for niche applications, but are currently looking to scale up a "true" plastic-to-plastic recycling process for the future.

A video by Blue Castle about the project is available here.

C2 NON-PVC BANNERS: OVERVIEW

PVC-free banners have the same construction as PVC banners, but use different coating materials. The thickness and finishes (e.g. ink type, fireproof coatings etc) vary depending on the banner application. Common variations within banner types are:

- **Standard single-sided banners,** including frontlit and backlit versions which consist of the same basic materials and structure, but vary in translucency.
- **Block-out banners** which have an extra interlayer of opaque material to help block out light. These can also be used as heavy duty building wraps, e.g. for stadium branding.
- **Mesh banners**, designed to let light and wind pass through, and can be used as building wraps and fence & barrier scrim
- **Coated textile graphic banners** which are lighter weight and possess a smooth face finish for high quality print and are primarily used indoors, e.g. in lightboxes or as a wall covering. This banner type has a large number of non-PVC material options.

Although there is a huge range of different banner types and weights, they are largely similar in terms of structure.

- **Non-PVC banner textile layers are usually PET, although some use woven PE or PP**
- **Non-PVC banner coating materials include: polyolefins (PO), polyethylene (PE), polyacrylic acid (PAA), polyurethane (PU), ethyl vinyl acetate (EVA, and PET resin.**

Materials in this study

Standard
Polyacrylic acid (PAA) coating, PET textile layer

Building wrap & blockout
PO coating, PET textile layer

Coated textile
PAA resin coating, PP textile layer

Mesh/scrim
PAA coating, PET textile mesh layer

End-of-life

As with PVC banners, these banners are **inherently difficult to recycle at the present time regardless of the materials used**; non-PVC banners face the same recyclability issues.

Non-PVC banners are considered to be safer for incineration as they are chlorine-free. However, reuse is recommended.

If a plastic-to-plastic recycling partnership is secured, check with the recycler that intended printing inks are compatible with the recycling process.

C2 NON-PVC BANNERS: ENVIRONMENTAL IMPACT

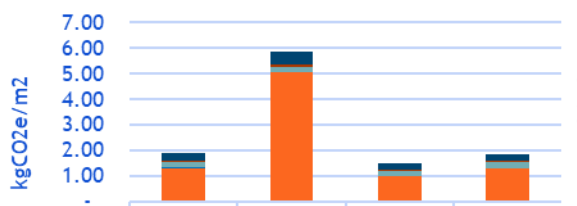
Key factors

- Other than the building wrap, non-PVC banners look to offer much lower impacts per m^2 than PVC based alternatives.
- End-of-life impacts are higher for heavier building wrap.
- As with PVC banners, non-PVC banners are also highly variable in terms of product weight which can have a significant influence on impact. Therefore, it is recommended that lighter materials are selected where possible, unless the banner is due to be used for a longer time and requires better durability.

All non-PVC banners here are considered to be alternative products

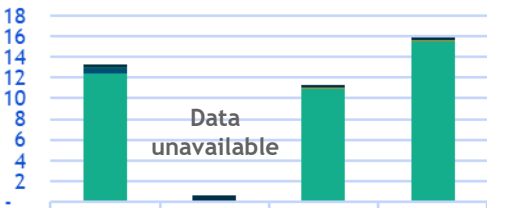
Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Alternative	**Standard banner** PAA (polyacrylic acid) coated PET textile	●	●	–	●	●
Alternative	**Building wrap / blockout banner** PO (polyolefin) coated PET textile	●	Data unavailable	◇	●	●
Alternative	**Coated graphic textile** PAA coated PP textile	●	●	–	●	●
Alternative	**Mesh banner** PAA coated PET mesh textile	●	●	◇	●	●

Non-PVC banners - climate change



	Standard non-PVC (PAA / PET) banner	Blockout non-PVC (PO / PET) banner	Coated textile graphic non-PVC (PAA / PP) banner	Mesh non-PVC (PAA / PET) banner
End of life	0.27	0.48	0.22	0.23
Transport	0.06	0.11	0.05	0.05
Printing	0.22	0.22	0.22	0.22
Manufacturing	0.05	-	-	-
Raw materials	1.26	5.03	0.96	1.31

Non-PVC banners - water



	Standard non-PVC (PAA / PET) banner	Blockout non-PVC (PO / PET) banner	Coated textile graphic non-PVC (PAA / PP) banner	Mesh non-PVC (PAA / PET) banner
End of life	0	0	0	0
Transport	0	0	0	0
Printing	0	0	0	0
Manufacturing	0	-	-	-
Raw materials	12	-	11	16

EPD data was used so no water impacts are available

C2 NON-PVC BANNERS: CIRCULARITY & END-OF-LIFE

As with PVC banners, different non-PVC banners generally have similar constructions, and therefore similar end-of-life characteristics.

The choice of material doesn't significantly affect end-of-life in this case, although there is currently one instance of a recycler who are processing polyolefin-based banners into new material.

Non-PVC Banners

*All banners are **inherently difficult to recycle** due to their bonded multilayer/multimaterial construction, requiring specialist processors.*

Recyclability: most banner recyclers downcycle, shredding them with other materials such as carpet to create equestrian surfaces. Very few recyclers are able to do plastic-to-plastic recycling.

Graphic considerations		Some direct printing inks and strong adhesives can be problematic for material recycling
Typical circularity		Landfill / incineration: most geographies do not have local capacity to process banners
Optimal circularity		Reuse / repurposing of banner material with landfill or incineration of remainder
Reuse		Banners are typically designed for long-term use and can easily be redeployed
Repurposing		Banners can be repurposed into saleable products or donated for use in schools etc.
Recycling		**Toppan (Japan)** have partnered with a recycler who can recycle polyolefin banners into plastic composite products.
Downcycling		**Soyang (UK)** are partnered with Blue Castle* in the UK to downcycle banners into equestrian surfaces

C2 NON-PVC BANNERS: CASE STUDY

Toppan Printing and Dow

In August 2020 Toppan Printing launched a new product called ‘ecocracy’ – a banner in which all plastic parts such as the membrane, mesh, eyelet and yarn are comprised only of polyolefins. The use of single material removes the complexity of recycling multiple materials. In addition, according to Toppan, the amount of plastic used is significantly reduced in relation to comparable products.

After use the banners are pelletised and blended with recycled wood to make products such as plant pots, benches and flooring.

It is intended that signage made from this product will be used at the delayed 2020 Olympic Games in Tokyo.

Further information about the product is available in this press release from Toppan.

C3 GRAPHIC TEXTILES: OVERVIEW

Printed textiles are versatile and used in many applications such as flags, backdrops, table skirts, etc.

Synthetic textiles – predominantly PET (polyester) – have almost entirely replaced natural fibres for events. Synthetic textiles can be supplied with different weights and weaves, making them very versatile.

Natural fibres are best suited to long-lasting applications, and where the look/texture of natural material is needed. Natural fibre products also tend to be heavier than synthetic ones.

Materials

PET (polyester) textiles are the industry standard

Recycled PET (rPET) textiles, usually made from recycled plastic bottles, are becoming popular as a sustainable material choice.

Hemp-based textiles and materials are currently niche products but are gaining traction as a sustainable alternative to cotton. Hemp textiles are very similar to flax/linen and have almost identical characteristics.

End-of-life

- Textile recycling is a major problem globally for both natural and synthetic fibres.
- Almost all post-consumer textile recycling involves downcycling to create cloths, insulation, and other products, with very little creation of new fabrics from recycled fibres.
- Limited fibre-to-fibre recycling is available, but mostly for cotton or linen.
- PET fibre-to-fibre recycling is in its infancy with a handful of operators globally. New advanced (chemical) recycling technologies are touted as a solution to the textile waste problem, but these are a few years away from achieving full scale.
- Single material textiles are the most compatible for fibre-to-fibre recycling - mixed materials are one of the biggest challenges for textile recycling.

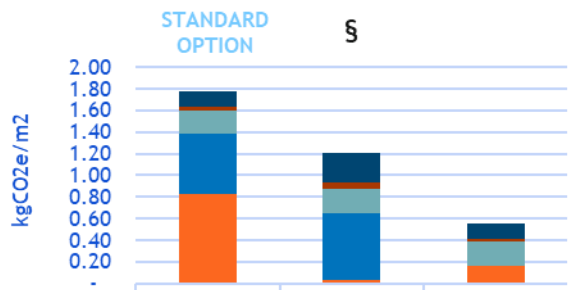
C3 GRAPHIC TEXTILES: ENVIRONMENTAL IMPACT

Key factors

- Graphic textiles are lightweight products with comparatively low impacts per m^2; however, gram-for-gram, the environmental impact is relatively high.
- Hemp has a lower climate change impact, even though hemp fabrics generally have a higher gsm than PET.
- Hemp also has a high water footprint due to its processing requirements.
- Biodiversity and land-use may also be important considerations for hemp cultivation.
- **§ - we recommend that further environmental data is obtained for hemp materials prior to making procurement decisions**. The impact of hemp will vary depending on material sourcing and processing and can vary substantially from product to product, especially as it is currently a niche product.

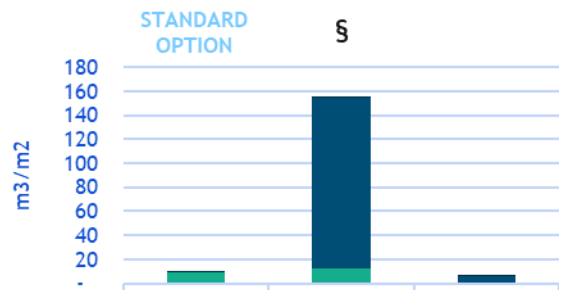
Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	PET textile, 100 % virgin	●	●	-	●	●
Alternative	Hemp fabric §	● §	● §	-	●	●
Alternative	Recycled PET textile, 100 % recycled content	●	●	-	●	●

Graphic textiles climate change



	PET textile	Hemp fabric	Recycled PET textile
End of life	0.14	0.28	0.14
Transport	0.03	0.06	0.03
Printing	0.22	0.22	0.22
Manufacturing	0.55	0.62	-
Raw materials	0.83	0.03	0.16

Graphic textiles - water



	PET textile	Hemp fabric	Recycled PET textile
End of life	0	0	0
Transport	0	0	0
Printing	0	0	0
Manufacturing	-	141	5
Raw materials	9	13	1

C3 GRAPHIC TEXTILES: CIRCULARITY & END-OF-LIFE

- All graphic textiles face similar challenges when it comes to end-of-life, as textile recycling is a major challenge, and true fibre-to-fibre recycling is rare.
- However, graphic textiles can readily be repurposed or “upcycled” to make new saleable goods, or reused internally.

Virgin PET textiles, hemp textiles

Recycled PET textiles

Textile recycling is not a well developed sector, although there are several new technologies which aim to offer fibre-to-fibre recycling. As graphic textiles are usually single material, they are potentially good candidates for fibre-to-fibre recycling

Recyclability: most textiles are downcycled at end of life. A very limited number of PET fibre-to-fibre recyclers operate worldwide.

Graphic considerations		Ink choice does not significantly change recyclability of textiles.
Typical circularity		Landfill / incineration: the majority of textiles are not recycled at end of life
Optimal circularity		Reuse / repurposing of graphic textiles
Reuse		Graphic textiles are versatile and can be readily reused multiple times
Repurposing		Graphic textiles can readily be repurposed into saleable products, e.g. branded bags
Recycling		PET: a few companies such as JEPLAN (Japan) operate small scale chemical recycling plants
Downcycling		Most textile recyclers downcycle materials to make cloths or insulation

C3 GRAPHIC TEXTILES: CASE STUDIES

Jeplan PET textile recycling

Jeplan is a specialist textile recycler based in Tokyo, Japan which uses an advanced chemical recycling processing technology to recycle PET textiles into new, like-virgin PET fibre (fibre-to-fibre recycling).

This process breaks the PET down into its constituent chemical components, which enables “cleaning” of the material, such as dye removal. Currently, JEPLAN uses post-consumer clothing from its BRING programme in retail stores and post-industrial material.

Although currently operating at small scale, JEPLAN are looking to scale up their technology.

Harrison Creative recycled content flags

Harrison Creative, based in the UK, offers a recycled content product called Enviroflag for flags and feather flags.
The flags are made from recycled PET bottles and industrial polyester waste, which has been chipped, melted and spun into yarn.

The company also provides a ‘fabric upcycling scheme’. Used flags, scrim and other fabric displays can be returned and made into sports bags, shopping bags, tote bags and dog toys in the company’s studio.

D Structural materials

- Structures
- D1 Structural materials

D

STRUCTURAL MATERIALS OVERVIEW

Structural materials are key materials used for building exhibition stands, temporary assets, and supporting signage.

Typically, structural materials are designed to be used and redeployed for several years (and are often provided on a hire basis), but in some event contexts become single-use items.

Section number	Product	Materials included in study
D1	Structural materials	Steel
		Aluminium
		Timber
		Recycled plastic composite

D1 STRUCTURAL MATERIALS: OVERVIEW

Structural materials are typically versatile and designed for long term use in various applications. Structural materials are often offered on a for-hire basis due to their long life.

Metal-based structural systems can be designed to be modular and highly adaptable, whereas timber and plastic composite systems are more static in design.

Materials

Aluminium is one of the **industry standards** used for building structures due to its durability and its light weight compared to other metals.

Steel is the most commonly used structural metal in the world, with several grades suitable for use over several years both indoors and outdoors.

Timber is popular as a low carbon structural material and commonly used as signage stands.

Recycled plastic composite is a relatively new structural material, but is marketed as a sustainable alternative due to its recycled content and durability.

End-of-life - Aluminium and steel

- Aluminium and steel products are durable and usually designed to be used over a very long time.
- Both aluminium and steel are widely recycled in almost every territory around the world.

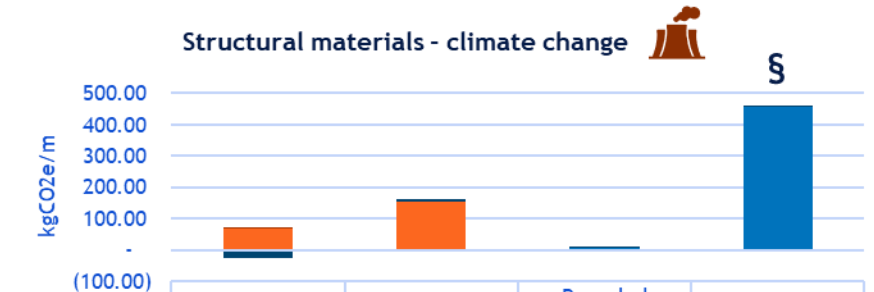
End-of-life - Timber

- Timber products are durable and can be used for several years.
- Timber recycling is available in many countries; however, paint or wood treatments may prevent recycling, and lead to it being used for fuel or landfilled, where it will decompose and release methane.
- Timber products can easily be repurposed for other uses, or reclaimed for use in other industries.

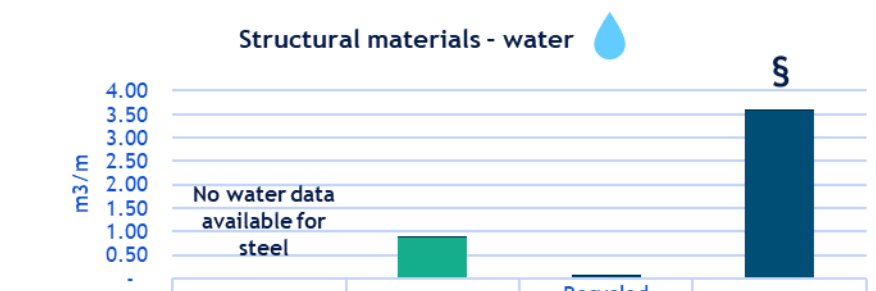
End-of-life - Recycled plastic composite

- As a mixed plastic material, plastic composite may not be accepted by many recyclers, and may end up in landfill or incineration.
- Manufacturers of these products – particularly if integrated with recycling facilities – may be able to accept these products, and some may operate takeback schemes.

D1 STRUCTURAL MATERIALS: ENVIRONMENTAL IMPACT



	Steel	Aluminium	Recycled plastic composite	Softwood timber
	Structural materials			
End of life	(24.61)	7.29	2.66	5.02
Transport	4.52	1.63	0.60	1.13
Printing	-	-	-	-
Manufacturing	-	-	3.74	454.25
Raw materials	67.95	153.03	2.67	0.84



	Steel	Aluminium	Recycled plastic composite	Softwood timber
	Structural materials			
End of life	0.02	0.01	0.00	0.00
Transport	0.00	0.00	0.00	0.00
Printing	0.00	0.00	0.00	0.00
Manufacturing	-	-	0.04	3.57
Raw materials	-	0.88	0.01	0.01

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	Steel	●	Data unavailable	-	●	●
Industry standard	Aluminium	●	●	-	●	●
Alternative	Recycled plastic composite, 100 % recycled mixed polyolefin	●	●	-	●	●
Alternative	Softwood timber §	● §	● §	-	●	●

Key factors

Functional unit used here is a 1m x 10cm x 10cm pole.

NB this is not comparable to other products included in this report.

- These structural materials are durable and designed to be used long-term.
- Recycled plastic composite performs well for climate change and water.
- Timber footprint varies widely according to the sourcing and processing. We recommend that timber is sourced from sustainably managed forests, preferably backed by certification.
- **The carbon sequestration associated with the growth of the wood is assumed to be released at the end of its life and not stored long-term.**
- Red flag for ecotoxicity for stainless steel.
- Industry average recycled content values were used for steel and aluminium.
- § - we recommend obtaining further environmental data on timber as its footprint can be highly variable depending on material sourcing and manufacturing processes.

D1 STRUCTURAL MATERIALS: CIRCULARITY & END-OF-LIFE

Aluminium and steel

Aluminium and steel are hardwearing materials and some of the most commonly recycled materials.

Recyclability: these metals can be recycled in almost every region globally

Graphic considerations		None
Typical circularity	0.56	Aluminium and steel is recycled at end of life
Optimal circularity	0.77	Aluminium and steel is reused, then recycled at end of life
Reuse		Metal structures are designed for long term reuse and redeployment and often offered on a for-hire basis
Repurposing		N/A
Recycling		Aluminium and steel recycling is established in almost all regions globally
Downcycling		None

Timber

Timber materials are durable and can be used in the long term

Recyclability: outside of direct reuse, most timber recycling is downcycling into engineered wood products or fuel

Graphic considerations		Paint and surface finishes will often lead to timber being rejected for recycling
Typical circularity	0.16	Timber is landfilled or used as a fuel source
Optimal circularity	0.53	Timber is reused and recycled at end of life
Reuse		Timber can be reused for several years
Repurposing		Timber structures can be easily adapted or cut for use in other applications
Recycling		Timber recycling and reclamation is established in some countries, but material is landfilled in many places
Downcycling		Lower grades of timber will be converted into boards (such as MDF) or pellets for fuel

Recycled plastic composite

Recycled plastic composite is designed to be used for several years

Recyclability: Plastic composite is not universally accepted by recyclers. However, it is likely to be accepted by recyclers who specialise in producing plastic composite material

Graphic considerations		Some paints or inks may disrupt recycling process at end of life
Typical circularity	0.59	Plastic composite landfilled or incinerated at end of life
Optimal circularity	0.92	Plastic composite is reused, then returned to manufacturer for recycling at end of life
Reuse		Plastic composite is durable and can be reused for several years
Repurposing		Plastic composite components are versatile and potentially could be deployed in other applications
Recycling		Not accepted by all recyclers, but recyclers which produce plastic composite may offer takeback
Downcycling		None

D1 STRUCTURAL MATERIALS: CASE STUDIES

Ecobooth bespoke recycled event equipment

Ecobooth is a London, UK, based company that designs and engineers waste plastic into a wide range of event equipment including signage, stands and stages.

Projects it has delivered include collection of Correx plastic waste from Canary Wharf for re-purposing into a bespoke exhibition stand (pictured below) and a 44sqm stand for T. Rowe Price which featured hanging plant pots from recycled plastic bottles and carpet tiles created from recycled fishing nets. Further details of projects can be found here.

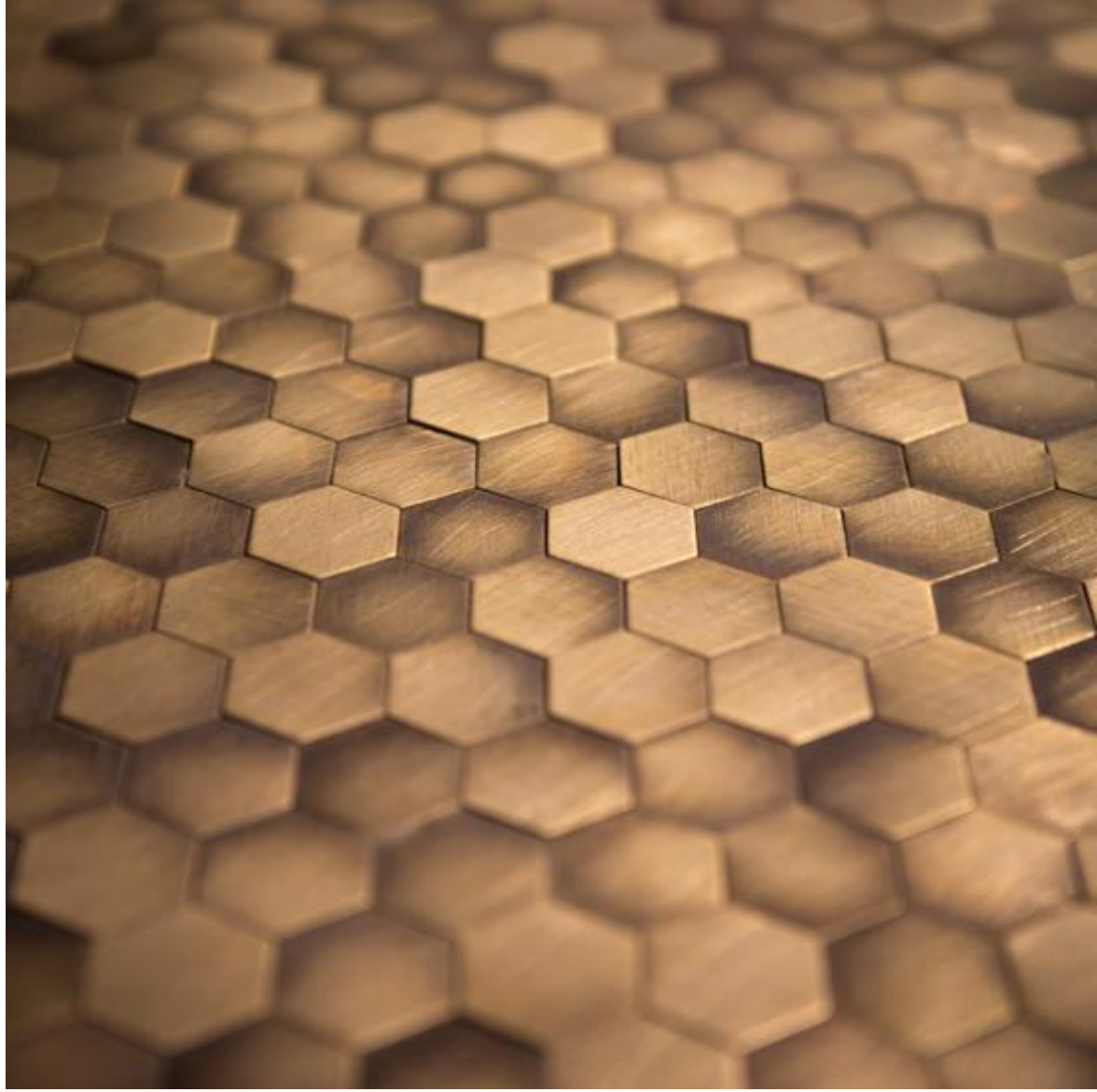
Octonorm aluminium framing

Octanorm is a provider of exhibition structures that operates across the globe. It specialises in modular aluminium framing, which can be adapted into different types of structure. Because of its adaptability the framing is designed for long term use in different applications and is easily reusable. It can also be recycled at end of life.

The company aims to minimise transportation distances by designing the framing at its central offices but having them manufactured locally by one of 150 exhibition builders it partners with. Further information is available in its sustainability brochure.

E Flooring

- Flooring
- E1 Floor coverings



E

FLOORING OVERVIEW

Flooring is a key part of event overlay, with both “functional” flooring and more decorative floor coverings playing important roles.

Event carpet has been identified as a significant source of waste due it being single use, leading to some industry response to address the issue.

Section number	Format	Product types included in study
E1	Floor coverings	PP carpet
		Paper-based floor covering
	Functional flooring	Recycled PP tile system

E1 FLOORING: OVERVIEW

There are several different flooring types used for events, with carpets and floor coverings being the most widely used. Functional flooring is also used to create audience areas or raised platforms.

Event flooring can be both single or multi-use. Typically, carpet and decorative floor coverings have been single-use, whereas functional flooring tends to be more hardwearing and reusable.

Materials

Carpet made from PP are the **industry standard** for events. Event carpets are typically single-use and can be a significant source of waste. Event carpets typically consist of a PP face fibre, needle-punched into a synthetic latex (SBR) backing compounded with a filler such as $CaCO_3$.

Plastic floor tile systems made from PP are hardwearing and designed to be redeployed over the long term (typically 10 years or more). Floor tile systems are usually black plastic and can require another floor covering. **The product modelled in this study contains 100 % recycled content.**

Paper floor coverings are a relatively new alternative product which aim to replace single-use carpet. **The product covered in this study contains 100 % recycled content.**

End-of-life - PP carpet

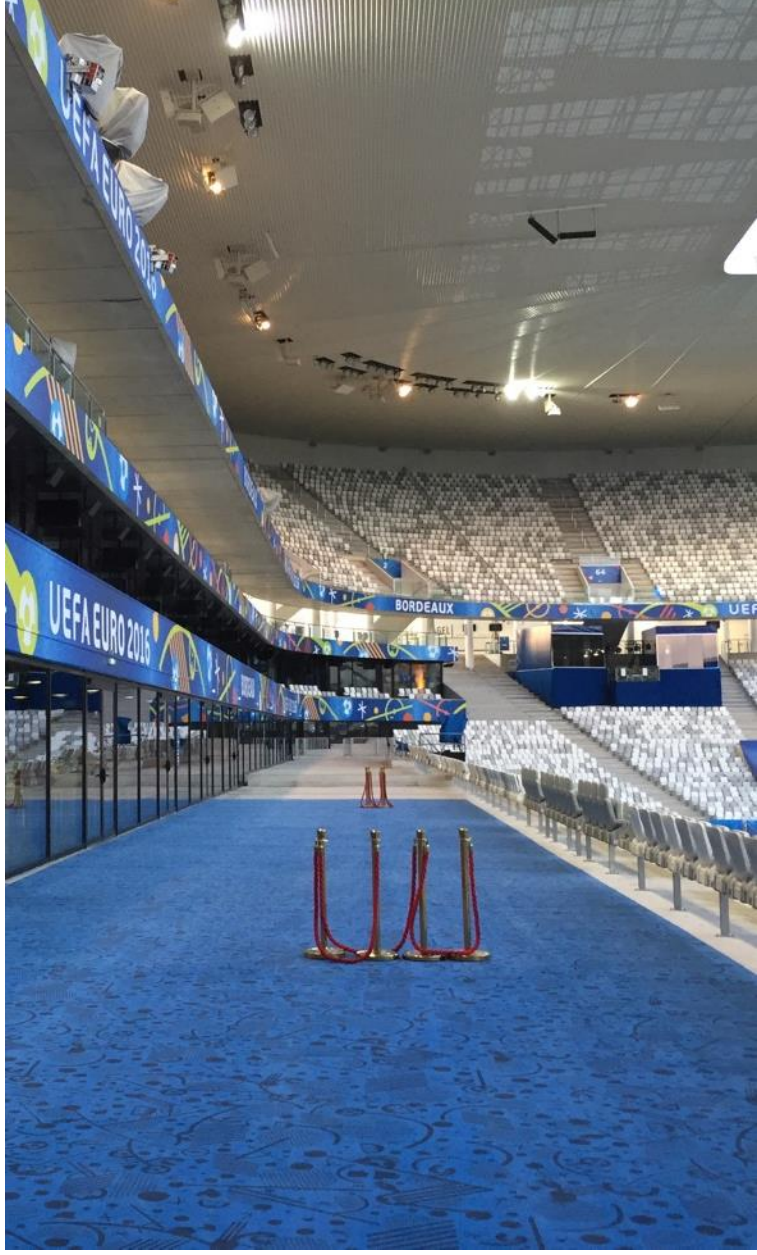
- Carpets are a hard to recycle waste stream due to high levels of contamination and difficulty separating polymer fibres from carpet backing. The vast majority of carpet ends up in landfill or incineration.
- Most carpet recycling is downcycling (similar to PVC banners)
- Event carpet has historically been single use; however, some event carpet manufacturers now offer a takeback service to reduce this waste.

End-of-life - Plastic floor tiles

- Plastic floor tile systems are designed to be reused for several years, and are offered by many companies on a hire basis.
- PP floor tiles will generally be accepted by PP recyclers. PP recyclers are fairly widespread, although not available in every region (US notably has very few commercial PP recyclers)

End-of-life - Paper floor coverings

- Paper-based floor coverings should be readily recyclable in paper waste streams.
- UV-based inks may cause recycling issues for some paper mills.



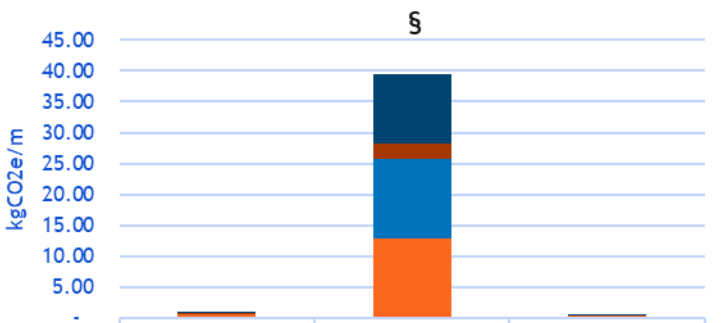
E1 FLOORING: ENVIRONMENTAL IMPACT

Key factors

- The weight of the recycled tile flooring makes its impact higher across all lifecycle stages.
- The advantage of the tile system is in its reusability – a single reuse will halve the per-use impact of raw materials and manufacturing (roughly 40x the carbon impact). The tile system is designed to last for ~10 years.
- Paper-based flooring offers a low-impact alternative.
- The toxicity flag for paper based flooring comes from flame retardant additives, although this may vary depending on the additive used.
- Carpets may also contain a range of flame retardants with varying toxicity impacts.
- § - we recommend obtaining further environmental information on the paper-based flooring as this is a recent market entrant and there may be variability in the manufacturing process

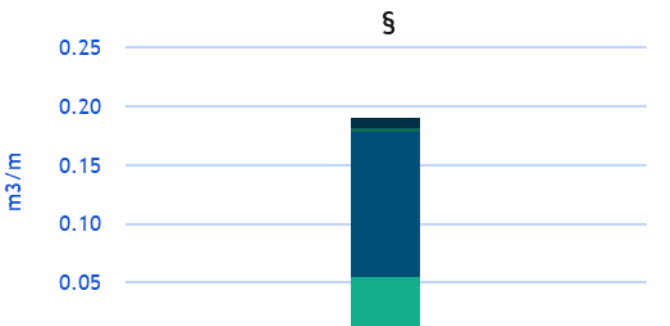
Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	PP carpet (PP face fibre with synthetic rubber backing)	●	●	–	●	●
Alternative	PP floor tiling system, 100 % recycled content §	●	●	◇	●	●
Alternative	Paper-based flooring, 100 % recycled content	● §	● §	◇ §	●	●

Flooring - climate change



	PP carpet	Recycled PP tile system	Paper-based floor covering, 100 % recycled content
	Flooring		
End of life	0.29	11.21	0.22
Transport	0.06	2.51	0.05
Printing	-	-	-
Manufacturing	-	12.85	-
Raw materials	0.60	12.80	0.31

Flooring - water



	PP carpet	Recycled PP tile system	Paper-based floor covering, 100 % recycled content
	Flooring		
End of life	0.00	0.01	0.00
Transport	0.00	0.00	0.00
Printing	0.00	0.00	0.00
Manufacturing	-	0.12	-
Raw materials	0.01	0.05	0.00

E1 FLOORING: CIRCULARITY & END-OF-LIFE

Carpet (PP fibre)

Carpets are used in large volumes for events and are often single use.

Recyclability: carpet is inherently difficult to recycle as plastic fibres are bound into the backing. Some manufacturers now offer recycling programmes.

Graphic considerations		None
Typical circularity	0.13	Carpet is landfilled or incinerated
Optimal circularity	0.42	Some of the carpet is recycled at end of life
Reuse		Carpet can be reused multiple times, but is often not due to storage/cleaning considerations
Repurposing		N/A
Recycling		A few events carpet manufacturers offer material recycling takeback programmes
Downcycling		The majority of carpet recycling is downcycling to make equestrian surfaces

PP floor tiles, 100 % recycled content

Plastic floor tile systems are designed for long term reuse (10 years+) and can be recycled by PP recyclers, although these are not present in every region globally

Recyclability: most PP recycling is plastic-to-plastic, although PP can be used in alternative applications such as road asphalt plasticiser.

Graphic considerations		Some direct printing inks and strong adhesives can be problematic for material recycling
Typical circularity	0.57	Limited recycling, significant proportion sent for incineration or landfill
Optimal circularity	0.92	100 % recycled content product, product sent to PP material recycler at end-of-life
Reuse		Floor tile systems are designed for long term reuse (and often offered on a for-hire basis)
Repurposing		Limited repurposing opportunities
Recycling		PP plastic-to-plastic recycling is fairly well established in many regions.
Downcycling		Some recyclers will use PP outputs for other applications, e.g. asphalt or cement additives.

Paper flooring, 100 % recycled content

Paper floor covering has been designed to replace single-use event carpets

Recyclability: Paper floor coverings are designed to be compatible with normal waste paper recycling systems; however, high contamination may lead to material rejection

Graphic considerations		UV cured inks may cause recycling problems for some paper mills
Typical circularity	0.70	Most floor coverings recycled at end of life
Optimal circularity	0.82	All floor coverings recycled at end of life
Reuse		Paper floor coverings are designed to be single use
Repurposing		Potentially could be used as packing material
Recycling		Accepted in regular waste paper recycling collections
Downcycling		None

E1 FLOORING: CASE STUDIES

Reeds Carpets take back service

Reeds Carpets is a UK based supplier of carpets for events and exhibitions. It offers an integrated service for supply, fit and return for recycling.

The recycling service is offered for the company's Evo-Collection range and is undertaken through its in-house recycling facility. The carpet is shredded then formed into polypropylene pellets which are sold for various applications including waste bins, plant pots and storage boxes.

Expofloors Ecofloor

Expofloor provides a product called Ecofloor which the company states is made from 100% recycled polypropylene, is half the weight of a timber floor, can be recycled after use and has a lifespan of 10 years. The flooring can be hired instead of purchased and is modular meaning damaged parts can be replaced without larger losses. Videos to demonstrate the flooring are available here and a datasheet here.

paprfloor

paprfloor produce paper-based printable flooring products designed to replace single-use plastic-based exhibition flooring. Paprfloor's product is made from 100% recycled paper and mixed with an additive to give it B1 fire protection. Paprfloor also offer a takeback service for their product.

F Self-adhesive decals and films

- Self-adhesive films and decals
- F1 Standard decal types
- F2 Specialist films and decals

F

SELF-ADHESIVE DECALS AND FILMS OVERVIEW

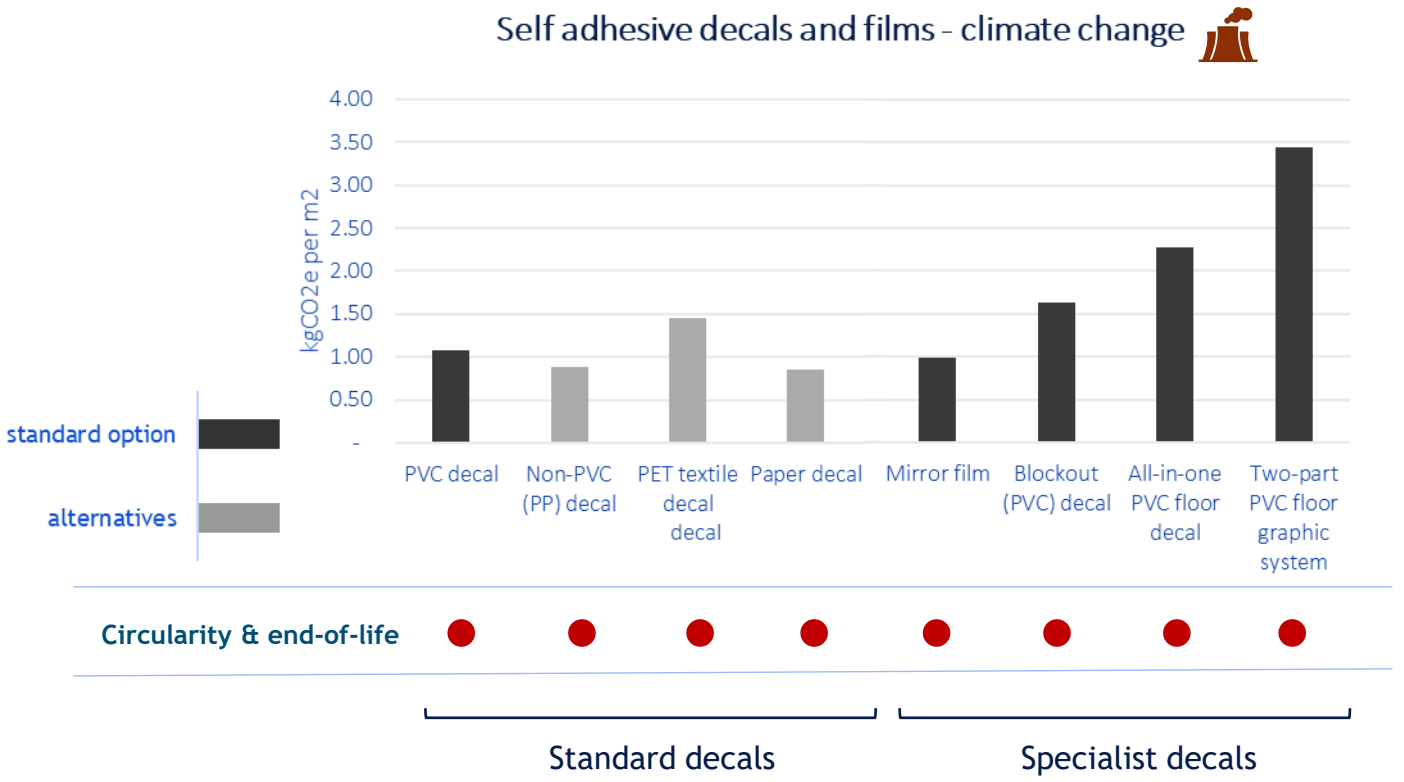
Decals (also referred to as self-adhesive vinyl or just “vinyl”) are versatile elements in event overlay and can be used to apply graphics to signage, walls, floors, vehicles.

All self-adhesive decals consist of a material layer (for printing), an adhesive, and a siliconised paper backing liner.

Section number	Signage format	Products included in study	Materials
F1	Standard decals	PVC decals	PVC film
		PVC-free decals	PE, PP, or polyolefin films
		Paper decals	Paper
		Textile decals	PET coated PET textile
F2	Specialist decals and films	Blockout decals	PVC film
		Mirror films	Metallised Aluminium-PET (BOPET) film
		All-in-one floor decals	PVC film with metal oxide particles (anti-slip)
		Two-part floor graphic system	PVC film decal PVC-metal oxide composite laminating overlayer (anti-slip)

F

SELF-ADHESIVE DECALS AND FILMS: IMPACT SUMMARY



F1 STANDARD DECALS: OVERVIEW

Self-adhesive vinyls and decals are versatile materials and play a major role in overlay.

While PVC films are the main material used for this purpose, a number of non-PVC materials are available, including polymer-based materials and paper ones.

Decals are single use, although there are different grades of adhesive which allow for repositioning, temporary or long-term use, and different surfaces.

Typically there is significant wastage with decal usage:

- the liner can make up around 50 % of the decal weight.
- Some material wastage will occur depending on the shape of the decal.
- Misplaced or mispositioned decals are often discarded, especially if the decal becomes stuck to itself.

However decals can also enable reuse of other overlay elements (e.g. signboards).

Materials

PVC film is the **industry standard** decal material

PE / PP or polyolefin films are the main polymer-based non-PVC alternatives

Paper based decals are sometimes used for indoor applications

Textile decals are similar to coated textile graphic banners – synthetic textile (usually PET) coated with a polymer layer for printing. The trade name Photo Tex® is often used to refer to this product type.

All decals are backed with an adhesive and liner. The most common adhesives are acrylic (MMA) based, with different formulations and application methods giving it different tackiness.

Almost all liners are made from silicone-coated Kraft paper.

End-of-life - decals

- Decals are very hard to recycle and will almost always end up in landfill or incineration, regardless of material. This is due to the film material format, high adhesive content, and printing inks.
- Additionally, liner materials are generally not recycled – although paper is widely recycled, the silicone layer makes them unsuitable for conventional processes.

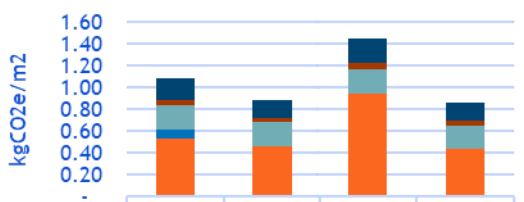
F1 STANDARD DECALS: ENVIRONMENTAL IMPACT

Key factors

- Decals have a generally high impact relative to their weight, however they may be used to extend the lifetime of other products.
- PVC-containing standard decals have higher water and climate change impact than non-PVC alternatives.
- PET textiles have higher impacts for climate change.
- Paper is the lowest-impact option for single use. However, these are generally only suited to indoor applications.

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	**PVC decal** PVC film	●	●	-	●	●
Alternative	**Non-PVC decal** PP film	●	●	-	●	●
Alternative	**PET textile decal** PAA (polyacylic acid) coated PET textile	●	●	-	●	●
Alternative	**Paper decal** Paper decal	●	●	-	●	●

Standard decals - climate change



	PVC decal	Non-PVC (PP) decal	PET textile decal	Paper decal
End of life	0.20	0.17	0.23	0.17
Transport	0.04	0.04	0.05	0.04
Printing	0.22	0.22	0.22	0.22
Manufacturing	0.08	-	-	-
Raw materials	0.54	0.46	0.95	0.43

Standard decals - water

	PVC decal	Non-PVC (PP) decal	PET textile decal	Paper decal
End of life	0.00	0.00	0.00	0.00
Transport	0.00	0.00	0.00	0.00
Printing	0.00	0.00	0.00	0.00
Manufacturing	0.00	-	-	-
Raw materials	0.01	0.01	0.01	0.01

F1 STANDARD DECALS: CIRCULARITY & END-OF-LIFE

Standard decals

Decals and films are a problematic waste stream and generally cannot be reused or recycled.

Recyclability: decal materials are hard to recycle due to the relatively high quantities of adhesive and ink. Additionally, decal liners are non-recyclable as the paper material is coated with silicone. Some advanced recycling technologies may be able to process decals in the future.

Graphic considerations		None, as decals are currently non-recyclable
Typical circularity		Landfill / incineration: decals are not recycled at end of life
Optimal circularity		Landfill / incineration: decals are not recycled at end of life
Reuse		Reusing decals with reversible adhesives is generally not practical
Repurposing		N/A
Recycling		While some recyclers process PE or PP film, decals will likely be rejected due to the adhesive content.
Downcycling		N/A

F2 SPECIALIST DECALS: INTRODUCTION

There are several decals used for particular applications – these include:

- Blockout decals which prevent light from passing through
- Mirrored film (for covering windows, either to block the view or for solar shading)
- Flooring decals – this includes all-in-one decals with an anti slip surface, and two-part systems (regular decal with a second laminate covering)

These decals currently have no alternatives which are sold as more sustainable as these products are sold primarily on the basis of their functionality.

Materials

Blockout films are typically made from PVC, as with standard decals, but are processed to be opaque.

Mirrored films are multilayer laminate films. These layers are usually made from BO-PET (biaxially orientated PET) films, metallised with a thin aluminium layer. PE layers are sometimes used as a barrier.

All-in-one flooring decals are typically made from a thick PVC decal with an anti-slip inorganic additive

Two-part flooring systems consist of a standard printed PVC decal, and a transparent laminating layer – usually also PVC with an anti-slip inorganic additive.

All decals are backed with an **adhesive and liner**. The most common adhesives are acrylic (MMA) based, with different formulations and application methods giving it different tackiness.

Almost all liners are made from silicone-coated Kraft paper.

End-of-life - decals

- Decals are very hard to recycle and will almost always end up in landfill or incineration regardless of materials used. This is due to the film material format, high adhesive content, and printing inks.
- Additionally, liner materials are generally not recycled – although paper is widely recycled, the silicone layer makes them unsuitable for conventional processes.

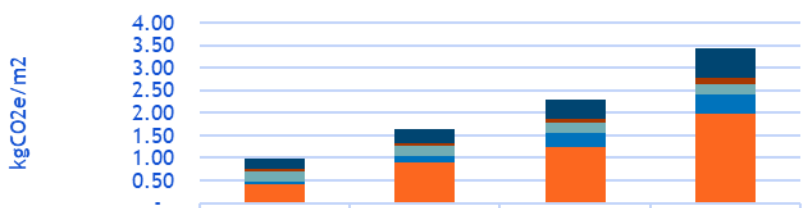
F2 SPECIALIST DECALS: ENVIRONMENTAL IMPACT

Key factors

- Specialist decals are higher impact than the more commonly used standards decals in Section F1.
- Raw material contribution is high as many of these are heavier than standard decals.
- The toxicity flag for mirror film arises from the aluminium content.
- The toxicity flags for the flooring decals arise from the anti-slip additives – this may vary depending on the type of additive used
- Currently no sustainable alternatives are available for these specialist products.

Product type	Product materials	Climate change	Water footprint	Toxicity	Recyclability	End-of-life & circularity
Industry standard	**Mirror film** Multilayer BOPET (biaxially orientated PET) film with metallised aluminium layer	●	●	◇	●	●
Industry standard	**Blockout decal** Opaque PVC film	●	●	-	●	●
Industry standard	**All-in-one flooring decal** PVC film with anti-slip filler	●	●	◇	●	●
Industry standard	**Two-part flooring decal** PVC film decal + laminate overlay PVC film with anti-slip filler	●	●	◇	●	●

Specialist decals- climate change



	Mirror film	Blockout (PVC) decal	All-in-one PVC floor decal	Two-part PVC floor graphic system
	Specialist decals			
End of life	0.24	0.31	0.41	0.66
Transport	0.05	0.07	0.09	0.15
Printing	0.22	0.22	0.22	0.22
Manufacturing	0.05	0.15	0.30	0.41
Raw materials	0.43	0.89	1.25	1.99

Specialist decals - water

	Mirror film	Blockout (PVC) decal	All-in-one PVC floor decal	Two-part PVC floor graphic system
	Specialist decals			
End of life	0.00	0.00	0.00	0.00
Transport	0.00	0.00	0.00	0.00
Printing	0.00	0.00	0.00	0.00
Manufacturing	0.00	0.01	0.01	0.02
Raw materials	0.00	0.01	0.02	0.03

F1 SPECIALIST DECALS: CIRCULARITY & END-OF-LIFE

Specialist decals

Decals and films are a problematic waste stream and generally cannot be reused or recycled.

Recyclability: decal materials are hard to recycle due to the relatively high quantities of adhesive and ink. Additionally, decal liners are non-recyclable as the paper material is coated with silicone. Some advanced recycling technologies may be able to process decals in the future.

Graphic considerations		None, as decals are currently non-recyclable
Typical circularity		Landfill / incineration: decals are not recycled at end of life
Optimal circularity		Landfill / incineration: decals are not recycled at end of life
Reuse		Reusing decals with reversible adhesives is generally not practical
Repurposing		N/A
Recycling		While some recyclers process PE or PP film, decals will likely be rejected due to the adhesive content.
Downcycling		N/A

04

PROJECT CONTACTS

Anthesis

INVITATION TO CONTRIBUTE

We recognise that this guidance will change and evolve as new materials are developed, new products reach the market, and waste management facilities improve.

We therefore welcome contributions from all stakeholders (event organisers, product manufacturers, signage specialists, procurement managers and so on).

If you have any ideas on how this guidance could be improved or expanded, please do get in touch.

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05

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