

Designing Packaging

for Performance, Compliance
and a Circular Economy

Prepared September 2026



Contents

3 The Changing Role of Packaging

3 Why Packaging Design Matters

3 Foreword

4 Understanding Packaging Materials

Functional Performance

Material Efficiency

Recyclability

Recycled Content

5 Designing for a Circular Economy

6 Balancing Sustainability with Commercial Performance

6 The Importance of Packaging Data

7 Opportunities for Packaging Optimisation

7 Looking Ahead

8 Conclusion

8 How Valpak can help





Foreword

Packaging has become a strategic business asset rather than simply a means of protecting products. Increasing environmental legislation, changing consumer expectations and rising material costs have placed greater emphasis on designing packaging that performs efficiently throughout its entire lifecycle.

Successful packaging must balance product protection, commercial performance, sustainability and regulatory compliance. Decisions made during the design phase can influence manufacturing costs, transport efficiency, recyclability, carbon emissions and future compliance obligations.

This white paper explores the principles of effective packaging design, examines how material selection influences environmental performance, and outlines practical approaches businesses can adopt to create packaging that is fit for the future.

The Changing Role of Packaging

Historically, packaging design focused primarily on protecting products and supporting brand identity. Today, organisations must also consider the environmental consequences of every packaging decision.

Legislation such as Extended Producer Responsibility (EPR), Plastic Packaging Tax, and the European Packaging and Packaging Waste Regulations (PPWR) is shifting responsibility towards producers. At the same time, retailers and consumers increasingly expect packaging to be recyclable, lightweight, made from recycled or renewable materials, and where appropriate, reusable.

As a result, packaging design has evolved from a procurement-led activity into a strategic business function. In this changing landscape, access to specialist packaging expertise has become essential for organisations seeking to achieve compliance, drive sustainability, and maintain commercial competitiveness.

Why Packaging Design Matters

The greatest opportunity to improve packaging performance occurs during the design stage. Decisions made early in development determine much of the packaging's environmental and commercial impact.

Well-designed packaging can incorporate provisions for future regulatory changes, evolving recycling infrastructure and changing consumer expectations, while also:

- Reducing raw material consumption and waste
- Improving transport and storage efficiency
- Lowering manufacturing costs
- Minimising product damage
- Increasing recyclability
- Improving consumer experience
- Reducing carbon emissions
- Supporting compliance with current and future legislation
- Reducing purchase costs of packaging

Conversely, poor design decisions can increase material consumption, complicate recycling pathways, raise operational and compliance costs, and negatively affect consumer perceptions, ultimately resulting in brand

Understanding Packaging Materials

Selecting the appropriate material requires consideration of far more than cost alone.

Material performance should be assessed against several criteria, including:

Functional Performance

Packaging should be no stronger, heavier or more complex than necessary, but it must still perform its primary function of protecting the product. This means withstanding production and packing lines, transportation, handling, storage, retail display and consumer use while continuing to meet performance requirements. Designing packaging that delivers the required level of performance using the minimum amount of material is fundamental to reducing costs, carbon emissions and environmental impacts.

Material Efficiency

Reducing unnecessary material while maintaining the required level of protection is a recognised approach to reducing the environmental impact of packaging¹. Lightweighting strategies can reduce material consumption, distribution emissions, and manufacturing costs. However, weight reduction should never compromise product protection, as damaged goods often create greater environmental impacts than the packaging itself.

The way a material is converted into a packaging format can be just as important as the material itself. Structural design optimisation offers a significant opportunity to reduce material consumption through lightweighting. For example, in corrugated packaging, different

carton designs can use substantially less board while maintaining the strength and performance required to protect the product, even when manufactured from the same board grade. By selecting a more efficient pack design, businesses can reduce material use, lower packaging costs and decrease the environmental impact of their packaging without impacting product protection or functionality.

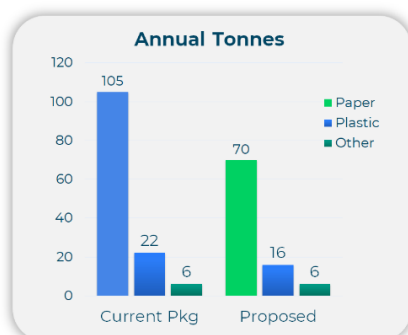
Material savings can also be achieved by reconfiguring the orientation of the product within the carton and optimising the layout of the box panels. These relatively simple design changes can significantly reduce the size of the carton blank while maintaining, or even improving, packaging performance. Our Packaging Technologists work directly with organisations to identify practical opportunities such as this to optimise packaging and reduce material use without compromising product protection.

The image shown in Figure 1 is taken from a Valpak Consulting Packaging Technology case study and illustrates the potential savings in packaging weight, compliance costs and carbon emissions that could be achieved by implementing the recommended packaging improvements².

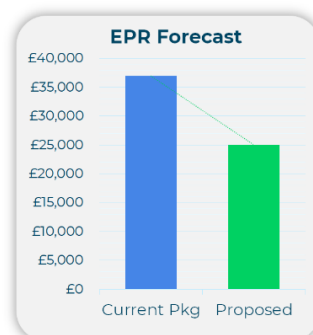
In this example, optimising the designs of the corrugated and solid board carton, switching materials from difficult to recycle plastic to alternatives and standardising packaging resulted in a potential 34% reduction in packaging weights, a 31% reduction in EPR fees and a 32% reduction in CO₂ emissions, demonstrating how relatively simple design and material changes can deliver significant environmental and financial benefits without sacrificing pack performance.

Figure 1: Case Study – Packaging optimisations savings identified through Valpak's Consulting Packaging Technology service.

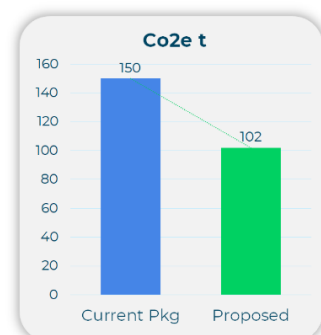
Potential Savings



Approx. **34%** of packaging weights could be saved if all re-designs were implemented



Approx. **31%** in EPR fees could be saved if all best-case proposals were implemented



Approx. **32%** of CO₂e could be saved if all best-case proposals were implemented

Packaging formats included PE bags, solid board and corrugated cartons, PVC and PET cartons, ribbons and tags.

¹Source: ISO 18602:2013, Packaging and the environment — Optimization of the packaging system, Clauses 1, 3.1 and 5; Annex A.2.

²All figures were accurate at the time the project was undertaken and are provided for reference purposes.

Recyclability

Packaging should, wherever practicable, be designed to take account of relevant collection and sorting systems and to be compatible with the requirements of applicable recycling technologies³. Certain materials and packaging formats remain difficult to recycle within existing UK infrastructure. These include multi-material laminates, paper-plastic composites, metallised films, black plastics that cannot be detected by near-infrared (NIR) sorting equipment, PVC, biodegradable and compostable plastics where no dedicated collection exists, and packaging made from multiple polymer types that cannot be easily separated. Small packaging components, such as caps, closures and labels below the minimum sorting size, are also more likely to be lost during the recycling process. Where possible, designers should select mono-material formats, use compatible labels and adhesives, avoid unnecessary material combinations, and ensure packaging components can be readily separated by consumers or recyclers.

Simpler packaging formats generally achieve higher recycling rates than complex multi-material or composite structures, as they are easier to identify, sort, and process within established recycling systems. Designing for compatibility with existing infrastructure can therefore improve material recovery, reduce contamination, and support the transition towards a more circular economy.

Recycled Content

Incorporating recycled materials supports the circular economy by reducing demand for virgin resources while helping organisations meet sustainability targets and legislative requirements. Increasing recycled content can also reduce exposure to regulatory costs, such as the UK's Plastic Packaging Tax (PPT), while supporting compliance with the recycled-content requirements of the EU Packaging and Packaging Waste Regulation (PPWR). Failure to meet the applicable recycled-content requirements may result in packaging being non-compliant with the PPWR, requiring organisations to review material choices, packaging specifications and supply chains to achieve compliance.⁴

When specifying recycled content, designers should balance environmental objectives with technical performance, product protection, food safety requirements, and the availability and quality of recycled materials. The suitability of recycled content will vary depending on the application, regulatory requirements, and the performance characteristics required throughout the product's lifecycle.

Designing for a Circular Economy

Circular packaging aims to keep materials and resources in circulation for as long as possible, prioritising reuse and recycling and, where appropriate, recovery, while minimising waste and the use of virgin resources.⁵

Key design principles include eliminating unnecessary packaging, designing for recyclability, increasing recycled content, reducing material complexity, optimising packaging weight and considering reuse where practical. In its truest form, a circular packaging system keeps materials in continuous use by collecting, sorting and reprocessing them into new packaging of equivalent quality wherever possible (known as closed-loop recycling), rather than downcycling them into lower-value products or disposing of them after a single use.

It is also important to recognise that recycling does not always create an infinite loop for every material. For example, paper and cardboard fibres gradually become shorter and weaker each time they are recycled, meaning they can typically only be reprocessed around five to seven times before they are no longer suitable for producing new paper products. To maintain material quality, recycled fibre therefore needs to be supplemented with virgin fibre from responsibly managed sources such as Forestry Stewardship Council (FSC®) or the Programme for the Endorsement of Forest Certification (PEFC™).

This highlights why circular packaging is about more than simply increasing recycling rates. Reducing unnecessary material use, designing packaging for reuse where appropriate, and ensuring materials remain suitable for high-quality recycling are all essential to keeping resources in circulation for as long as possible.



³Source: ISO 18604:2013, Packaging and the environment — Material recycling, Annex B, B.2 and B.5.

⁴Regulation (EU) 2025/40 on packaging and packaging waste (PPWR), Article 7, Minimum recycled content in plastic packaging.

⁵Based on the Ellen MacArthur Foundation, Circular Economy: Definition & Model Explained, which defines the circular economy around keeping products and materials in circulation through processes including reuse, refurbishment, remanufacturing, recycling and composting.

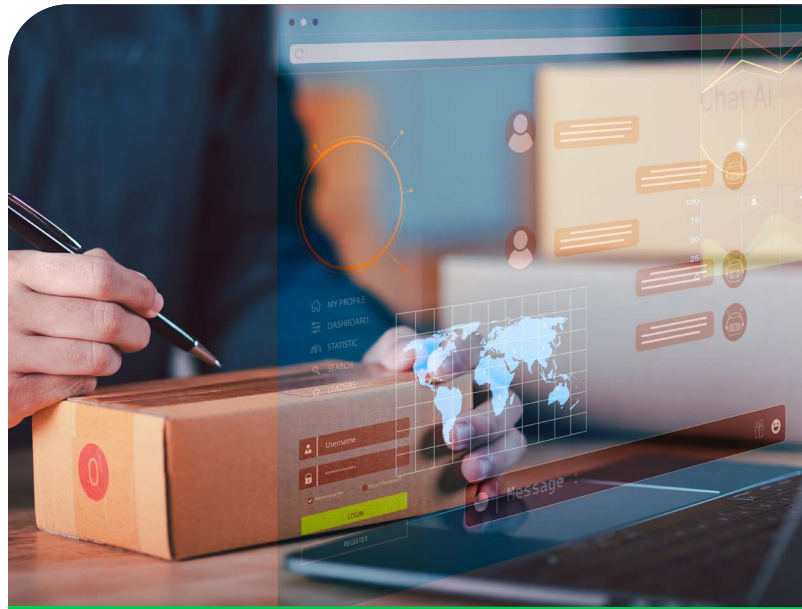
Balancing Sustainability with Commercial Performance

One of the greatest challenges in packaging design is balancing environmental performance with commercial and operational requirements. There is rarely a single solution that optimises every aspect of sustainability, cost, functionality, and consumer expectations. Instead, every packaging solution involves a series of informed trade-offs.

For example:

- **Glass** offers excellent recyclability and can be recycled repeatedly without loss of its inherent material properties. However, its relatively high density means that glass packaging can be heavier than alternative packaging formats, potentially increasing transport-related emissions and distribution costs.^{6 7}
- **Flexible plastics** typically use less material than rigid alternatives, making them lightweight and potentially reducing packaging weight and associated transport and storage impacts. However, depending on their construction, they can be more challenging to recycle, particularly where they comprise multiple layers or different materials. If flexible plastics are not effectively collected and managed at end of life, they can contribute to plastic pollution and, when released into the environment, can persist and fragment into smaller plastic particles, including microplastics.^{8 9}
- **Paper-based packaging** is often perceived positively by consumers due to its renewable origins and established recycling infrastructure. However, some applications require barrier coatings or additional treatments to achieve the necessary performance. These can reduce recyclability, increase material usage, and lead to higher purchasing costs. Compared with plastic, paper-based packaging can be heavier and bulkier for equivalent packaging functions, potentially reducing transport efficiency and increasing associated transport-related emissions. For applications requiring high moisture, grease or oxygen barriers, paper may not provide an effective solution without incorporating additional materials or coatings.

Effective packaging design considers environmental performance alongside technical requirements, product protection, regulatory compliance, consumer expectations, operational efficiency, and overall cost. Decisions should be based on the specific requirements of the application rather than a single sustainability indicator, ensuring that improvements in one area do not create unintended impacts elsewhere.



The Importance of Packaging Data

Reliable packaging data forms the foundation of effective decision-making. Without accurate data, organisations cannot establish a meaningful baseline from which to measure performance, identify opportunities for improvement or demonstrate progress over time.

Businesses should maintain accurate information relating to:

- Material composition
- Packaging weights
- Recycled content
- Recyclability
- Packaging format
- Supplier specifications
- Sales per unit

⁶National Glass Association, Recycling & Circular Economy, which states that glass is infinitely recyclable and can be recycled into new glass containers and other products.

⁷European Commission Joint Research Centre (2026), Packaging materials in the EU: quantities stay significant, which identifies glass as accounting for the majority of packaging weight due to its higher density.

⁸WRAP (2024), Creating a circular economy for flexible plastic packaging. WRAP describes flexible plastic packaging as generally resource efficient and lightweight, while highlighting the fragmented UK recycling system.

⁹European Commission, CORDIS, Improving circularity of multilayer flexible plastic food contact packaging. Supports the statement that multilayer flexible films are commonly difficult to recycle and highlights the importance of collection, sorting and recycling and also statements concerning persistence of microplastics in the environment.

Establishing this baseline enables organisations to monitor changes in packaging performance, evaluate the impact of design improvements both on a per unit and overall basis, assess and model potential changes against compliance obligations and measure progress against sustainability and regulatory objectives. It also provides the evidence needed to support informed decision-making and identify opportunities for continuous improvement.

In many cases, organisations can benefit from working with experienced packaging technologists and specialist packaging data consultancies such as Valpak that maintain extensive packaging databases and expertise across the full packaging lifecycle. Valpak maintains the largest packaging database in the UK, with over 60 million SKUs and over 10 million packaging weights. Access to large databases can help businesses to establish robust baselines and benchmark packaging performance against industry peers, to identify best-in-class solutions and to prioritise opportunities for performance.

Partnering with organisations that provide cradle-to-grave Life Cycle Assessment (LCA) services can support businesses throughout the packaging life cycle. This includes data collection and regulatory compliance, packaging optimisation, carbon footprinting, recyclability assessments, the substantiation of environmental claims, and the development of circular packaging strategies. By taking a whole-life approach, businesses can make more informed packaging decisions that reduce environmental impacts while meeting legislative and commercial requirements.

Opportunities for Packaging Optimisation

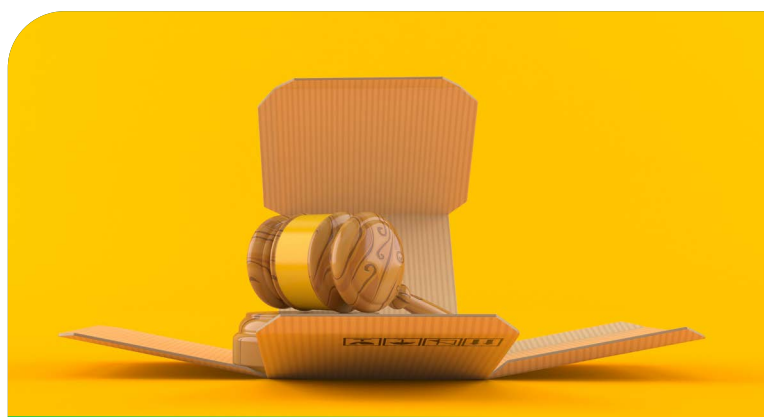
Many organisations have significant opportunities to improve the sustainability of existing packaging without undertaking major redesign programmes. Incremental changes can often deliver meaningful environmental and commercial benefits while minimising disruption to manufacturing operations and supply chains.

Common optimisation strategies include removing unnecessary packaging components, reducing material thickness where appropriate, replacing difficult-to-recycle materials with more recyclable alternatives, simplifying multi-material constructions, and increasing recycled content where technically feasible. Optimising structural design by selecting more efficient packaging formats or switching to alternative styles can also reduce the total surface area and weight of packaging

without compromising product protection. In addition, improving transport efficiency through packaging redesign and standardising packaging across product ranges can reduce material consumption, logistics costs, and operational complexity.

Beyond individual business improvements, organisations should also consider opportunities for pre-competitive collaboration across their sector. Industry initiatives such as RecyClass and the UK Packaging Pact demonstrate how organisations can work collectively to develop common approaches to packaging design, material specifications and recycling. In areas such as rigid plastics, greater alignment across the value chain can support more consistent packaging formats, improve the quality and availability of recycled materials, increase recycling rates and help create the conditions needed for more circular packaging systems.^{10 11}

While each individual improvement may appear relatively small, implementing these changes across large product portfolios and through wider industry collaboration can result in substantial reductions in material use, packaging waste, carbon emissions and overall costs.



Looking Ahead

Packaging legislation and sustainability expectations will continue to evolve over the coming decade. Businesses that embed sustainable design principles into packaging development today will be better positioned to respond to future regulatory changes, meet customer expectations and improve operational efficiency.

Packaging should no longer be viewed solely as a cost of doing business, but as a strategic asset that can create value through innovation, resource efficiency and responsible design. Organisations that invest in well designed, resource efficient packaging will not only strengthen compliance and reduce environmental impact but also enhance resilience, improve competitiveness and help accelerate the transition towards a more circular economy.

¹⁰Design for Recycling Guidelines - RecyClass

¹¹UK Packaging Pact | WRAP - The Waste and Resources Action Programme

Conclusion

The future of packaging lies in balancing functionality, commercial performance and environmental responsibility. By adopting a lifecycle approach to packaging design, organisations can reduce waste, improve recyclability, optimise material use and prepare for the transition to a more circular economy.

Investing in robust packaging design processes today will help businesses reduce costs, strengthen sustainability performance and build resilience in an evolving regulatory and commercial landscape. Ultimately, organisations that view packaging as a strategic business function, rather than simply a means of product containment, will be best placed to deliver long-term value for both their business and the environment.



How Valpak can help

Our **Benchmarking Service** and **What If Modelling Service** provide organisations with a strategic, high-level understanding of how their packaging compares with similar packaging formats placed on the market. Drawing on our extensive packaging weight database of over 60 million SKUs, these services enable businesses to benchmark packaging weights, estimate Extended Producer Responsibility (EPR) fee implications, and explore the potential financial and environmental impacts of alternative packaging scenarios before changes are implemented. This can help identify where packaging may be underperforming against market benchmarks, as well as providing assurance where existing solutions are already performing strongly.

Valpak's team of **Life Cycle Assessment (LCA) specialists** can support organisations in understanding the environmental impacts of their packaging and products, identifying opportunities for improvement. Using internationally recognised LCA methodologies, the team can assess packaging (and products) across its full life cycle, quantify environmental impacts, evaluate alternative materials and designs, and provide evidence-based recommendations that balance sustainability objectives with regulatory compliance, product protection and commercial considerations.

Together, these insights provide a strong evidence base for identifying opportunities for improvement and prioritising areas where further investigation is likely to deliver the greatest value.

For organisations seeking a more detailed evaluation, our **Packaging Technology Service** offers a comprehensive technical assessment of packaging systems and opportunities for optimisation. Through on-site packaging design reviews, material and recyclability assessments, carbon footprint calculations, real-world market benchmarking, and packaging optimisation studies, we help organisations make informed, evidence-based decisions.

By combining packaging benchmarking, environmental assessment, technical expertise and packaging development support, Valpak can provide an end-to-end approach to packaging optimisation, from initial assessment and concept development through to implementation and validation. This enables organisations to understand not only where improvements may be possible, but also whether proposed changes deliver meaningful benefits in practice.

Valpak has also partnered with ThePackHub to develop **PackReady**, combining Valpak's packaging and compliance expertise with packaging innovation knowledge to guide organisations through the packaging development process from concept through to implementation.

The outcome may be the identification of opportunities to reduce environmental impact, improve compliance, optimise costs, or enhance product protection and functionality. In some cases, the assessment may demonstrate that existing packaging is already performing strongly against relevant benchmarks. This independent, evidence-based validation gives organisations confidence in their current packaging solutions and helps ensure future investment is directed towards the areas where the greatest benefits can be achieved.

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